UNIT 8 Musculoskeletal Function

Case Study

IMPLEMENTING EVIDENCE-BASED PRACTICE IN PAIN MANAGEMENT

You are a nurse working on an orthopedic unit caring for a 76-year-old female with osteoporosis who had fallen at home and underwent a right hip replacement. She is 2 days postoperative, recovering from her surgery without complications, and you are discussing plans for her transition to a skilled rehabilitation unit. However, the patient does not want to get out of bed and participate in physical or occupational therapy because she is in pain. Despite having spoken with the pain team, she states she does not want to take any medications that may cause her to become addicted. You need to develop an evidence-based plan of care that implements pharmacologic and nonpharmacologic strategies for pain management so the patient is able to participate in her physical and occupational therapies and thus help facilitate her recovery.

QSEN Competency Focus: **Evidence-Based Practice (EBP)**

The complexities inherent in today's health care system challenge nurses to demonstrate integration of specific interdisciplinary core competencies. These competencies are aimed at ensuring the delivery of safe, quality patient care (Institute of Medicine, 2003). The Quality and Safety Education for Nurses project (Cronenwett, Sherwood, Barnsteiner, et al., 2007; QSEN, 2020) provides a framework for the knowledge, skills, and attitudes (KSAs) required for nurses to demonstrate competency in these key areas, which include ***patient-centered care***, ***interdisciplinary teamwork and collaboration***, ***evidence-based practice***, ***quality improvement***, ***safety***, and ***informatics.***

Evidence-Based Practice Definition: Integrate best current evidence with clinical expertise and patient/family preferences and values for delivery of optimal health care.

SELECT PRE-LICENSURE KSAs	APPLICATION AND REFLECTION
Knowledge	
Explain the role of evidence in determining best clinical practice	Differentiate between evidence-based guidelines in managing acute postoperative pain verses chronic osteoporosis pain. Evidence-based practice guidelines include adherence to pharmacologic and nonpharmacologic interventions to promote recovery after surgery. How does managing the patient's pain reduce postoperative complications, including risk for blood clot, pneumonia, and gastric complications?
Skills	
Locate evidence reports related to clinical practice topics and guidelines	What additional strategies might you use to educate this patient on controlling acute postoperative pain? Differentiate between the various types of pain medications, including opioid and nonopioid analgesics, that are used to decrease pain. Evidence-based pain management includes the use of pain scales. Which scale would be the best to evaluate this patient's pain?
Attitudes	
Value the need for continuous improvement in clinical practice based on new knowledge	Reflect on your attitudes toward patients who are prescribed opioid medications postoperatively for pain control. Because this patient may have chronic pain due to her osteoporosis, how can your approach regarding acute and chronic pain management reflect evidence-based practice guidelines?

Cronenwett, L., Sherwood, G., Barnsteiner, J., et al. (2007). Quality and safety education for nurses. *Nursing Outlook*, *55*(3), 122–131; Institute of Medicine. (2003). *Health professions education: A bridge to quality*. Washington, DC: National Academies Press; QSEN Institute. (2020). *QSEN Competencies: Definitions and pre-licensure KSAs: Evidence based practice*. Retrieved on 8/15/2020 at: qsen.org/competencies/pre-licensure-ksas/#evidence-based_practice

35 Assessment of Musculoskeletal Function

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Describe the basic structure and function of the musculoskeletal system.
2. Discuss the significance of the health history to the assessment of musculoskeletal health.
3. Recognize and evaluate the major manifestations of musculoskeletal dysfunction by applying concepts from the patient's health history and physical assessment findings.
4. Explain clinical indications, patient preparation, and other related nursing implications for common tests and procedures used to assess musculoskeletal function.

NURSING CONCEPTS

Assessment
Mobility

GLOSSARY

atonic: without tone; denervated muscle that atrophies

atrophy: decrease in the size of a muscle

bursa: fluid-filled sac found in connective tissue, usually in the area of joints

callus: cartilaginous/fibrous tissue at fracture site

cancellous bone: latticelike bone structure; trabecular bone

cartilage: tough, elastic, avascular tissue at ends of bone

clonus: rhythmic contractions of a muscle

contracture: abnormal shortening of muscle, joint, or both; fibrosis

cortical bone: compact bone

crepitus: grating or crackling sound or sensation; may occur with movement of ends of a broken bone or irregular joint surface

diaphysis: shaft of long bone

effusion: excess fluid in joint

endosteum: a thin, vascular membrane covering the marrow cavity of long bones and the spaces in cancellous bone

epiphysis: end of long bone

fascia: fibrous tissue that covers, supports, and separates muscles (*synonym:* epimysium)

fasciculation: involuntary twitch of muscle fibers

flaccid: limp; without muscle tone

hypertrophy: enlargement; increase in the size of a muscle

isometric contraction: muscle tension is increased without changing its length; there is no associated joint motion

isotonic contraction: muscle is shortened without a change in its tension; a joint is moved as a result

joint: area where bone ends meet; provides for motion and flexibility

joint capsule: fibrous tissue that encloses bone ends and other joint surfaces

kyphosis: increase in the convex curvature of the thoracic spine

lamellae: mature compact bone structures that form concentric rings of bone matrix; lamellar bone

ligament: ropelike bundles of collagen fibrils connecting bones

lordosis: increase in concave curvature of the lumbar spine

ossification: process in which minerals (calcium) are deposited in bone matrix

osteoblast: bone-forming cell

osteoclast: bone resorption cell

osteocyte: mature bone cell

osteogenesis: bone formation
osteon: microscopic functional bone unit
osteopenic: refers to a reduction in bone mass to below-normal levels
paresthesia: abnormal sensation (e.g., burning, tingling, numbness)
periosteum: fibrous connective tissue covering bone
remodeling: process that ensures bone maintenance through simultaneous bone resorption and formation
resorption: removal/destruction of tissue, such as bone
scoliosis: lateral curving of the spine
spastic: having greater-than-normal muscle tone
synovium: membrane in joint that secretes lubricating fluid
tendon: cord of fibrous tissue connecting muscle to bone
tone: normal tension (resistance to stretch) in resting muscle (*synonym:* tonus)
trabeculae: latticelike bone structure; cancellous bone

The musculoskeletal system is composed of the bones, joints, muscles, tendons, ligaments, and bursae of the body. The major functions of this system are to support and protect the body and foster movement of the extremities. The components of this system are highly integrated; therefore, disease in or injury to one component adversely affects the others. For instance, an infection in a joint (e.g., septic arthritis) causes degeneration of the articular surfaces of the bones within the joint and local muscle atrophy.

Musculoskeletal disorders and injuries directly affect the quality of life of individuals and are a leading cause of disability in the United States. The annual cost to treat these conditions is estimated to be over $980 billion for direct costs as well as indirect costs, such as lost wages from loss of work time (United States Bone and Joint Initiative [USBJI], 2018). Arthritis is the chief cause of musculoskeletal-related disability in the United States, with an estimated 54.4 million adults diagnosed with this disorder. Because the incidence of arthritis increases with age, the number of adults with arthritis is expected to increase to 78 million by 2040 (Centers for Disease Control and Prevention [CDC], 2019). Nurses in all practice areas may encounter patients with complaints about or impairment of the musculoskeletal system.

Anatomic and Physiologic Overview

The musculoskeletal system provides protection for vital organs, including the brain, heart, and lungs; serves as a framework to support body structures; and makes mobility possible. Muscles and tendons hold the bones together, and joints allow the body to move. They also move to produce heat that helps maintain body temperature. Movement facilitates the return of deoxygenated blood to the right side of the heart by massaging the venous vasculature. The musculoskeletal system serves as a reservoir for immature blood cells and essential minerals, including calcium, phosphorus, magnesium, and fluoride (Norris, 2019). More than 98% of total-body calcium is present in bone (National Institutes of Health [NIH], 2019a).

Structure and Function of the Skeletal System

There are 206 bones in the human body, divided into four categories classified by their shape: long, short, flat, and irregular. The long bones are found in the upper and lower extremities (e.g., the femur). Long bones are shaped like rods or shafts with rounded ends (Fig. 35-1). The shaft, known as the **diaphysis**, is primarily **cortical bone** (compact bone). The ends of the long bones, called **epiphyses**, are primarily **cancellous bone** (trabecular bone). During childhood and adolescence, there is a layer of cartilage known as the epiphyseal plate, or growth plate, that separates the epiphysis from the diaphysis. The epiphyseal plate nurtures and facilitates longitudinal growth. The epiphyseal plate is calcified in adults. The ends of long bones are covered at the joints by articular **cartilage**, which is tough, elastic, and avascular tissue (Norris, 2019).

The short bones are the irregularly shaped bones located in the ankle and hand (e.g., metacarpals). The flat bones are located where extensive protection of underlying structures is needed (e.g., the sternum or skull). Finally, because of their shape, the irregular bones cannot be categorized in any other group and include bones such as the vertebrae and bones of the jaw.

The shape and construction of a specific bone are determined by its function and the forces exerted on it. Bones are constructed of cortical or cancellous bone tissue. Cortical bone exists in areas where support is needed, and cancellous bone is found where hematopoiesis and bone formation occur. For example, long bones are designed for weight bearing and movement and tend to be composed primarily of cortical bone, whereas flat bones, which are important sites of hematopoiesis and frequently protect vital organs, are made of cancellous bone layered between compact bone. Short bones consist of cancellous bone covered by a layer of cortical bone. Irregular bones have unique shapes related to their function. Generally, irregular bone structure is similar to that of flat bones (Norris, 2019).

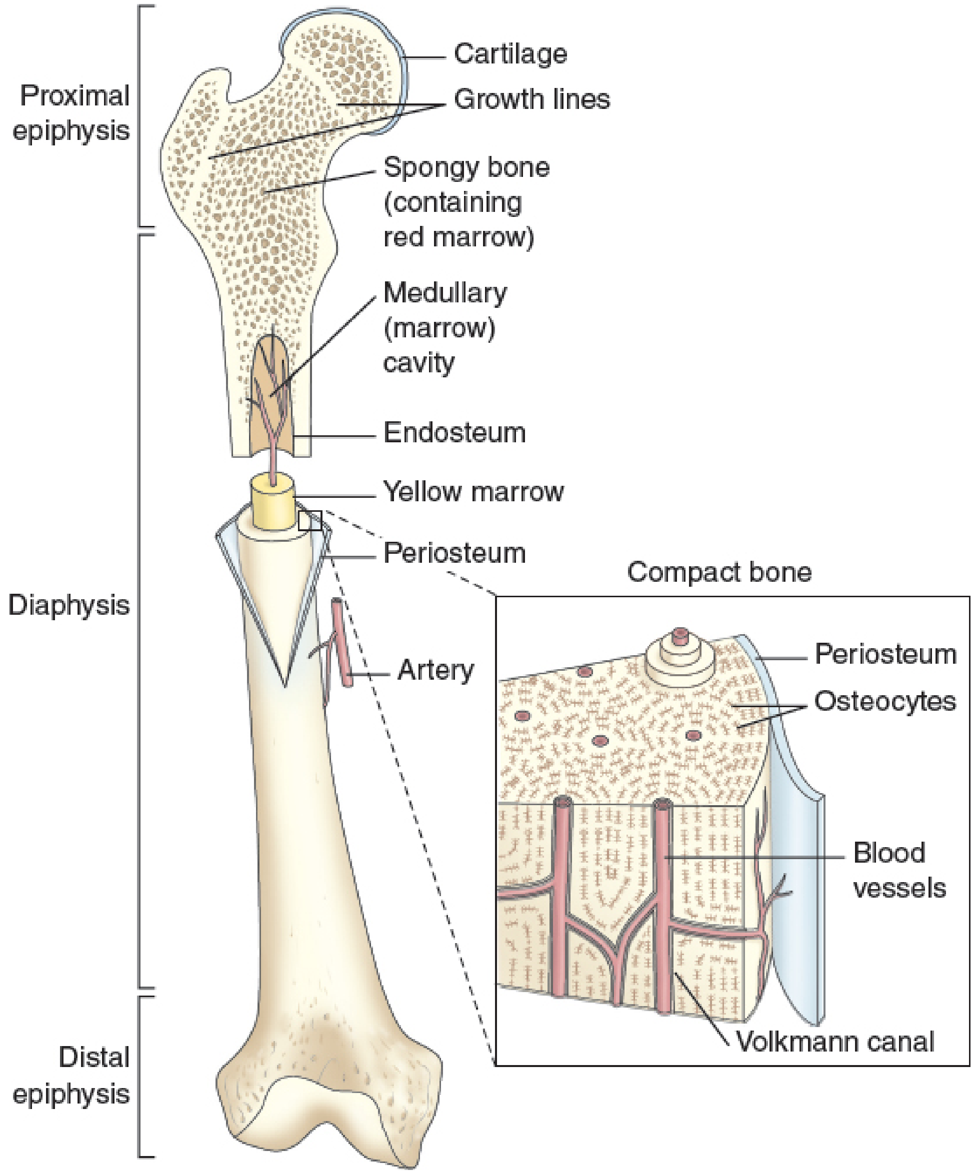


Figure 35-1 • Structure of a long bone; composition of compact bone.

Bone is composed of cells, protein matrix, and mineral deposits. The cells are of three basic types—osteoblasts, osteocytes, and osteoclasts. **Osteoblasts** function in bone formation by secreting bone matrix. The matrix consists of collagen and ground substances (glycoproteins and proteoglycans) that provide a framework in which inorganic mineral salts are deposited. These minerals are primarily composed of calcium and phosphorus. **Osteocytes** are mature bone cells involved in bone maintenance; they are located in lacunae (bone matrix units). **Osteoclasts**, located in shallow Howship's lacunae (small pits in bones), are multinuclear cells involved in dissolving and resorbing bone. The microscopic functioning unit of mature cortical bone is the **osteon**, or haversian system. The center of the osteon—the haversian canal—contains a capillary. Around the capillary are circles of mineralized bone matrix called **lamellae**. Within the lamellae are lacunae that contain osteocytes. These are nourished through tiny structures called *canaliculi* (canals), which communicate with adjacent blood vessels within the haversian system. Lacunae in cancellous bone are layered in an irregular lattice network known as **trabeculae**. Red bone marrow fills the lattice network. Capillaries nourish the osteocytes located in the lacunae (Norris, 2019).

Covering the bone is a dense, fibrous membrane known as the **periosteum**. This membranous structure nourishes bone and facilitates its growth. The periosteum contains nerves, blood vessels, and lymphatics. It also provides for the attachment of tendons and ligaments (Norris, 2019).

The **endosteum** is a thin, vascular membrane that covers the marrow cavity of long bones and the spaces in cancellous bone. Osteoclasts, which dissolve bone matrix to maintain the marrow cavity, are located near the endosteum in Howship's lacunae (Norris, 2019).

Bone marrow is a vascular tissue located in the medullary cavity (shaft) of long bones and in flat bones. Red bone marrow, located mainly in the sternum, ilium, vertebrae, and ribs in adults, is responsible for producing red blood cells, white blood cells, and platelets through a process called *hematopoiesis.* In adults, the long bone is filled with fatty, yellow marrow (Norris, 2019).

Bone tissue is well vascularized. Cancellous bone receives a rich blood supply through metaphyseal and epiphyseal vessels. Periosteal vessels carry blood to compact bone through minute Volkmann canals. In addition, nutrient arteries penetrate the periosteum and enter the medullary cavity through foramina (small openings). Arteries supply blood to the marrow and bone. The venous system may accompany arteries or may exit independently (Norris, 2019).

Bone Formation

Osteogenesis (bone formation) begins before birth. **Ossification** is the process by which the bone matrix is formed and hard mineral crystals composed of calcium and phosphorus (e.g., hydroxyapatite) are bound to the collagen fibers. These mineral components give bone its characteristic strength, whereas the proteinaceous collagen gives bone its resilience (Norris, 2019).

Bone Maintenance

Bone is a dynamic tissue in a constant state of turnover. Throughout the lifespan, a process known as bone **remodeling** occurs, in which old bone is removed and new bone is added to the skeleton (formation). During childhood and the teenage years, new bone is added faster than old bone is removed; therefore, bones become larger, heavier, and denser. This continues until peak bone mass is reached, typically by age 20 years. Remodeling maintains bone structure and function through simultaneous resorption and osteogenesis, and as a result, complete skeletal turnover occurs every 10 years (Norris, 2019).

The balance between bone **resorption** (removal or destruction) and formation is influenced by the following factors: physical activity; dietary intake of certain nutrients, especially calcium; and several hormones, including calcitriol (i.e., activated vitamin D), parathyroid hormone (PTH), calcitonin, thyroid hormone, cortisol, growth hormone, and the sex hormones estrogen and testosterone (Norris, 2019).

Physical activity, particularly weight-bearing activity, acts to stimulate bone formation and remodeling. Bones subjected to continued weight bearing tend to be thick and strong. Conversely, people who are unable to engage in regular weight-bearing activities, such as those on prolonged bed rest or those with some physical disabilities, have increased bone resorption from calcium loss, and their bones become **osteopenic** (reduced in terms of mass) and weak. These weakened bones may fracture easily (Meiner & Yeager, 2019).

Good dietary habits are integral to bone health. Daily intake of approximately 1000 to 1200 mg of calcium is essential to maintaining adult bone mass. Quality sources of calcium include low-fat milk, yogurt, and cheese. Foods with added calcium such as orange juice, cereals, and bread are also beneficial (NIH, 2019a). Vitamin D also plays a major role in calcium absorption and bone health. Young adults need a daily vitamin D intake of 600 IU, whereas adults 50 years and older require a daily intake of 800 to 1000 IU to ensure good bone health (NIH, 2019b). Dietary sources of vitamin D include vitamin D–fortified milk and cereals, egg yolks, saltwater fish, and liver.

Several hormones are vital in ensuring that calcium is properly absorbed and available for bone mineralization and matrix formation. Calcitriol functions to increase the amount of calcium in the blood by promoting absorption of calcium from the gastrointestinal tract. It also facilitates mineralization of osteoid tissue. A deficiency of vitamin D results in bone mineralization deficit, deformity, and fracture (Norris, 2019).

PTH and calcitonin are the major hormonal regulators of calcium homeostasis. PTH regulates the concentration of calcium in the blood, in part by promoting movement of calcium from the bone. In response to low calcium levels in the blood, increased levels of PTH prompt the mobilization of calcium, the demineralization of bone, and the formation of bone cysts. Calcitonin, secreted by the thyroid gland in response to elevated blood calcium levels, inhibits bone resorption and increases the deposit of calcium in bone (Norris, 2019).

Both thyroid hormone and cortisol have multiple systemic effects with specific effects on bones. Excessive thyroid hormone production in adults (e.g., Graves’ disease) can result in increased bone resorption and decreased bone formation. Increased levels of cortisol have these same effects. Patients receiving long-term synthetic cortisol or corticosteroids (e.g., prednisone) are at increased risk for steroid-induced osteopenia and fractures.

Growth hormone has direct and indirect effects on skeletal growth and remodeling. It stimulates the liver and, to a lesser degree, the bones to produce insulinlike growth factor 1 (IGF-I), which accelerates bone modeling in children and adolescents. Growth hormone also directly stimulates skeletal growth in children and adolescents. It is believed that the low levels of both growth hormone and IGF-I that occur with aging may be partly responsible for decreased bone formation and resultant osteopenia (Norris, 2019).

The sex hormones testosterone and estrogen have important effects on bone remodeling. Estrogen stimulates osteoblasts and inhibits osteoclasts; therefore, bone formation is enhanced and resorption is inhibited. Testosterone has both direct and indirect effects on bone growth and formation. It directly causes skeletal growth in adolescence and has continued effects on skeletal muscle growth throughout the lifespan. Increased muscle mass results in greater weight-bearing stress on bones, resulting in increased bone formation. In addition, testosterone converts to estrogen in adipose tissue, providing an additional source of bone-preserving estrogen for aging men (Kennedy-Malone, Martin-Plank, & Duffy, 2019).

During the process of bone remodeling, osteoblasts produce a receptor for activated nuclear factor-kappa B ligand (RANKL) that binds to the receptor for activated nuclear factor-kappa B (RANK) present on the cell membranes of osteoclast precursors, causing them to differentiate and mature into osteoclasts, which causes bone resorption. Conversely, osteoblasts may produce osteoprotegerin (OPG), which blocks the effects of RANKL, thereby turning off the process of bone resorption. T cells that may become activated as a result of the inflammatory process may also produce RANKL, overriding the effects of OPG and causing continued bone resorption during times of stress and injury, which can lead to loss of bone matrix and fractures (Takeno, Kanazawa, Notsu, et al., 2018).

Blood supply to the bone also affects bone formation. With diminished blood supply or hyperemia (congestion), osteogenesis, and bone density decrease. Bone necrosis occurs when the bone is deprived of blood (Norris, 2019).

Bone Healing

Most fractures heal through a combination of intramembranous and endochondral ossification processes. When a bone is fractured, the bone begins a healing process to reestablish continuity and strength. The bone fragments are not patched together with scar tissue; instead, the bone regenerates itself.

Fracture healing occurs in the bone marrow, where endothelial cells rapidly differentiate into osteoblasts; in the bone cortex, where new osteons are formed; in the periosteum, where a hard **callus** (fibrous tissue) is formed through intramembranous ossification peripheral to the fracture, and where cartilage is formed through endochondral ossification adjacent to the fracture site; and in adjacent soft tissue, where a bridging callus forms that provides stability to the fractured bones (Norris, 2019).

When a fracture occurs, the body's response is similar to that after injury elsewhere in the body. The repair of a simple fracture occurs in essentially four stages. These include the following (Norris, 2019):

Stage I: Hematoma formation occurs during the first 1 to 2 days of the fracture. Bleeding into the injured tissue and local vasoconstriction occur, and a hematoma forms at the site of the fracture. Cytokines are released, initiating the fracture healing processes by causing replicating cells known as fibroblasts to proliferate, which in turn causes angiogenesis to occur (i.e., the growth of new blood vessels). Granulation tissue begins to form within the clot and becomes dense. At the same time, degranulated platelets and inflammatory cells release growth factor, which stimulates the generation of osteoclasts and osteoblasts.

Stage II: Inflammatory phase occurs with the formation of granulation tissue. Fibroblasts and osteoblasts migrate into the fractured site and begin the reconstruction of bone. The fibroblasts produce a fibrocartilaginous soft callus bridge that connects the bone fragments. Although tissue repair may reach maximum girth by the end of the second or third week, it is still not strong enough for weight bearing.

Stage III: Reparative phase usually begins during the third or fourth week of fracture healing and continues until a firm bony union is formed. During this stage, mature bone gradually replaces the fibrocartilaginous callus and the excess callus is gradually reabsorbed by the osteoclasts. During this stage, the fracture site feels immovable and appears aligned on x-ray. At this time, it is usually safe to remove a cast, if one is present.

Stage IV: Remodeling occurs as necrotic bone is removed by the osteoclasts. Compact bone replaces spongy bone around the periphery of the fracture. Although the final structure of the remodeled bone resembles the original unbroken bone, a thickened area on the surface of the bone may remain after healing. Remodeling may take months to years, depending on the extent of bone modification needed, the function of the bone, and the functional stresses on the bone.

Serial x-rays are used to monitor the progress of bone healing. The type of bone fractured, the adequacy of blood supply, the condition of the fracture fragments, the immobility of the fracture site, and the age and general health of the person influence the rate of fracture healing. Adequate immobilization is essential until there is x-ray evidence of bone formation with ossification (Norris, 2019).

When fractures are treated with internal or external fixation techniques, the bony fragments can be placed in direct contact. Primary bone healing occurs through cortical bone (haversian) remodeling. Little or no cartilaginous callus develops. Immature bone develops from the endosteum. There is an intensive regeneration of new osteons, which develop in the fracture line by a process similar to normal bone maintenance. Fracture strength is obtained when the new osteons have become established (Norris, 2019).

Structure and Function of the Articular System

The junction of two or more bones is called a **joint,** or articulation. There are three basic kinds of joints: synarthrosis, amphiarthrosis, and diarthrosis joints. Synarthrosis joints, also referred to as fibrous joints, are immovable because of fibrous tissue banding (e.g., the skull sutures). Amphiarthrosis joints, also referred to as cartilaginous joints, allow limited motion (e.g., the vertebral joints and the symphysis pubis). Diarthrosis joints, also referred to as synovial joints, are freely movable joints (Fig. 35-2).

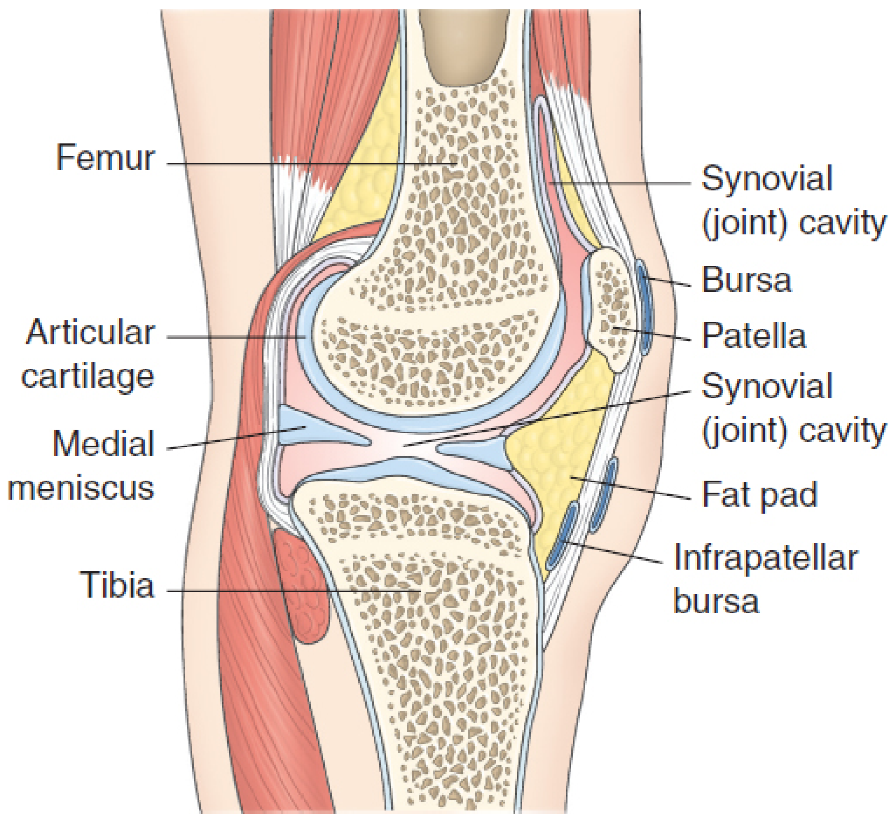


Figure 35-2 • Hinge joint of the knee.

There are several types of diarthrosis joints:

- *Ball-and-socket joints* (e.g., the hip and the shoulder) permit full freedom of movement.
- *Hinge joints* permit bending in only one direction, either flexion or extension (e.g., the elbow and the knee).
- *Saddle joints* allow movement in two planes at right angles to each other. The joint at the base of the thumb is a saddle, biaxial joint.
- *Pivot joints* allow one bone to move around a central axis without displacement. An example of a pivot joint is the articulation between the radius and the ulna. They permit rotation for such activities as turning a doorknob.
- *Gliding joints* allow for limited movement in all directions and are represented by the joints of the carpal bones in the wrist.

The ends of the articulating bones of a typical movable joint are covered with smooth hyaline cartilage. A tough, fibrous sheath called the **joint capsule** surrounds the articulating bones. The capsule is lined with a membrane, the **synovium**, which secretes the lubricating and shock-absorbing synovial fluid into the joint capsule. Therefore, the bone surfaces are not in direct contact. In some synovial joints (e.g., the knee), fibrocartilage discs (e.g., medial meniscus) are located between the articular cartilage surfaces. These discs provide shock absorption (Bickley, 2017).

Ligaments (ropelike bundles of collagen fibrils) bind the articulating bones together. **Tendons** are cords of fibrous tissue that connect muscle to bone. Ligaments and tendons, which pass over the joint, provide joint stability. In some joints, interosseous ligaments (e.g., the cruciate ligaments of the knee) are found within the capsule and add anterior and posterior stability to the joint. Ligaments are pliable enough to allow movement of the joints; however, they can tear rather than stretch if they are subjected to excess stress (Norris, 2019).

A **bursa** is a sac filled with synovial fluid that cushions the movement of tendons, ligaments, and bones over bones or other joint structures. Bursae can be found in the joints of the elbow, shoulder, hip, and knee. They may become inflamed, causing discomfort, swelling, and limited movement in that area.

Structure and Function of the Skeletal Muscle System

Muscles are attached by tendons to bones, connective tissue, other muscles, soft tissue, or skin. The muscles of the body are composed of parallel groups of muscle cells (fasciculi) encased in fibrous tissue called **fascia** (epimysium). The more fasciculi contained in a muscle, the more precise the movements. Muscles vary in shape and size according to the activities for which they are responsible. Skeletal (striated) muscles are involved in body movement, posture, and heat-production functions. Muscles contract to bring the two points of attachment closer together, resulting in movement (Norris, 2019).

Skeletal Muscle Contraction

Each muscle cell (also referred to as a muscle fiber) contains myofibrils, which in turn are composed of a series of sarcomeres—the actual contractile units of skeletal muscle. Sarcomeres contain thick myosin and thin actin filaments.

Muscle cells contract in response to electrical stimulation delivered by an effector nerve cell at the motor end-plate. When stimulated, the muscle cell depolarizes and generates an action potential in a manner similar to that described for nerve cells. These action potentials propagate along the muscle cell membrane and lead to the release of calcium ions that are stored in a specialized organelle called *sarcoplasmic reticulum.* When there is a local increase in calcium ion concentration, the myosin and actin filaments slide across one another. Shortly after the muscle cell membrane is depolarized, it recovers its resting membrane voltage. Calcium is rapidly removed from the sarcomeres by active reaccumulation in the sarcoplasmic reticulum. When the calcium concentration in the sarcomere decreases, the myosin and actin filaments cease to interact, and the sarcomere returns to its original resting length (relaxation). Actin and myosin do not interact in the absence of calcium (Norris, 2019).

The contraction of muscle fibers can result in either isotonic or isometric contraction of the muscle. In **isometric contraction**, the length of the muscles remains constant but the force generated by the muscles is increased; an example of this is pushing against an immovable wall. **Isotonic contraction** is characterized by the shortening of the muscle without an increase in tension within the muscle; an example of this is flexing the forearm. In normal activities, many muscle movements are a combination of isometric and isotonic contraction. For example, during walking, isotonic contraction results in shortening of the leg, and isometric contraction causes the stiff leg to push against the floor.

Energy is consumed during muscle contraction and relaxation. The main source of energy for the muscle cells is adenosine triphosphate (ATP), which is generated through cellular oxidative metabolism. At low levels of activity (i.e., sedentary activity), the skeletal muscle synthesizes ATP from the oxidation of glucose to water and carbon dioxide. During periods of strenuous activity, when sufficient oxygen may not be available, glucose is metabolized primarily to lactic acid, an inefficient process compared with that of oxidative pathways. Stored muscle glycogen is used to supply glucose during periods of activity. Muscle fatigue is thought to be caused by depletion of glycogen and accumulation of lactic acid. As a result, the cycle of muscle contraction and relaxation cannot continue (Norris, 2019).

During muscle contraction, the energy released from ATP is not completely used. The excess energy is dissipated in the form of heat. During isometric contraction, almost all of the energy is released in the form of heat; during isotonic contraction, some of the energy is expended in mechanical work. In some situations (i.e., shivering), the need to generate heat is the main stimulus for muscle contraction.

The speed of the muscle contraction is variable. Myoglobulin is a hemoglobinlike protein pigment present in striated muscle cells that transports oxygen. Muscles containing large quantities of myoglobulin (red muscles) have been observed to contract slowly and powerfully (e.g., respiratory and postural muscles). Muscles containing little myoglobulin (white muscles) contract quickly (e.g., extraocular eye muscles). Most muscles contain both red and white muscle fibers (Norris, 2019).

Muscle Tone

Muscle **tone** (tonus) is produced by the maintenance of some of the muscle fibers in a contracted state. Muscle spindles, which are sense organs in the muscles, monitor muscle tone. Muscle tone is minimal during sleep and is increased when the person is anxious. A muscle that is limp and without tone is described as **flaccid**; a muscle with greater-than-normal tone is described as **spastic**. Typically, upper motor neuron lesions produce increased tone, whereas lower motor neuron lesions produce decreased tone. For example, in conditions characterized by upper motor neuron destruction (e.g., cerebral palsy), muscle becomes hypertonic and reflexes become hyperactive. In contrast, conditions characterized by lower motor neuron destruction (e.g., muscular dystrophy), denervated muscle becomes **atonic** (soft and flabby) and atrophies (Norris, 2019). See Chapter 60, Table 60-4, for a comparison of upper and lower motor function.

Muscle Actions

Muscle contraction produces movement. The body is able to perform a wide variety of movements as a result of the coordination of muscle groups (Fig. 35-3). The prime mover is the muscle that causes a particular motion. The muscles assisting the prime mover are known as synergists. The muscles causing movement opposite to that of the prime mover are known as antagonists. An antagonist must relax to allow the prime mover to contract, producing motion. For example, when contraction of the biceps causes flexion of the elbow joint, the biceps are the prime movers and the triceps are the antagonists. A person with muscle paralysis (i.e., loss of movement) may be able to retrain functioning muscles within the synergistic group to produce the needed movement. Muscles of the synergistic group then become the prime movers (Norris, 2019).

Exercise, Disuse, and Repair

Muscles need exercise to maintain function and strength. When a muscle repeatedly develops maximum or close to maximum tension over a long time, as in regular exercise with weights, the cross-sectional area of the muscle increases. This enlargement, known as **hypertrophy**, results from an increase in the size of individual muscle fibers without an increase in their number. Hypertrophy persists only if the exercise is continued. The opposite phenomenon occurs with disuse of muscle over a long period of time. Age and disuse cause loss of muscular function as fibrotic tissue replaces the contractile muscle tissue. The decrease in the size of a muscle is called **atrophy**. Bed rest and immobility cause loss of muscle mass and strength. When immobility is the result of a treatment modality (e.g., casting, traction, or bed rest), the patient can decrease the effects of immobility by isometric exercise of the muscles of the immobilized part. Quadriceps contraction exercises (tightening the muscles of the thigh) and gluteal setting exercises (tightening of the muscles of the buttocks) help maintain the larger muscle groups that are important in ambulation. Active and weight-resistance exercises of uninjured parts of the body maintain muscle strength. When muscles are injured, they need rest and immobilization until tissue repair occurs. The healed muscle then needs progressive exercise to resume its pre-injury strength and functional ability.

Gerontologic Considerations

Multiple changes in the musculoskeletal system occur with aging (Table 35-1) and bring complaints of pain and joint limitations. There is a loss of height due to osteoporosis (abnormal excessive bone loss), kyphosis (forward curvature of the thoracic spine), thinned intervertebral discs, compressed vertebral bodies, and flexion of the knees and hips. Numerous metabolic changes, including menopausal withdrawal of estrogen and decreased activity, contribute to osteoporosis (National Osteoporosis Foundation [NOF], 2019). Women lose more bone mass than men. In addition, bones change in shape and have reduced strength. Fractures are common. Collagen structures are less able to absorb energy. Increased inactivity, diminished neuron stimulation, and nutritional deficiencies contribute to the loss of muscle strength. In addition, remote musculoskeletal problems for which the patient has compensated may become new problems with age-related changes. For example, people who have had polio and who have been able to function normally by using synergistic muscle groups may discover increasing incapacity because of a reduced compensatory ability. Older adults may suffer from chronic musculoskeletal disorders that limit mobility and interfere with their ability to perform self-care. This may lead older adults to depend on others for completion of their activities of daily living (ADLs); in turn, they may grieve over the loss of independence. In particular, musculoskeletal disorders of the hand and wrist are prevalent among older adults; and, the incidence of these disorders increases with increasing age (Leow, Teo, Low, et al., 2019) (see Nursing Research Profile: Hand Assessment of Older Adults in Chart 35-1). Despite a multitude of age-related musculoskeletal changes, the many effects of aging can be slowed if the body is kept healthy and active through positive lifestyle behaviors (Eliopoulos, 2018).

Assessment

The nursing assessment of the patient with musculoskeletal dysfunction includes a health history and physical examination that evaluate the effects of the musculoskeletal disorder on the patient.

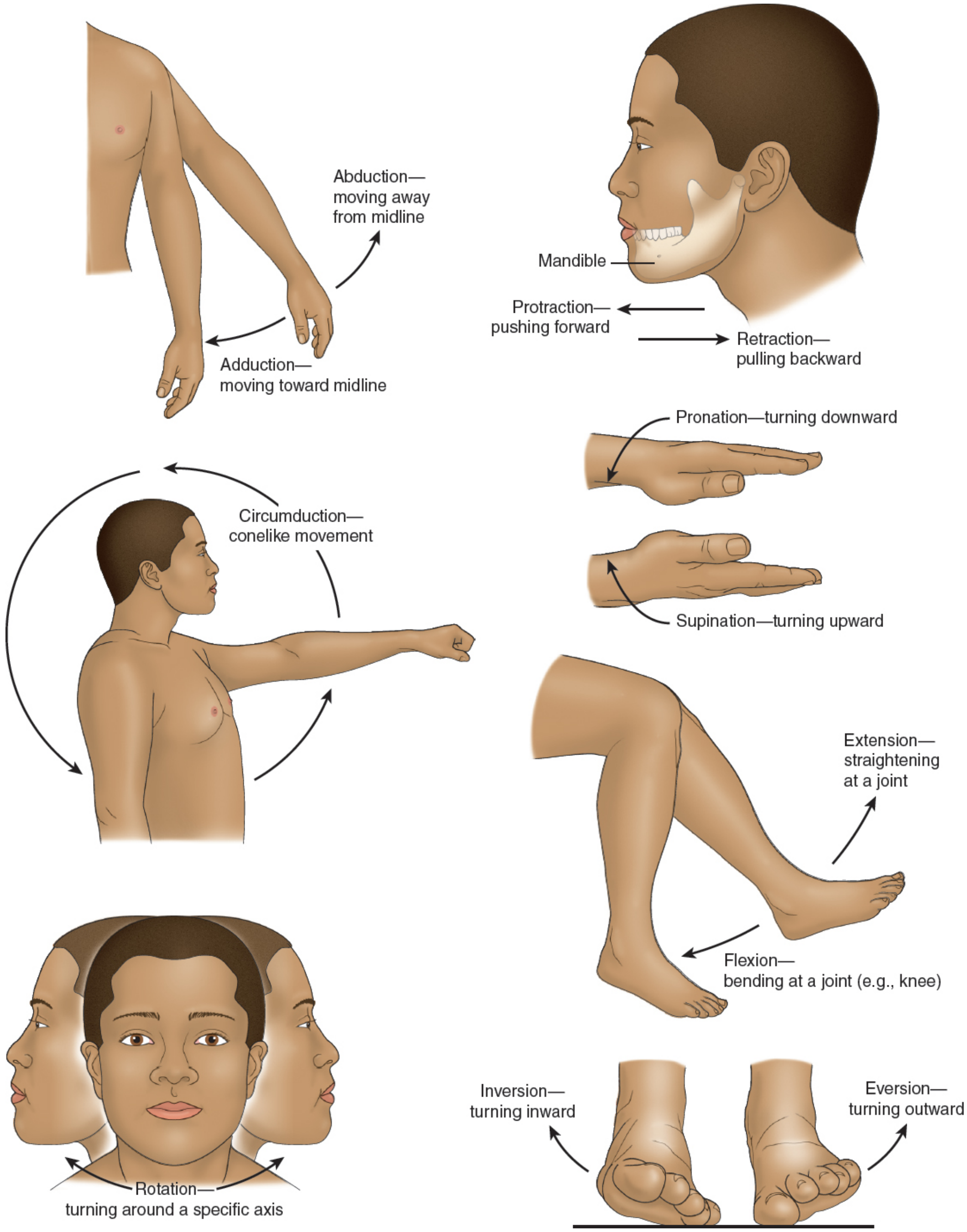


Figure 35-3 • Body movements produced by muscle contraction.

TABLE 35-1 Age-Related Changes of the Musculoskeletal System

Musculoskeletal System	Structural Changes	Functional Changes	History and Physical Findings
Bones	Gradual, progressive loss of bone mass after 30 y of age Vertebral collapse	Bones fragile and prone to fracture—vertebrae, hip, wrist	Loss of height Postural changes Kyphosis Loss of flexibility Flexion of hips and knees Back pain Osteoporosis Fracture
Muscles	Increase in collagen and resultant fibrosis Muscles atrophy (diminish in size); wasting Tendons less elastic	Loss of strength and flexibility Weakness Fatigue Stumbling Falls	Loss of strength Diminished agility Decreased endurance Prolonged response time (diminished reaction time) Diminished tone Broad base of support History of falls
Joints	Cartilage—progressive deterioration Thinning of intervertebral discs	Stiffness, reduced flexibility, and pain interfere with activities of daily living	Diminished range of motion Stiffness Loss of height
Ligaments	Lax ligaments (less-than-normal strength; weakness)	Postural joint abnormality Weakness	Joint pain on motion; resolves with rest Crepitus Joint swelling/enlargement Osteoarthritis (degenerative joint disease)

Chart 35-1 **NURSING RESEARCH PROFILE**

Hand Assessment of Older Adults

Leow, M. Q., Teo, W., Low, T. L., et al. (2019). Hand assessment for elderly people in the community. *Orthopaedic Nursing*, *38*(1), 25–30.

Purpose

Hand and wrist disorders are common, particularly among older adults. These disorders typically include osteoarthritis, trigger finger, and carpal tunnel syndrome. These conditions can cause significant pain, stiffness, numbness, and decreased range of motion in the affected extremity. Early treatment may mitigate the detrimental effects of these disorders; yet, treatment is uncommon until later, when there is a disruption in the patient's activities of daily living (ADLs). The purpose of this study was to evaluate the prevalence of these hand disorders among older adults in a community setting.

Design

This descriptive study solicited participation from older adults who frequented a neighborhood day center in Singapore. All eligible participants were independent in completing their ADLs. Demographic information, a brief health history, hand and wrist assessments, and grip and pinch strength were obtained from all participants. Questionnaires completed by participants included the 11-item QuickDASH questionnaire, a psychometrically validated tool for assessing functional ability of the upper extremities, and a numeric pain intensity scale score that assessed hand and wrist pain. Assessments were conducted specifically for participants who were experiencing symptoms associated with osteoarthritis, trigger finger, and carpal tunnel syndrome. Fifty-five older adults participated in this study.

Findings

Participants (N = 55) ranged in age from 60 to 90 years with a mean age of 74 years. The majority of participants were female (n = 41). Nearly one third of participants presented with a hand condition (n = 17); 11 had osteoarthritis, one had trigger finger, three had carpal tunnel syndrome, and two had both trigger finger and carpal tunnel. Hand disorders were more prevalent in female participants than in males (39% in females, 7% in males). Of those with hand disorders, 34.5% reported difficulty in doing household chores, 21.8% had difficulty opening jars, and 21.8% reported difficulty participating in recreational activities that required arm, shoulder, or hand strength. This study found that participants who had an abnormal hand assessment finding did not seek medical attention until these conditions impacted their ADLs.

Nursing Implications

Findings from this study suggest that hand and wrist disorders are indeed commonplace among community-dwelling older adults; yet most study participants had not previously sought medical treatment for their disorders. Nurses may develop screening programs for hand and wrist disorders in older adults with the tools used in this study. Screening older adults for early-stage hand and wrist disorders can lead to timely and effective treatment that can preserve function and assist the older adult to maintain independence in ADLs.

Health History

An important aspect of a musculoskeletal assessment is the history of the present illness. Musculoskeletal disorders may be stable or progressive, characterized by symptom-free periods as well as fluctuations in symptoms. The health history therefore includes details about the onset, character, severity, location, duration, and frequency of symptoms and signs; associated complaints; precipitating, aggravating, and relieving factors; progression, remission, and exacerbation; and the presence or absence of similar symptoms among family members.

Common Symptoms

During the interview and physical assessment, the patient with a musculoskeletal disorder may report pain, tenderness, and altered sensations (Weber & Kelley, 2018).

Pain

Most patients with diseases and traumatic conditions or disorders of the muscles, bones, and joints experience pain. Bone pain is typically described as a dull, deep ache that is “boring” in nature. This pain is not typically related to movement and may interfere with sleep. Muscular pain is described as soreness or aching and is referred to as “muscle cramps.” Fracture pain is sharp and piercing and is relieved by immobilization. Sharp pain may also result from bone infection with muscle spasm or pressure on a sensory nerve. Joint pain is felt around or in the joint and typically worsens with movement (Kennedy-Malone et al., 2019).

Rest relieves most musculoskeletal pain. Pain that increases with activity may indicate joint sprain, muscle strain, or compartment syndrome, whereas steadily increasing pain points to the progression of an infectious process (osteomyelitis), a malignant tumor, or neurovascular complications. Radiating pain occurs in conditions in which pressure is exerted on a nerve root (Kennedy-Malone et al., 2019).

The time of day that the pain occurs may be important to evaluate. Those experiencing pain with an inflammatory rheumatic disorder experience pain that is worse in the morning, especially upon waking. Tendonitis worsens during the early morning and eases by midday, whereas osteoarthritis worsens as the day progresses (Kennedy-Malone et al., 2019). Pain is variable, and its assessment and nursing management must be individualized.

The nurse assesses the patient's pain as described in Chapter 9. Specific assessments that the nurse should make regarding the pain include the following:

- Is the body in proper alignment?
- Are the joints symmetrical or are bony deformities present?
- Is there any inflammation or arthritis, swelling, warmth, tenderness, or redness?
- Is there pressure from traction, bed linens, a cast, or other appliances?
- Is there tension on the skin at a pin site?

The patient's pain and discomfort must be managed successfully. Not only is pain exhausting, but also, if prolonged, it can force the patient to become increasingly withdrawn and dependent on others as the musculoskeletal disorder continues.

Altered Sensations

Sensory disturbances are frequently associated with musculoskeletal problems. The patient may describe **paresthesias,** which are sensations of burning, tingling, or numbness. These sensations may be caused by pressure on nerves or by circulatory impairment. Soft tissue swelling or direct trauma to these structures can impair their function. The nurse assesses the neurovascular status of the involved musculoskeletal area.

Questions that the nurse should ask regarding altered sensations include the following:

- Is the patient experiencing abnormal sensations, such as burning, tingling, or numbness?
- If the abnormal sensation involves an extremity, how does this feeling compare to sensation in the unaffected extremity?
- When did the condition begin? Is it getting worse?
- Does the patient also have pain? (If the patient has pain, then the questions and assessments for pain discussed previously should be followed.)

Past Health, Social, and Family History

When assessing the musculoskeletal system, the nurse should gather pertinent data to include in the patient's health history, such as occupation (e.g., does the patient's work require physical activity or heavy lifting?), exercise patterns, alcohol consumption, tobacco use, and dietary intake (e.g., calcium, vitamin D). Concurrent health conditions (e.g., diabetes, heart disease, chronic obstructive pulmonary disease, infection, preexisting disability) and related problems (e.g., familial or genetic abnormalities; see Chart 35-2) need to be considered when developing and implementing the plan of care. Any previous history of trauma or injury to the musculoskeletal system or a history of falls should be included as well (Weber & Kelley, 2018).

The Fracture Risk Assessment Tool (FRAX®)

The Fracture Risk Assessment Tool (FRAX®) was developed in 2008 by a task force convened by the World Health Organization (WHO). It is a tool that predicts a patient's 10-year risk of fracturing a hip or other major bone, which includes the spine, forearm, or shoulder (NOF, 2019). The tool may be accessed online, where it automatically calculates a patient's odds of fracture. Data entered are validated risks for fracture, and include:

- age (risk increases with increasing age)
- gender (risk is higher in females)
- body mass index (risk is higher with lower body mass indices)
- history of a previous fracture
- parental history of hip fracture
- current cigarette smoker
- current use of a corticosteroid (e.g., prednisone)
- history of rheumatoid arthritis
- alcohol intake of 3 or more drinks per day
- history of secondary causes/risks for osteoporosis, which include any of the following:
  - type 1 diabetes
  - osteogenesis imperfecta
  - untreated long-standing hyperthyroidism
  - hypogonadism or premature menopause
  - chronic malnutrition or malabsorption syndromes
  - chronic liver disease

Chart 35-2 GENETICS IN NURSING PRACTICE

Musculoskeletal Disorders

Genetic musculoskeletal disorders vary in presentation and can tend to present at different points in time across the lifespan. Consideration must be given to other genetic disorders that will impact the musculoskeletal system. Some examples of inherited genetic musculoskeletal disorders include:
Autosomal Dominant:

- Achondroplasia
- Nail–Patella syndrome
- Osteogenesis imperfecta
- Polydactyly
- van der Woude syndrome

Autosomal Recessive:

- Tay-Sachs

Forms of Muscular Dystrophy:

- Becker muscular dystrophy
- Congenital muscular dystrophy
- Distal muscular dystrophy
- Duchenne muscular dystrophy (X-linked)
- Emery–Dreifuss muscular dystrophy (X-linked)
- Facioscapulohumeral muscular dystrophy (autosomal dominant)
- Limb–girdle muscular dystrophy (autosomal dominant and autosomal recessive forms)

Other genetic disorders that impact the musculoskeletal system:

- Amyotrophic lateral sclerosis (neurologic disorder)
- Ehlers–Danlos syndrome (connective tissue disorder)
- Marfan syndrome (connective tissue disorder)
- Spina bifida (neurologic disorder)
- Stickler syndrome (connective tissue disorder)

Nursing Assessments

See Chapter 4, Chart 4-2 for Genetics in Nursing Practice: Genetic Aspects of Health Assessment.

Family History Assessment Related to Genetic Musculoskeletal Disorders

- Assess for other similarly affected family members in the past three generations.
- Assess for the presence of other related genetic conditions (e.g., hematologic, cardiac, integumentary conditions).
- Determine the age at onset (e.g., fractures present at birth such as osteogenesis imperfecta, hip dislocation present at birth in DDH, or

early-onset osteoporosis).

Patient Assessment Specific to Genetic Musculoskeletal Disorders

- Assess stature for general screening purposes (unusually short stature may be related to achondroplasia; unusually tall stature may be related to Marfan syndrome).
- Assess for disease-specific skeletal findings (e.g., pectus excavatum, scoliosis, long fingers [Marfan syndrome], osteoarthritis of the hip or waddling gait).
- Assessment findings that could indicate a genetic musculoskeletal disorder include:
  - Bone pain
  - Enlarged hands or feet
  - Excessive height, short stature, or decrease in height
  - Flat feet or highly arched feet
  - Frequency of bone-related injuries or unexplained fractures
  - Hypermobility of joints
  - Large or small head circumference
  - Protruding jaw or forehead
  - Unexplained changes in muscle tone (hypotonia)

Genetic Resources

The National Osteoporosis Foundation, www.nof.org

NIH Osteoporosis and Related Bone Diseases National Resource Center, www.niams.nih.gov/Health_Info/Bone

See Chapter 6, Chart 6-7 for components of genetic counseling.

DDH, developmental dysplasia of the hip(s)

An additional validated risk factor that may be entered into the FRAX® is the patient's bone mineral density (BMD), based on bone densitometry results, if those results are hip based (see later discussion). However, while entering BMD results in the FRAX® provides a more accurate fracture risk calculation, it is not necessary (Bickley, 2017). Thus, the FRAX® provides a good estimate of fracture risk in patients who may not have submitted to BMD testing. Patients who should be assessed for hip or major bone fracture risk include men and postmenopausal women over the age of 50, patients with known low BMD, and patients with known secondary causes/risks for osteoporosis. See Chapter 36 for further discussion of osteoporosis.

Physical Assessment

An examination of the musculoskeletal system ranges from a basic assessment of functional capabilities to sophisticated physical examination maneuvers that facilitate diagnosis of specific bone, muscle, and joint disorders. The extent of assessment depends on the patient's physical complaints, health history, and physical clues that warrant further exploration. The nursing assessment is primarily a functional evaluation, focusing on the patient's ability to perform ADLs.

Techniques of inspection and palpation are used to evaluate the patient's posture, gait, bone integrity, joint function, and muscle strength and size. In addition, assessing the skin and neurovascular status is an important part of a complete musculoskeletal assessment. The nurse should also understand and be able to perform correct assessment techniques on patients with musculoskeletal trauma. When specific symptoms or physical findings of musculoskeletal dysfunction are apparent, the nurse carefully documents the examination findings and shares the information with the primary provider, who may decide that a more extensive examination and a diagnostic evaluation are necessary.

Posture

The normal curvature of the spine is convex through the thoracic portion and concave through the cervical and lumbar portions. Common deformities of the spine include **kyphosis**, which is an increased forward curvature of the thoracic spine that causes a bowing or rounding of the back, leading to a hunchback or slouching posture. The second deformity of the spine is referred to as **lordosis**, or swayback, an exaggerated curvature of the lumbar spine. A third deformity is **scoliosis**, which is a lateral curving deviation of the spine (Fig. 35-4). Kyphosis can occur at any age and may be caused by degenerative diseases of the spine (e.g., arthritis or disc degeneration), fractures related to osteoporosis, and injury or trauma (Meiner & Yeager, 2019). It may also be seen in patients with other neuromuscular disease. Lordosis can affect people of any age. Common causes of lordosis include tight low back muscles, excessive visceral fat, and pregnancy as the woman adjusts her posture in response to changes in her center of gravity. Scoliosis may be congenital, idiopathic (without an identifiable cause), or the result of damage to the paraspinal muscles (e.g., muscular dystrophy).

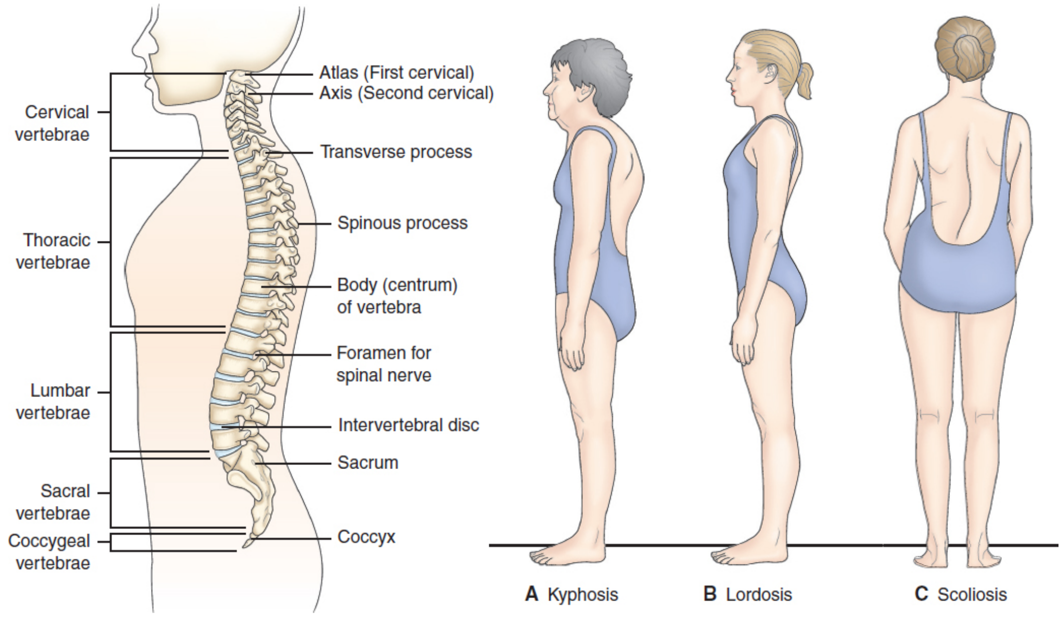


Figure 35-4 • A normal spine and three abnormalities. **A.** Kyphosis: an increased convexity or roundness of the spine's thoracic curve. **B.** Lordosis: swayback; exaggeration of the lumbar spine curve. **C.** Scoliosis: a lateral curvature of the spine.

During inspection of the spine, the entire back, buttocks, and legs are exposed. The examiner inspects the spinal curves and trunk symmetry from posterior and lateral views. Standing behind the patient, the examiner notes any differences in the height of the shoulders or iliac crests. Shoulder and hip symmetry, as well as the line of the vertebral column, is inspected with the patient erect and with the patient bending forward (flexion). Scoliosis is evidenced by an abnormal lateral curve in the spine; shoulders that are not level; an asymmetric waistline; and a prominent scapula, which is accentuated by bending forward. The examiner should then instruct the patient to bend backward (extension) with the examiner supporting the patient by placing hands on the posterior iliac spine (Weber & Kelley, 2018). Older adults experience a loss in height due to the loss of vertebral cartilage and osteoporosis-related vertebral compression fractures. Therefore, an adult's height should be measured during each health screening.

Gait

Gait is assessed by having the patient walk away from the examiner for a short distance. The examiner observes the patient's gait for smoothness and rhythm. Any unsteadiness or irregular movements (frequently noted in older adult patients) are considered abnormal. A limping motion is most frequently caused by painful weight bearing. In such instances, the patient can usually pinpoint the area of discomfort, thus guiding further examination. If one extremity is shorter than another, a limp may also be observed as the patient's pelvis drops downward on the affected side with each step. The knee should be flexed during normal gait; therefore, limited joint motion may interrupt the smooth pattern of gait. Evaluation of the knee involves the joints, bones, ligaments, tendons, and cartilage, and may include tests for the anterior and collateral ligaments, medial and lateral ligaments, and medial meniscus (Weber & Kelley, 2018). In addition, a variety of neurologic conditions are associated with abnormal gait, such as a spastic hemiparesis gait (stroke), steppage gait (lower motor neuron disease), and shuffling gait (Parkinson's disease).

Bone Integrity

The bony skeleton is assessed for deformities and alignment. Symmetric parts of the body, such as extremities, are compared. Abnormal bony growths due to bone tumors may be observed. Shortened extremities, amputations, and body parts that are not in anatomic alignment are noted. Fracture findings may include abnormal angulation of long bones, motion at points other than joints, and **crepitus** (a grating or crackling sound or sensation) at the point of abnormal motion. Movement of fracture fragments must be minimized to avoid additional injury. The nurse should include the following observations (Weber & Kelley, 2018):

- If the affected part is an extremity, how does its overall appearance compare to the unaffected extremity?
- Can the patient move the affected part? If an extremity is involved, does each toe or finger have normal sensation and motion (flexion and extension), and is the skin warm or cool?
- What is the color of the part distal to the affected area? Is it pale? Dusky? Mottled? Cyanotic?
- Does rapid capillary refill occur? (The nurse can gently squeeze a nail until it blanches, then release the pressure. The amount of time for the color under the nail to return to normal is noted. Color normally returns within 3 seconds. The return of color is evidence of capillary refill.)
- Is a pulse distal to the affected area palpable? If the affected area is an extremity, how does the pulse compare to the pulse of the unaffected extremity?
- Is edema present?
- Is any constrictive device or clothing causing nerve or vascular compression?
- Does elevating the affected part or modifying its position affect the symptoms?

Joint Function

The articular system is evaluated by noting range of motion, deformity, stability, tenderness, and nodular formation. Range of motion is evaluated both actively (the joint is moved by the muscles surrounding the joint) and passively (the joint is moved by the examiner). The examiner is familiar with the normal range of motion of major joints. Precise measurement of range of motion can be made by a goniometer (a protractor designed for evaluating joint motion) (Bickley, 2017). Limited range of motion may be the result of skeletal deformity, joint pathology, or **contracture** (shortening of surrounding joint structures) of the surrounding muscles, tendons, and joint capsule. In older adult patients, limitations of range of motion associated with osteoarthritis may reduce their ability to perform ADLs (Eliopoulos, 2018).

If joint motion is compromised or the joint is painful, the joint is examined for **effusion** (excessive fluid within the capsule), swelling, and increased temperature that may reflect active inflammation. An effusion is suspected if the joint is swollen and the normal bony landmarks are obscured. The most common site for joint effusion is the knee. If large amounts of fluid are present in the joint spaces beneath the patella, it may be identified by assessing for the balloon sign and for ballottement of the knee (Fig. 35-5). If inflammation or fluid is suspected in a joint, consultation with a specialist (e.g., orthopedic surgeon or rheumatologist) is indicated.

Joint deformity may be caused by contracture, dislocation (complete separation of joint surfaces), subluxation (partial separation of articular surfaces), or disruption of structures surrounding the joint. Weakness or disruption of joint-supporting structures may result in a weak joint that requires an external supporting appliance (e.g., brace).

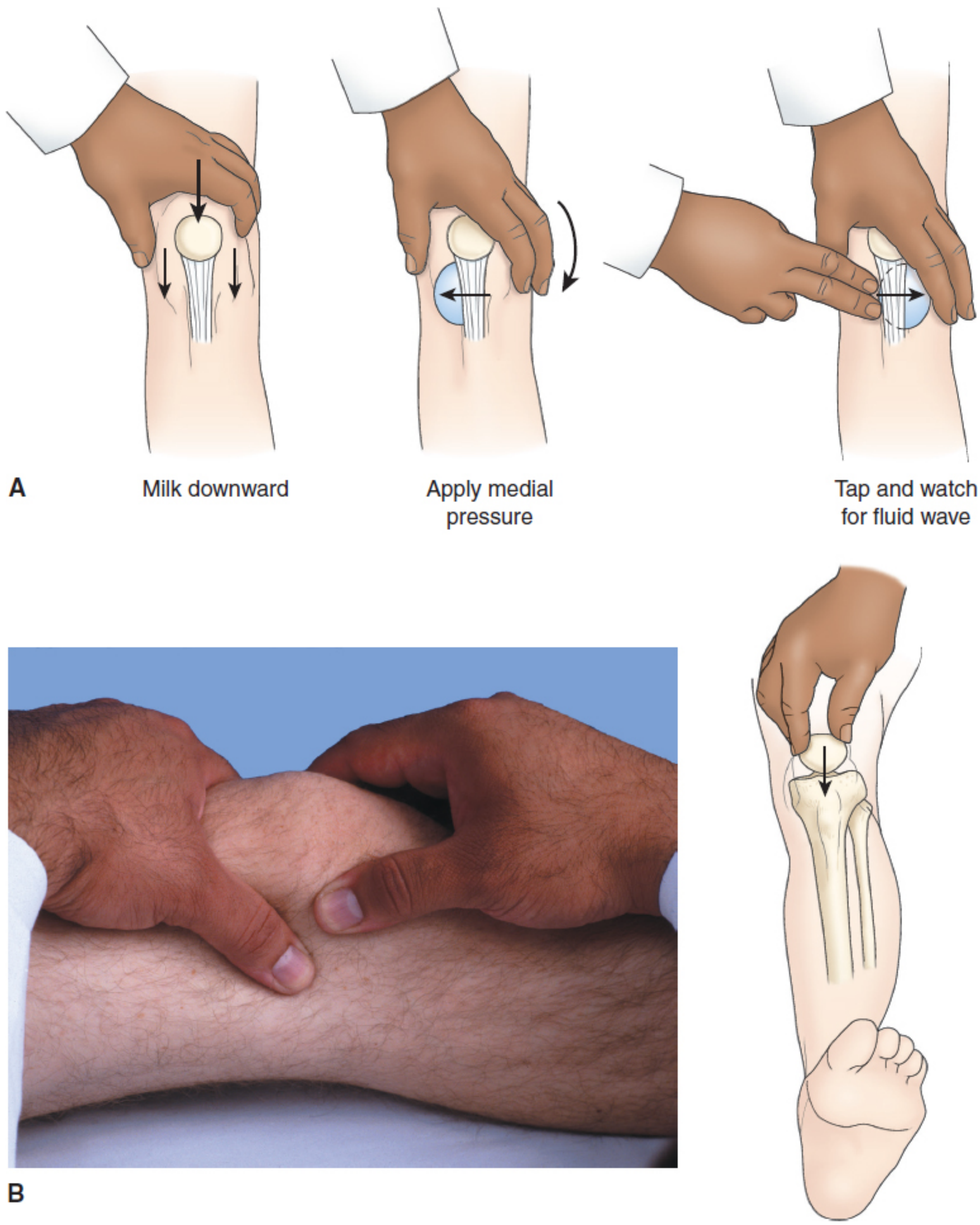


Figure 35-5 • Tests for detecting fluid in the knee. **A.** Technique for balloon sign. The medial and lateral aspects of the extended knee are milked firmly in a downward motion, which displaces any fluid downward. The examiner feels for any fluid entering the space directly inferior to the patella. When larger amounts of fluid are present, the subpatellar region feels as if it is “ballooning,” and the balloon sign test is positive. **B.** Technique for ballottement sign. The medial and lateral aspects of the extended knee are milked firmly in a downward motion. The examiner pushes the patella toward the femur and observes for fluid return to the region superior to the patella. When larger amounts of fluid are present, the patella elevates, there is visible return of fluid to the region directly superior to the patella, and the ballottement test is positive. Photograph used with permission from Bickley, L. S. (2017). *Bates' guide to physical examination and history taking* (12th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

Palpation of the joint while it is moved passively provides information about the integrity of the joint. Normally, the joint moves smoothly. A snap or crack may indicate that a ligament is slipping over a bony prominence. Slightly roughened surfaces, as in arthritic conditions, result in crepitus as the irregular joint surfaces move across one another (Bickley, 2017).

The tissues surrounding joints are examined for nodule formation. Rheumatoid arthritis, gout, and osteoarthritis may produce characteristic nodules. The subcutaneous nodules of rheumatoid arthritis are soft and occur within and along tendons that provide extensor function to the joints. The nodules of gout are hard and lie within and immediately adjacent to the joint capsule itself. They may rupture, exuding white uric acid crystals onto the skin surface. Osteoarthritic nodules are hard and painless and represent bony overgrowth that has resulted from the destruction of the cartilaginous surface of bone within the joint capsule. They are frequently seen in older adults (Bickley, 2017).

Often, the size of the joint is exaggerated by atrophy of the muscles proximal and distal to that joint. This is seen in rheumatoid arthritis of the knees, in which the quadriceps muscle may atrophy dramatically. In rheumatoid arthritis, joint involvement assumes a symmetric pattern (Fig. 35-6). See Chapter 34 for further information about rheumatoid arthritis.

Muscle Strength and Size

The muscular system is assessed by noting muscular strength and coordination, the size of individual muscles, and the patient's ability to change position. Weakness of a group of muscles may indicate a variety of conditions, such as polyneuropathy, electrolyte disturbances (particularly potassium and calcium), myasthenia gravis, poliomyelitis, and muscular dystrophy. By palpating the muscle while passively moving the relaxed extremity, the nurse can determine the muscle tone (Bickley, 2017). Muscle strength is assessed by having the patient perform certain maneuvers with and without added resistance. For example, when the biceps are tested, the patient is asked to extend the arm fully and then to flex it against resistance applied by the nurse. A simple handshake may provide an indication of grasp strength.

Figure 35-6 • Rheumatoid arthritis joint deformity with ulnar deviation of fingers and “swan neck” deformity of fingers (i.e., hyperextension of proximal interphalangeal joints with flexion of distal interphalangeal joints).

The nurse may elicit muscle **clonus** (rhythmic contractions of a muscle) in the ankle or wrist by sudden, forceful, sustained dorsiflexion of the foot or extension of the wrist. **Fasciculation** (involuntary twitching of muscle fiber groups) may be observed.

The nurse measures the girth of an extremity to monitor increased size due to exercise, edema, or bleeding into the muscle. Girth may decrease due to muscle atrophy. The unaffected extremity is measured and used as the reference standard for the affected extremity. Measurements are taken at the maximum circumference of the extremity. It is important that the measurements be taken at the same location on the extremity, and with the extremity in the same position, with the muscle at rest. Distance from a specific anatomic landmark (e.g., 10 cm below the medial aspect of the knee for measurement of the calf muscle) should be indicated in the patient’s record so that subsequent measurements can be made at the same point. For ease of serial assessment, the nurse may indicate the point of measurement by marking the skin. Variations in size greater than 1 cm are considered significant (Bickley, 2017).

Skin

In addition to assessing the musculoskeletal system, the nurse inspects the skin for edema, temperature, and color. Palpation of the skin may reveal whether any areas are warmer, suggesting increased perfusion or inflammation, or cooler, suggesting decreased perfusion, and whether edema is present. Cuts, bruises, skin color, and evidence of decreased circulation or inflammation can influence nursing management of musculoskeletal conditions.

Neurovascular Status

The nurse must perform frequent neurovascular assessments of patients with musculoskeletal disorders (especially of those with fractures) because of the risk of tissue and nerve damage. Chart 35-3 describes methods the nurse may use to evaluate peripheral nerve function. The nurse needs to be particularly aware of signs and symptoms of compartment syndrome (which is described in detail later in this unit) when assessing the patient with a musculoskeletal injury. This neurovascular problem is caused by pressure within a muscle compartment that increases to such an extent that microcirculation diminishes, leading to nerve and muscle anoxia and necrosis. Function can be permanently lost if the anoxic situation continues for longer than 6 hours. Assessment of neurovascular status (Chart 35-4) is frequently referred to as assessment of CMS (circulation, motion, and sensation).

Diagnostic Evaluation

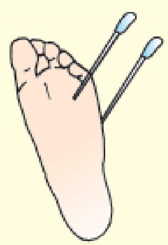
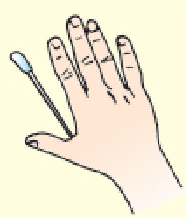
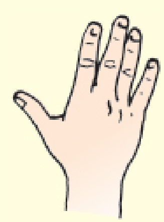
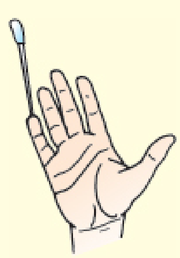
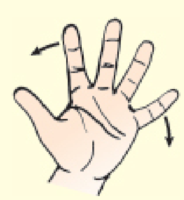
X-Ray Studies

Bone x-rays determine bone density, texture, erosion, and changes in bone relationships. X-ray study of the cortex of the bone reveals any widening, narrowing, or signs of irregularity. Joint x-rays reveal fluid, irregularity, spur formation, narrowing, and changes in the joint structure. Multiple x-rays, with multiple views (e.g., anterior, posterior, lateral), are needed for full assessment of the structure being examined. Serial x-rays may be indicated to determine the status of the healing process (Kennedy-Malone et al., 2019).

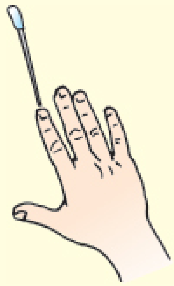
Chart 35-3 ASSESSMENT

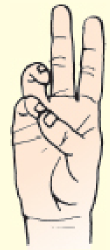
Assessing for Peripheral Nerve Function

Assessment of peripheral nerve function has two key elements: evaluation of sensation and evaluation of motion. The nurse may perform one or all of the following during a musculoskeletal assessment.

Nerve	Test of Sensation	Test of Movement
Peroneal	Prick the skin midway between the great and second toe. 	Ask the patient to dorsiflex the foot and extend the toes. 
Tibial	Prick the medial and lateral surface of the sole. 	Ask the patient to plantar flex toes and foot. 
Radial	Prick the skin midway between the thumb and second finger. 	Ask the patient to stretch out the thumb, then the wrist, and then the fingers at the metacarpal joints. 
Ulnar	Prick the distal fat pad of the small finger. 	Ask the patient to abduct all fingers. 
Median	Prick the top or distal surface of the index	Ask the patient to touch the thumb to the little finger. In addition, observe whether the patient

finger. can flex the wrist.





Adapted from Bickley, L. S. (2017). *Bates' guide to physical examination and history taking* (12th ed.). Philadelphia, PA: Wolters Kluwer; Weber, J., & Kelley, J. (2018). *Health assessment in nursing* (6th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

Chart 35-4

Indicators of Peripheral Neurovascular Dysfunction

Circulation

Color: Pale, cyanotic, or mottled
Temperature: Cool
Capillary refill: More than 3 s

Motion

Weakness
Paralysis

Sensation

Paresthesia
Unrelenting pain
Pain on passive stretch
Absence of feeling

Adapted from Bickley, L. S. (2017). *Bates' guide to physical examination and history taking* (12th ed.). Philadelphia, PA: Wolters Kluwer; Weber, J., & Kelley, J. (2018). *Health assessment in nursing* (6th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

Computed Tomography

A computed tomography (CT) scan, which may be performed with or without the use of oral or intravenous (IV) contrast agents, shows a more detailed cross-sectional image of the body. It may be used to visualize and assess tumors; injury to the soft tissue, ligaments, or tendons; and severe trauma to the chest, abdomen, pelvis, head, or spinal cord. It is also used to identify the location and extent of fractures in areas that are difficult to evaluate (e.g., acetabulum) and not visible on x-ray (Van Leeuwen & Bladh, 2019).

Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) is a noninvasive imaging technique that uses magnetic fields and radio waves to create high-resolution pictures of bones and soft tissues. It can be used to visualize and assess torn muscles, ligaments, and cartilage; herniated discs; and a variety of hip or pelvic conditions. The patient does not experience any pain during the procedure. The MRI scanner is noisy, and it may take 30 to 90 minutes to complete the test. Because an electromagnet is used, patients with most metal implants (i.e., cochlear implants) or clips are not candidates for MRI (Van Leeuwen & Bladh, 2019).

Quality and Safety Nursing Alert

Jewelry, hair clips, hearing aids, credit cards with magnetic strips, and other metal-containing objects must be removed before the MRI is performed; otherwise, they can become dangerous projectile objects or cause burns. Credit cards with magnetic strips may be erased, and nonremovable cochlear devices can become inoperable; therefore, their presence is a contraindication for MRI. In addition, transdermal patches (e.g., nicotine patch, nitroglycerin transdermal, scopolamine transdermal, clonidine transdermal) that have a thin layer of aluminized backing must be removed before MRI because they can cause burns. The primary provider should be notified before the patches are removed.

To enhance visualization of anatomic structures, an IV contrast agent may be used. Patients who experience claustrophobia may be unable to tolerate the confinement of closed MRI equipment without sedation. Open MRI systems are available, but they use lower-intensity magnetic fields, which produce lower-quality images. Advantages of open MRI include increased patient comfort, reduced problems with claustrophobic reactions, and reduced noise.

Arthrography

Arthrography is used to identify the cause of any unexplained joint pain and progression of joint disease. A radiopaque contrast agent or air is injected into the joint cavity to visualize the joint structures, such as the ligaments, cartilage, tendons, and joint capsule. The joint is put through its range of motion to distribute the contrast agent while a series of x-rays are obtained. If a tear is present, the contrast agent leaks out of the joint and is evident on the x-ray image (Van Leeuwen & Bladh, 2019).

Bone Densitometry

Bone densitometry is used to evaluate BMD. This can be performed through the use of x-rays or ultrasound. The most common modalities used include dual-energy x-ray absorptiometry (DXA or DEXA), quantitative computed tomography (QCT), and quantitative ultrasound (QUS). DXA measures BMD and predicts fracture risk through accurate monitoring of bone density changes in patients with osteoporosis who are undergoing treatment. The density of bones in the spine, hip, and wrist may be calculated, as well as the total body. Peripheral dual-energy x-ray absorptiometry (pDXA) may be an alternative test that measures BMD of the forearm, finger, or heel, although its ability to project hip or spine fracture risk is less accurate than DXA (Felicilda-Reynaldo & Kenneally, 2019).

Bone density may vary among different skeletal areas; therefore, BMD results may be normal at one site but low at another. Because these tests only measure density at specific sites, they may miss abnormal findings in other skeletal areas. Thus, although the BMD of the heel can be used to diagnose and monitor osteoporosis, predicting bone fracture risk related to osteoporosis is best achieved through DXA of the hip and spine. Hence, DXA is the most commonly prescribed diagnostic test for determining BMD (Bickley, 2017; Van Leeuwen & Bladh, 2019). See Chapter 36 for a further discussion of osteoporosis risks.

Nursing Interventions

Before any of the imaging studies described previously (i.e., x-rays, CT scans, MRIs, arthrography, bone densitometry) are performed, the nurse prepares the patient. For all of these studies, the patient must lie still. During an MRI study, the patient may hear a knocking sound. In addition, the nurse assesses for conditions that may require special consideration during the study or that may be contraindications to the study (e.g., pregnancy; claustrophobia; inability to tolerate required positioning due to age, debility, or disability; metal implants). If contrast agents will be used for the CT scan, MRI, or arthrography, the patient is assessed for possible allergies (Van Leeuwen & Bladh, 2019).

The patient having an arthrogram may feel some discomfort or tingling during the procedure. After the arthrogram, a compression elastic bandage may be applied if prescribed, and the joint is usually rested for 12 hours. Strenuous activity should be avoided until approved by the primary provider. The nurse provides additional comfort measures (e.g., mild analgesia, ice) as appropriate and explains to the patient that it is normal to experience clicking or crackling in the joint for 24 to 48 hours after the procedure until the contrast agent or air is absorbed.

Bone Scan

A bone scan is performed to detect metastatic and primary bone tumors, osteomyelitis, some fractures, and aseptic necrosis, and to monitor the progression of degenerative bone diseases. A bone scan may accurately identify bone disease before it can be detected on x-ray; as such, it may diagnose a stress fracture in a patient who continues to experience pain after x-ray findings are negative (Van Leeuwen & Bladh, 2019). A bone scan requires the injection of a radioisotope through an IV line; the scan is performed 2 to 3 hours afterward. At this point, distribution and concentration of the isotope in the bone are measured. The degree of nuclide uptake is related to the metabolism of the bone; areas of abnormal bone formation will appear brighter. An increased uptake of the isotope is seen in primary skeletal disease (osteosarcoma), metastatic bone disease, inflammatory skeletal disease (osteomyelitis), and fractures that do not heal as expected.

Nursing Interventions

Prior to the bone scan, the nurse inquires about possible allergies to the radioisotope and assesses for any condition that would contraindicate performing the procedure (e.g., pregnancy, breast-feeding). The patient is educated about why the bone scan may be indicated and how it can assist in the identification of bone disease before it can be detected on an x-ray. The nurse should explain that the patient may experience moments of discomfort from the isotope (e.g., flushing, warmth) but provide reassurance that the radionuclide poses no radioactive hazard (Van Leeuwen & Bladh, 2019). In addition, the patient is encouraged to drink plenty of fluids to help distribute and eliminate the isotope. Before the scan, the patient should empty the bladder, because a full bladder interferes with accurate scanning of the pelvic bones.

Arthroscopy

Arthroscopy allows direct visualization of a joint through the use of a fiberoptic endoscope. Thus, it is a useful adjunct to diagnosing joint disorders. Biopsy and treatment of tears, defects, and disease processes may be performed through the arthroscope. The procedure takes place in the operating room under sterile conditions with either injection of a local anesthetic agent into the joint or general anesthesia. A large-bore needle is inserted, and the joint is distended with saline. The arthroscope is introduced, and joint structures, synovium, and articular surfaces are visualized. After the procedure, the puncture wound is closed with adhesive strips or sutures and covered with a sterile dressing. Complications are rare but may include infection, hemarthrosis, neurovascular compromise, thrombophlebitis, stiffness, effusion, adhesions, and delayed wound healing (Van Leeuwen & Bladh, 2019).

Nursing Interventions

After the arthroscopic procedure, the joint is wrapped with a compression dressing to control swelling. In addition, ice may be applied to control edema and enhance comfort. Frequently, the joint is kept extended and elevated to reduce swelling. The nurse monitors and documents the neurovascular status (see Chart 35-4). Analgesic agents are given as needed. The patient is instructed to avoid strenuous activity of the joint, and exercises must be approved by the primary provider. The patient and family are instructed to monitor for signs and symptoms of complications (e.g., fever, excessive bleeding, swelling, numbness, cool skin) and the importance of notifying the primary provider should any of these occur (Van Leeuwen & Bladh, 2019).

Arthrocentesis

Arthrocentesis (joint aspiration) is carried out to obtain synovial fluid for purposes of examination or to relieve pain due to effusion. Examination of synovial fluid is helpful in the diagnosis of septic arthritis and other inflammatory arthropathies and reveals the presence of hemarthrosis (bleeding into the joint cavity), which suggests trauma or a bleeding disorder. Normally, synovial fluid is clear, pale, straw colored, and scanty in volume. Using aseptic technique, the primary provider inserts a needle into the joint and aspirates fluid. Anti-inflammatory medications may be injected into the joint. A sterile dressing is applied after aspiration. There is a risk of infection after this procedure (Van Leeuwen & Bladh, 2019).

Nursing Interventions

The nurse should review the procedure with the patient and its indications. Hair may need to be removed from the site before the procedure. Pain may be a concern; telling the patient that antispasmodic agents may be given to alleviate discomfort during the procedure may help decrease anxiety. Ice may be prescribed for the first 24 to 48 hours postprocedure; the patient should be educated about why ice may be indicated (i.e., to diminish edema formation and pain). If antibiotics are prescribed postprocedure, the patient must be educated about their use and reminded to take medications as prescribed. The patient and family are educated about the possible signs and symptoms of complications, particularly infection and bleeding (e.g., fever, excessive bleeding, swelling, numbness, cool skin) and the importance of promptly notifying the primary provider if any of these occur (Van Leeuwen & Bladh, 2019).

Electromyography

Electromyography (EMG) provides information about the electrical potential of the muscles and the nerves leading to them. The test is performed to evaluate muscle weakness, pain, and disability. The purpose of the procedure is to determine any abnormality of function and to differentiate muscle and nerve problems. An EMG can be used to identify the extent of damage if nerve function does not return within 4 months of an injury. Needle electrodes are inserted into selected muscles, and responses to electrical stimuli are recorded on an oscilloscope. Warm compresses may relieve residual discomfort after the study.

Nursing Interventions

Before the patient undergoes an EMG, the nurse inquires if the patient is taking any anticoagulant medications and assesses for any active skin infection. If the patient is found to be taking an anticoagulant or has a skin infection, the primary provider is notified. An EMG is usually contraindicated in patients receiving anticoagulant therapy (e.g., warfarin) because the needle electrodes may cause bleeding within the muscle. EMG also may be contraindicated in patients with extensive skin infections due to the risk of spreading infection from the skin to the muscle. The nurse instructs the patient to avoid using any lotions or creams on the day of the test (Van Leeuwen & Bladh, 2019).

Biopsy

Biopsy may be performed to determine the structure and composition of bone marrow, bone, muscle, or synovium to help diagnose specific diseases. It involves excising a sample of tissue that can be analyzed microscopically to determine cell morphology and tissue abnormalities.

Nursing Interventions

The nurse educates the patient about the procedure and offers assurance that analgesic agents will be provided. The biopsy site is monitored for edema, bleeding, pain, hematoma formation, and infection. Ice is applied as prescribed to control bleeding and edema. In addition, antibiotics and analgesic agents are given as prescribed. The patient is instructed to report signs of redness, bleeding, or pain at the biopsy site as well as fever or chills to the primary provider (Van Leeuwen & Bladh, 2019).

Laboratory Studies

Examination of the patient's blood and urine is used to identify the presence and amount of chemicals and other substances. The results may indicate a primary musculoskeletal problem (e.g., Paget's disease of the bone), a developing complication (e.g., infection), the baseline for instituting therapy (e.g., anticoagulant therapy), or the response to therapy, as well as possible causes of bone loss. Before surgery, coagulation studies are performed to detect bleeding tendencies (because bone is vascular tissue).

Serum calcium levels are altered in patients with osteomalacia, parathyroid dysfunction, Paget's disease, metastatic bone tumors, or prolonged immobilization. Serum phosphorus levels are inversely related to calcium levels and are diminished in osteomalacia associated with malabsorption syndrome. Acid phosphatase is elevated in Paget's disease and metastatic cancer. Alkaline phosphatase (ALP) is elevated during early fracture healing and in diseases with increased osteoblastic activity (e.g., metastatic bone tumors). Bone metabolism may be evaluated through thyroid studies and determination of calcitonin, PTH, and vitamin D levels. Serum enzyme levels of creatine kinase and aspartate aminotransferase become elevated with muscle damage. Serum osteocalcin indicates the rate of bone turnover. Urine calcium levels increase with bone destruction (e.g., parathyroid dysfunction, metastatic bone tumors, multiple myeloma) (Van Leeuwen & Bladh, 2019).

Specific urine and serum biochemical markers can be used to provide information about the speed of bone resorption or bone formation, as well as to document the effects of therapeutic interventions prescribed for patients diagnosed with musculoskeletal disorders. These include urinary *N*-telopeptide of type 1 collagen (NTx) and deoxypyridinoline (Dpd), both of which reflect increased osteoclast activity and increased bone resorption. Conversely, elevated serum levels of bone-specific ALP, osteocalcin, and intact *N*-terminal propeptide of type 1 collagen (P1NP) reflect increased activity of osteoblasts and enhanced bone remodeling activity (NOF, 2019).

CRITICAL THINKING EXERCISES

1 pq You are a nurse working in an urgent care facility and are assigned to care for a 35-year-old man who fell while hiking. He is holding his left arm. You note a small laceration and a few abrasions to the arm as well as swelling and deformity. What are the priority interventions for this patient? What diagnostic test would most likely be indicated? What comfort measure should be provided until a diagnosis is confirmed?

2 ebp You are a faith community nurse and your parish has many older adult parishioners. You want to develop an educational program regarding healthy lifestyle choices and bone health. What are the current evidence-based recommendations to maintain bone health for older adults? What is the level of evidence that supports each of the recommendations and strategies for reducing musculoskeletal risk for the aging adult?

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Resources

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National Association of Orthopaedic Nurses (NAON), www.orthonurse.org
National Institute of Arthritis and Musculoskeletal and Skin Diseases, www.niams.nih.gov
National Osteoporosis Foundation, www.nof.org
World Health Organization (WHO) Collaborating Centre for Metabolic Bone Diseases: the fracture risk assessment tool (FRAX®), www.sheffield.ac.uk/FRAX/tool.aspx?country=9

36 Management of Patients with Musculoskeletal Disorders

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Describe the pathophysiology, clinical manifestations, and medical and nursing management of low back pain.
2. Discuss common musculoskeletal disorders of the hand, wrist, shoulder, and foot, and nursing management of the patient undergoing surgery to correct these disorders.
3. Identify the pathophysiology, clinical manifestations, and medical, surgical, and nursing management of osteoarthritis.
4. Explain the pathophysiology, clinical manifestations, and medical and nursing management of metabolic bone disorders, including osteoporosis, osteomalacia, and Paget disease.
5. Articulate the pathophysiology, clinical manifestations, and medical and nursing management of musculoskeletal infections, including osteomyelitis and septic arthritis, and of bone tumors.
6. Use the nursing process as a framework for care of the patient undergoing total hip arthroplasty, with select complications of osteoporosis, or with osteomyelitis.

NURSING CONCEPTS

Comfort
Inflammation
Mobility

GLOSSARY

abduction: movement away from the center or median line of the body

adduction: movement toward the center or median line of the body

arthroplasty: surgical replacement of a joint

avascular necrosis: death of tissue due to insufficient blood supply

bursitis: inflammation of a fluid-filled sac in a joint

contracture: abnormal shortening of muscle or fibrosis of joint structures

heterotopic ossification: misplaced formation of bone

involucrum: new bone growth around a sequestrum

osteolysis: lysis of bone from inflammatory reaction against polyethylene particulate debris

osteopenia: low bone mineral density

osteophyte: a bony outgrowth or protuberance; bone spur

osteoporosis: degenerative disease of the bone characterized by reduced mass, deterioration of matrix, and diminished architectural strength

osteotomy: surgical cutting of bone

radiculopathy: disease of a spinal nerve root, often resulting in pain and extreme sensitivity to touch

sciatica: inflammation of the sciatic nerve, resulting in pain and tenderness along the nerve through the thigh and leg

sequestrum: dead bone in abscess cavity

subchondral bone: bony plate that supports the articular cartilage

tendonitis: inflammation of muscle tendons

Musculoskeletal disorders, particularly impairment of the back, joints, and spine, are leading health problems and causes of disability. The functional and psychological limitations for the patient may be severe. Nurses should be cognizant of these limitations and the effects these disorders may have on these patients when providing care in inpatient and outpatient settings.

Low Back Pain

Most low back pain is caused by one of many musculoskeletal problems, including acute lumbosacral strain, unstable lumbosacral ligaments and weak muscles, intervertebral disc problems, and unequal leg length. Depression, smoking, alcohol abuse, obesity, and stress are frequent comorbidities (Ramanathan, Hibbert, Wiles, et al., 2018). Generally, back pain due to musculoskeletal disorders is aggravated by activity, whereas pain due to other conditions is not. Higher numbers of areas of pain are associated with a higher level of disability. Other nonmusculoskeletal causes of back pain, beyond the scope of this chapter, include kidney disorders, pelvic problems, retroperitoneal tumors, and abdominal aortic aneurysms.

Gerontologic Considerations

Older patients may experience back pain associated with osteoporotic vertebral fractures (see later discussion), osteoarthritis of the spine, and spinal stenosis. In addition, inactivity can have grave consequences on quality of life, progression of medical disease, energy level, and morbidity in older adults (Simon & Hicks, 2018).

Pathophysiology

The spinal column can be considered a rod constructed of rigid units (vertebrae) and flexible units (intervertebral discs) held together by complex facet joints, multiple ligaments, and paravertebral muscles. Its unique construction allows for flexibility while providing maximum protection for the spinal cord. The spinal curves absorb vertical shocks from running and jumping. The abdominal and thoracic muscles are important in lifting activities, working together to minimize stress on the spinal units. Disuse weakens these supporting muscular structures. Obesity, postural problems, structural problems, and overstretching of the spinal supports may result in back pain (McCance & Huether, 2019).

The intervertebral discs change in character as a person ages. A young person's discs are mainly fibrocartilage with a gelatinous matrix. Over time, the fibrocartilage becomes dense and irregularly shaped. Disc degeneration is a common cause of back pain. The lower lumbar discs, L4–5 and L5–S1, are subject to the greatest mechanical stress and the greatest degenerative changes. Disc protrusion or facet joint changes can cause pressure on nerve roots as they leave the spinal canal, which results in pain that radiates along the nerve (McCance & Huether, 2019). See Chapter 65 for discussion of the management of intervertebral disc disease.

Clinical Manifestations

The typical patient reports either acute back pain (lasting fewer than 3 months) or chronic back pain (3 months or longer without improvement) and fatigue. The patient may report pain radiating down the leg, which is known as **radiculopathy** (i.e., pain radiating from a diseased spinal nerve root) or **sciatica** (i.e., pain radiating from an inflamed sciatic nerve); presence of this symptom suggests nerve root involvement. The patient's gait, spinal mobility, reflexes, leg length, leg motor strength, and sensory perception may be affected. Physical examination may disclose paravertebral muscle spasm (greatly increased muscle tone of the back postural muscles) with a loss of the normal lumbar curve and possible spinal deformity.

Assessment and Diagnostic Findings

The initial evaluation of acute low back pain includes a focused history and physical examination, including observation of the patient, gait evaluation, and neurologic testing (see Chapter 35). The findings suggest either nonspecific lumbar strain or potentially serious problems, such as a spinal fracture, cancer, infection, or rapidly progressing neurologic deficits. The presence of bruising, older age, and prolonged use of corticosteroid medications increases the risk of a fracture posttraumatic injury (Gironda, Nguyen, & Mosqueda, 2016). In addition, the nurse should be alert to the potential for older adult abuse.

Another potential cause of low back pain is *cauda equina syndrome,* which results from compression of the cauda equina, the bundle of spinal nerves that arise from the lower portion of the spinal cord. When these nerves become compressed, the patient will have signs and symptoms that include severe or progressive neurologic deficit, recent bowel or bladder dysfunction, and saddle anesthesia which is characterized by paresthesias in the perineal, inner thigh, or buttock region that may be asymmetrical (Qaseem, Wilt, McLean, et al., 2017). Cauda equina syndrome is a medical emergency requiring immediate referral to an emergency department so that the patient may receive expeditious treatment to relieve the underlying cause before nerve damage occurs (e.g., treatment can consist of surgical removal of vertebral fragments, decompression of a tumor mass).

The diagnostic procedures described in Chart 36-1 may be indicated for the patient with potentially serious or prolonged low back pain. Red flags that trigger prescribing these studies include suspected spinal infection, severe neurologic weakness, urinary or fecal incontinence, and a new onset of back pain in a patient with cancer (Qaseem et al., 2017). The nurse prepares the patient for these studies, provides the necessary support during the testing period, and monitors the patient for any adverse responses to the procedures.

Medical Management

Most back pain is self-limited and resolves within 4 to 6 weeks with analgesics, rest, and avoidance of strain. Based on initial assessment findings indicating nonspecific back symptoms, the patient is reassured that the pain is not due to a serious condition and x-rays or other imaging modalities are not necessary (Qaseem et al., 2017). Management focuses on relief of discomfort, activity modification, and patient education. The presence of other medical problems and fear of pain complicates the picture and has higher cost, less favorable outcomes, and more long-term disability (Karasawa, Yamadada, Iseki, et al., 2019).

Chart 36-1

Diagnostic Procedures for Low Back Pain

X-ray of the spine: may demonstrate a fracture, dislocation, infection, osteoarthritis, or scoliosis

Bone scan and blood studies: may disclose infections, tumors, and bone marrow abnormalities

Computed tomography (CT) scan: useful in identifying underlying problems, such as obscure soft tissue lesions adjacent to the vertebral column and problems of vertebral discs

Magnetic resonance imaging (MRI) scan: permits visualization of the nature and location of spinal pathology

Electromyogram (EMG) and nerve conduction studies: used to evaluate spinal nerve root disorders (radiculopathies)

Myelogram: permits visualization of segments of the spinal cord that may have herniated or may be compressed (infrequently performed; indicated when MRI scan is contraindicated)

Ultrasound: useful in detecting tears in ligaments, muscles, tendons, and soft tissues in the back

Adapted from Fischbach, F. T., & Fischbach, M. A. (2018). *A manual of laboratory and diagnostic tests* (10th ed.). Philadelphia, PA: Wolters Kluwer; Wheeler, S. G., Wipf, J. E., Staiger, T. O., et al. (2019). Evaluation of low back pain in adults. *UpToDate*. Retrieved on 3/9/2020 at: www.uptodate.com/contents/evaluation-of-low-back-pain-in-adults

Nonprescription analgesics such as nonsteroidal anti-inflammatory drugs (NSAIDs) and short-term prescription muscle relaxants (e.g., cyclobenzaprine) are effective in relieving acute low back pain, but no one medication is considered superior to another (Michigan Quality Improvement Consortium [MQIC], 2018). Tricyclic antidepressants (e.g., amitriptyline) and the dual-action serotonin-norepinephrine reuptake inhibitors (e.g., duloxetine) or atypical anticonvulsant medications (e.g., gabapentin, which is prescribed for pain from radiculopathy) are used effectively in chronic low back pain. Opioid medications are indicated only short term (1 to 2 weeks) for acute moderate to severe cases of low back pain, except in older adults, those with kidney disease, or those who must avoid chronic NSAID exposure because of its adverse gastric effects. Systemic corticosteroids and acetaminophen are not effective in fully alleviating acute low back pain (Krebs, Gravely, Nugent, et al., 2018). For chronic pain, a reduction of pain by 30% less than baseline is the goal (Dupuis & Duff, 2019).

Effective nonpharmacologic interventions include thermal applications (hot or cold) and spinal manipulation (e.g., chiropractic therapy). Lumbar support belts are not recommended to treat acute low back pain but may be marginally effective devices for preventing low back pain in occupational health settings (MQIC, 2018). Orthopedic shoe inserts are not recommended for prevention but may help correct an underlying issue contributing to the problem (e.g., unequal leg length). Cognitive-behavioral therapy (e.g., biofeedback), exercise regimens, spinal manipulation, physical therapy, acupuncture, massage, and yoga are all effective nonpharmacologic interventions for treating chronic low back pain (Qaseem et al., 2017).

Most patients need to alter their activity patterns to avoid aggravating the pain. They should avoid twisting, bending, lifting, and reaching—all of which stress the back. The patient is taught to change position frequently. Sitting should be limited to 20 to 50 minutes based on level of comfort. Absolute bed rest is no longer recommended; typical activities of daily living (ADLs) should be resumed as soon as possible. A quick return to normal activities and a program of low-stress aerobic exercise are recommended (MQIC, 2018). Conditioning exercises for both back and trunk muscles are begun after about 2 weeks to help prevent recurrence of pain. Active motion activities such as walking have a beneficial impact on outcomes (Dupuis & Duff, 2019).

Nursing Management

The nurse asks the patient to describe the discomfort (e.g., location, severity, duration, characteristics, radiation, and weakness in the legs). Descriptions of how the pain occurred, such as with a specific action (e.g., opening a garage door) or with an activity in which weak muscles were overused (e.g., weekend gardening), and how the patient has dealt with the pain often suggest areas for intervention and patient education.

If back pain is a recurring problem, assessment about previous successful pain control methods helps in planning current management. Information about work and recreational activities helps identify areas for back health education. Because stress and anxiety can evoke muscle spasms and pain (Feinstein, Khalsa, Yeh, et al., 2018), the nurse assesses environmental variables, work situations, and family relationships. In addition, the nurse assesses the effect of chronic pain on the emotional well-being of the patient. Referral to a mental health professional for assessment and management of stressors contributing to the low back pain and related depression may be appropriate.

During the interview, the nurse observes the patient’s posture, position changes, and gait. Often, the patient’s movements are guarded, with the back kept as still as possible. The patient should be directed to a chair of standard seat height with arms for support. The patient may sit and stand in an unusual position, leaning away from the most painful side, and may need assistance when undressing for the physical examination.

On physical examination, the nurse assesses the spinal curve, any leg length discrepancy, and pelvic crest and shoulder symmetry. The nurse palpates the paraspinal muscles and notes spasm and tenderness. When the patient is in a prone position, the paraspinal muscles relax and any deformity caused by spasm can subside. The nurse asks the patient to bend forward and then laterally, noting any discomfort or limitations in movement. It is important to determine the effect of these limitations on ADLs. The nurse evaluates nerve involvement by assessing deep tendon reflexes, sensations (e.g., paresthesia), and muscle strength. Back and leg pain on straight-leg raising (with the patient supine, the patient’s leg is lifted upward with the knee extended) suggests nerve root involvement.

The major nursing goals for patient management include relief of pain, improved physical mobility, the use of back-conserving techniques of body mechanics, improved self-esteem, and weight reduction (as necessary) (see Chart 36-2).

The nurse assesses the patient’s response to analgesic agents. As the acute pain subsides, medication dosages are reduced. The nurse evaluates and notes the patient’s response to various pain management modalities (see Chapter 9). The nurse cautions the patient with severe pain not to remain on bed rest because extended periods of inactivity are not effective and result in deconditioning. A medium to firm, nonsagging mattress (a bed board may be used) is recommended; there is no evidence to support the use of a firm mattress (Radwan, Fess, James, et al., 2015). Lumbar flexion is increased by elevating the head and thorax 30 degrees by using pillows or a foam wedge and slightly flexing the knees supported on a pillow. Alternatively, the patient can assume a lateral position with knees and hips flexed (curled position) with a pillow between the knees and legs and a pillow supporting the head (see Fig. 36-1). A prone position should be avoided because it accentuates lordosis. The nurse instructs the patient to get out of bed by rolling to one side and placing the legs down while pushing the torso up, keeping the back straight.

Chart 36-2 HEALTH PROMOTION

Strategies for Preventing Acute Low Back Pain

Prevention

- Weight reduction as needed
- Stress reduction
- Avoid high heels
- Walk daily and gradually increase the distance and pace of walking
- Avoid jumping and jarring activities
- Stretch to enhance flexibility. Do strengthening exercises

Body Mechanics

- Practice good posture
- Avoid twisting, lifting above waist level, and reaching up for any length of time
- Push objects rather than pull them
- Keep load close to your body when lifting
- Lift with the large leg muscles, not the back muscles
- Squat while keeping the back straight when it is necessary to pick something up off the floor
- Bend your knees and tighten abdominal muscles when lifting
- Avoid overreaching or a forward flexion position
- Use a wide base of support

Work Modifications

- Adjust height of chair using a footstool to position knees higher than hips
- Adjust height of work area to avoid stress on back
- Avoid bending, twisting, and lifting heavy objects
- Avoid prolonged standing and repetitive tasks
- Avoid work involving continuous vibrations
- Use lumbar support in straight back chair with arm rests
- When standing for any length of time, rest one foot on a small stool or box to relieve lumbar lordosis

As the patient achieves comfort, an exercise program is gradually initiated with low-stress aerobic exercises, such as short walks or swimming. The physical therapist designs an exercise program for the patient to reduce lordosis, increase flexibility, and reduce strain on the back. It may include hyperextension exercises to strengthen the paravertebral muscles, flexion exercises to increase back movement and strength, and isometric flexion exercises to strengthen trunk muscles. Each 30-minute daily exercise period begins and ends with muscle stretching and relaxation.

Figure 36-1 • Positioning to promote lumbar flexion. Photo by B. Proud.

The nurse encourages the patient to adhere to the prescribed exercise program. Some patients may find it difficult to do so for a long period. In these instances, alternating activities may help facilitate adherence to the regimen. Activities should not cause excessive lumbar strain or twisting, with avoidance of activities such as horseback riding and weight lifting.

Good body mechanics and posture are essential to avoid recurrence of back pain. The patient must be taught how to stand, sit, lie, and lift properly (see Fig. 36-2). Providing the patient with a list of suggestions helps in making these long-term changes (see Chart 36-2). The patient who wears high heels is encouraged to change to low heels with good arch support. The patient who is required to stand for long periods should shift weight frequently and rest one foot on a low stool, which decreases lumbar lordosis. Standing on a foot cushion made of foam or rubber can be helpful. The proper posture can be verified by looking in a mirror to see whether the chest is up, the abdomen is tucked in, and the shoulders are down and relaxed. Locking the knees when standing is avoided as well as bending forward for long periods.

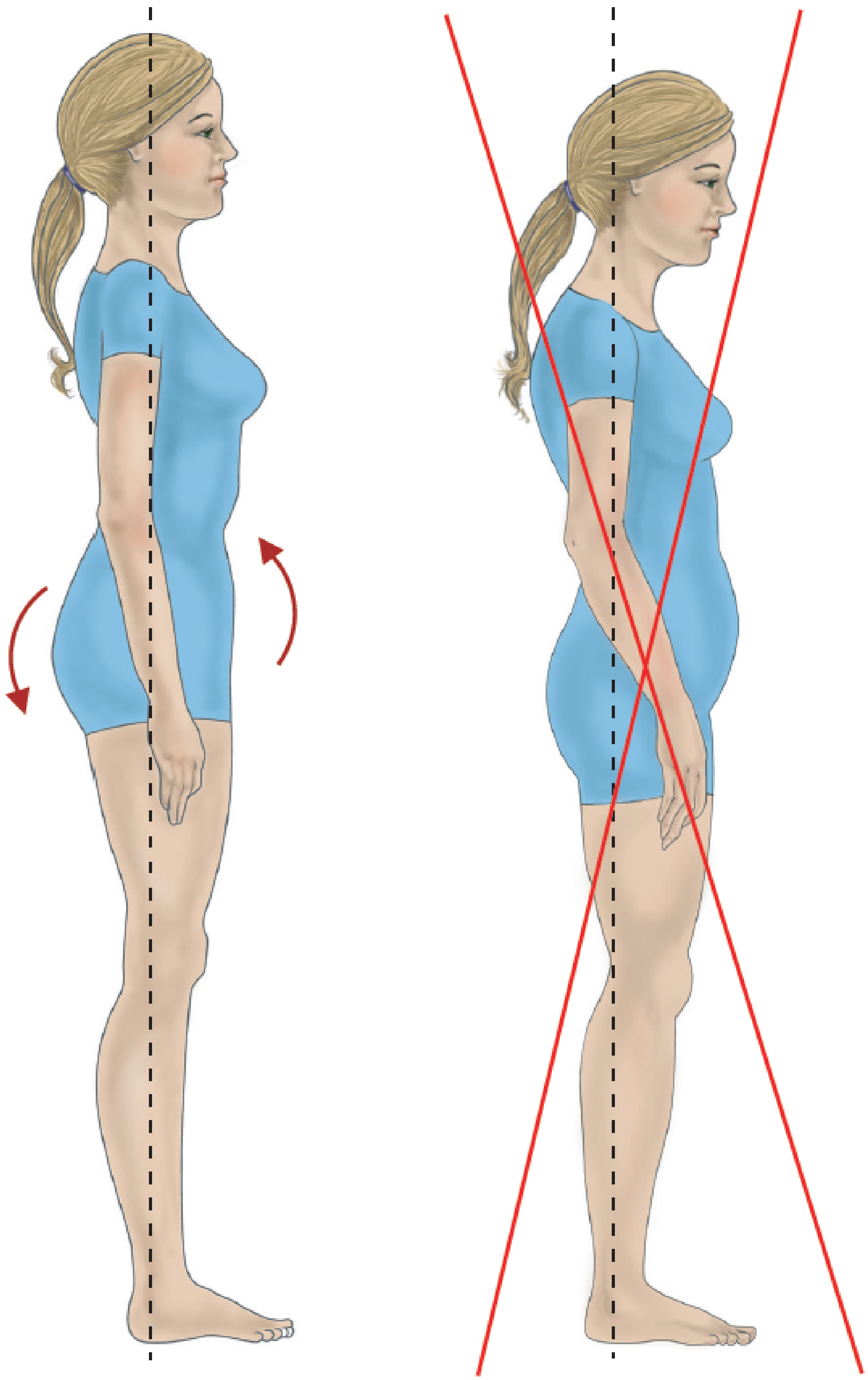

Figure 36-2 • Proper and improper standing postures. (*Left*) Abdominal muscles contracted, giving a feeling of upward pull, and gluteal muscles contracted, giving a downward pull. (*Right*) Slouch position, showing abdominal muscles relaxed and body out of proper alignment.

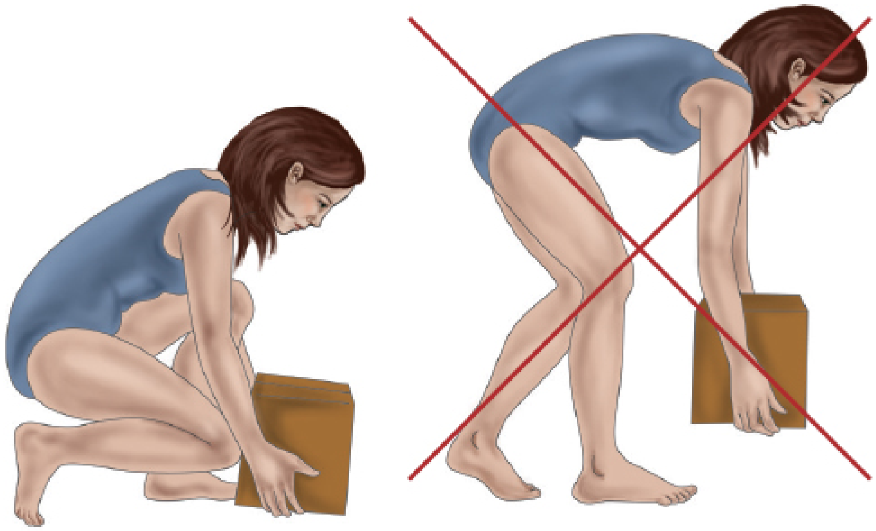

Figure 36-3 • Proper and improper lifting techniques. (***Left***) Correct position for lifting. This person is using the long and strong muscles of the arms and legs and holding the object so that the line of gravity falls within the base of support. (***Right***) Incorrect position for lifting. In this position, pull is exerted on the back muscles, and leaning causes the line of gravity to fall outside the base.

When sitting, the knees and hips should be flexed, with the knees in level with the hips or higher to minimize lordosis. The feet should be flat on the floor or supported on a raised surface. Patients should avoid sitting on stools or chairs that do not provide firm back support.

The nurse instructs the patient in the safe and correct way to lift objects—using the strong quadriceps muscles of the thighs, with minimal use of weak back muscles (see Fig. 36-3). With feet placed hip-width apart to provide a wide base of support, the patient should bend the knees, tighten the abdominal muscles, and lift the object close to the body with a smooth motion, avoiding twisting and jarring motions. The patient should avoid lifting more than one third of their ideal weight without help to prevent injury.

Role-related responsibilities may have to be modified with the onset of low back pain (e.g., carrying children). As recovery progresses, the patient may resume them. However, if these activities contributed to the development of low back pain, resuming them may lead to the development of chronic low back pain, with associated disability. If the patient experiences secondary gains associated with low back disability (e.g., workers' compensation, easier lifestyle or workload, increased emotional support), there is a risk that the patient will not fully resume work and family roles. Earlier return to work and lifestyle, even at a reduced level, have better outcomes than waiting for full recovery (Qaseem et al., 2017). Antidepressants and counseling may be needed to assist the person in resuming a full, productive life. Specialized back clinics use multidisciplinary approaches to help the patient with chronic pain resume role-related responsibilities; these approaches are especially beneficial for patients who experience fear and depression associated with chronic pain (Karasawa et al., 2019).

Obesity contributes to back strain by overtaxing the relatively weak back muscles in the absence of abdominal muscle support. Exercises are less effective and more difficult to perform when the patient is overweight. Weight reduction through diet modification is important to minimize recurrence of back pain. A sound nutritional plan that includes a change in eating habits and low-impact activities is vital. Noting achievement of weight reduction and providing positive reinforcement facilitate adherence. Back problems may or may not fully resolve as optimal weight is achieved (MQIC, 2018).

Common Upper Extremity Disorders

The structures in the upper extremities are frequently the sites of painful syndromes. This is especially true in occupational health settings, where many patient visits involve the shoulder, wrist, and hand.

Bursitis and Tendonitis

Bursitis and tendonitis are inflammatory conditions that commonly occur in the shoulder. Bursae are fluid-filled sacs that prevent friction between joint structures during joint activity and are painful when inflamed; **bursitis** is the consequence when these sacs become inflamed. Muscle tendon sheaths also become inflamed with repetitive stretching, causing **tendonitis**. The inflammation causes proliferation of synovial membrane and pannus formation, which restricts joint movement. Conservative treatment includes rest of the extremity, intermittent ice and heat to the joint, and NSAIDs to control the inflammation and pain. Newer therapies that include extracorporeal shock waves, pulsed magnetic fields, laser phototherapy, radiofrequency ablation, and stem cell therapies are touted to accelerate tendon healing, although further research is needed to determine their overall effectiveness (Cook & Young, 2020). There are no non–research-based sites for injection of cellular therapies that are registered with the Centers for Disease Control and Prevention (CDC) in the United States

(Cook & Yong, 2020). The World Anti-Doping Agency (WADA) for sports allows autologous (self-donated) localized injections for soft tissue injuries, but IV infusions are prohibited (WADA, 2020). Arthroscopic synovectomy may be considered if shoulder pain and weakness persist. Corticosteroid injections remain more evidence based than most other interventions for short-term, rapid improvement, but are not always helpful in the long term (McAlindon, LaValley, Harvey, et al., 2017). Most tendon and bursal inflammatory problems are self-limiting; they go away on their own with or without therapy. The treatments are primarily aimed at pain relief, not cure.

Loose Bodies

Loose bodies ("joint mice") may occur in a joint space as a result of articular cartilage wear and bone erosion. These fragments can interfere with joint movement ("locking the joint"). Loose bodies are removed by arthroscopic surgery if they cause pain or mobility issues.

Impingement Syndrome

Impingement syndrome is a general term that describes impaired movement of the rotator cuff of the shoulder. Impingement usually occurs from repetitive overhead movement of the arm or from acute trauma resulting in irritation and eventual inflammation of the rotator cuff tendons or the subacromial bursa as they grate against the coracoacromial arch. Early manifestations of this syndrome are characterized by edema from hemorrhage of these structures, pain, shoulder tenderness, limited movement, muscle spasm, and eventual disuse atrophy. The process may progress to a partial or complete rotator cuff tear (see Chapter 37).

Chart 36-3 PATIENT EDUCATION

Measures to Promote Shoulder Healing of Impingement Syndrome

The nurse instructs the patient to:

- Rest the joint in a position that minimizes stress on the joint structures to prevent further damage and the development of adhesions.
- Support the affected arm on pillows while sleeping to keep from turning onto the shoulder.
- Gradually resume motion and use of the joint. Assistance with dressing and other activities of daily living may be needed.
- Avoid working and lifting above shoulder level or pushing an object against a “locked” shoulder.
- Perform the prescribed daily range-of-motion and strengthening exercises.

Medications used to treat early impingement syndrome include oral NSAIDs or intra-articular injections of corticosteroids. Application of superficial cold or heat may subjectively improve patients’ symptoms; however, a therapeutic exercise program (see Chapter 37) is required to improve outcomes, including reduction of pain and improved shoulder function (see Chart 36-3).

Carpal Tunnel Syndrome

Carpal tunnel syndrome is an entrapment neuropathy that occurs when the median nerve at the wrist is compressed by a thickened flexor tendon sheath, skeletal encroachment, edema, or a soft tissue mass. It frequently occurs in women between 30 and 60 years of age. Women going through menopause or who are taking estrogen or birth control pills have the highest risk (Calandruccio & Thompson, 2018). While carpal tunnel syndrome is commonly caused by repetitive hand and wrist movements, it is also associated with rheumatoid arthritis (RA), diabetes, acromegaly, hyperthyroidism, or trauma (McCance & Huether, 2019). People employed in occupations that require frequent repetitive hand movements or flexing of the wrist, such as assembly line workers and hairdressers, and those exposed to vibration when doing tasks, such as construction workers and machinists, may be at increased risk for carpal tunnel syndrome (Calandruccio & Thompson, 2018).

The patient experiences pain, numbness, paresthesia, and, possibly, weakness along the median nerve distribution (thumb, index, and middle fingers). Night pain and/or fist clenching upon awakening is common. A positive Tinel sign helps identify patients requiring intervention (see Fig. 36-4).

Evidence-based treatment of acute carpal tunnel syndrome includes oral or intra-articular injections of corticosteroids, use of NSAIDs and acupuncture with and without electrical stimulation (attached to the needles). Application of splints to prevent hyperextension and prolonged flexion of the wrist is also effective; however, laser and ultrasound therapies are ineffective, as are prolotherapies, or the injection of substances (e.g., dextrose, lidocaine) purported to stimulate healing, diuretics, and vitamin B_6 (Calandruccio & Thompson, 2018). The risks of inhibiting the synthesis of reparative substrates like collagen can potentiate an increased risk for tendon rupture; therefore, long-term use of corticosteroids is not supported (McAlindon et al., 2017).

Figure 36-4 • Tinel sign may be elicited in patients with carpal tunnel syndrome by percussing lightly over the median nerve, located on the inner aspect of the wrist. If the patient reports tingling, numbness, and pain, the test for Tinel sign is considered positive. Reprinted with permission from Weber, J. W., & Kelley, J. (2018). *Health assessment in nursing* (6th ed.). Philadelphia, PA: Wolters Kluwer. Photo by B. Proud.

Traditional open nerve release or endoscopic laser surgery are the two most common surgical management options when nonsurgical treatments fail. Both of these procedures are performed under local anesthesia and involve making incisions into the affected wrist and cutting the carpal ligament so that the carpal tunnel is widened. Smaller incisions are made with the endoscopic laser procedure, resulting in less scar formation and a shorter recovery time than with the open method. Following either procedure, the patient wears a hand splint and limits hand use during healing. The patient may need assistance with personal care. Full recovery of motor and sensory function after either type of nerve release surgery may take several weeks or months.

Ganglion

A ganglion—a collection of neurologic gelatinous material near the tendon sheaths and joints—appears as a round, firm, cystic swelling, usually on the dorsum of the wrist. It frequently occurs in women younger than 50 years (McCance & Huether, 2019). The swelling is locally tender and may cause an aching pain. When a tendon sheath is involved, weakness of the finger occurs. Treatment may include aspiration, corticosteroid injection, or surgical excision. After treatment, a compression dressing and immobilization splint are used; however, a ganglion may recur after medical intervention (De Keyser, 2019).

Dupuytren Disease

Dupuytren disease results in a slowly progressive **contracture** (i.e., an abnormal shortening) of the palmar fascia that causes flexion of the fourth, fifth, and, sometimes, middle finger, rendering these fingers more or less useless (see Fig. 36-5). It is linked to an inherited autosomal dominant trait and occurs most frequently in men of Scandinavian or Celtic heritage who are older than 50 years (McCance & Huether, 2019). Dupuytren disease is also associated with arthritis, diabetes, gout, cigarette smoking, and alcoholism (Ball, Izadi, Verjee, et al., 2016). Starting as a nodule, it may or may not progress, producing a contracture of the fingers and palmar skin changes. The patient may experience dull and aching discomfort, morning numbness, and stiffness in the affected fingers. This condition starts in one hand, but eventually both are affected. Finger-stretching exercises in early disease or intranodular injections of corticosteroids or collagenases may prevent contractures (Ball et al., 2016). With loss of movement, palmar and digital fasciotomies are performed to improve function.

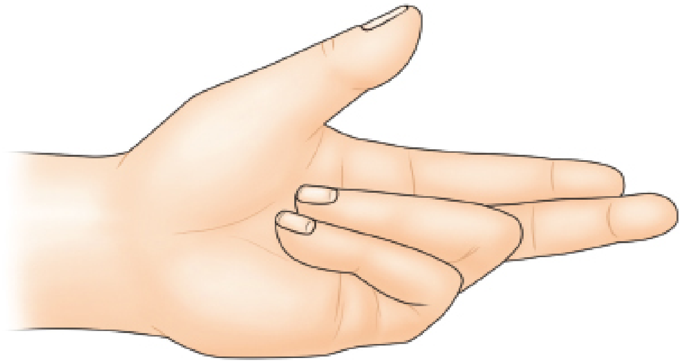

Figure 36-5 • Dupuytren contracture, a flexion deformity caused by an inherited trait, is a slowly progressive contracture of the palmar fascia, which severely impairs the function of the fourth, fifth, and, sometimes, middle finger.

Nursing Management of the Patient Undergoing Surgery of the Hand or Wrist

Surgery of the hand or wrist, unless related to major trauma, is generally an ambulatory procedure. Before surgery, the nurse assesses the patient's level and type of discomfort, as well as limitations in function, caused by the condition.

Hourly neurovascular assessment of the exposed fingers for the first 24 hours following surgery is essential for monitoring function of the nerves and perfusion. This is especially important if an intraoperative tourniquet technique was used, which is implicated in neurovascular deficits. The nurse compares the affected extremity with the unaffected extremity and the postoperative status with the documented preoperative status. The nurse asks the patient to describe sensations in the digits and has the patient demonstrate mobility, while enforcing limitations in movement prescribed by the patient's surgeon. With tendon repairs and nerve, vascular, or skin grafts, more extensive function is tested (see Chapter 35, Chart 35-3). Percutaneous pins may be used to hold bones in position. These pins serve as potential sites of infection. Patient education concerning aseptic wound and pin care may be necessary.

Dressings provide support but should be nonconstrictive. Intermittent use of ice packs to the surgical area during the first 24 to 48 hours may be prescribed to control edema. Unless contraindicated, active extension and flexion of the fingers to promote circulation are encouraged, even though movement is limited by the bulky dressing.

Generally, pain and discomfort can be controlled by the use of oral analgesic agents. Patient education concerning the risk of falls and impaired cognition is important. Pain out of proportion to what is expected, particularly if it is accompanied with compromised neurovascular functioning, needs to be evaluated as an indication of compartment syndrome (see Chapter 37). Pain may be related to surgery, edema, hematoma formation, or restrictive bandages. To control swelling that may increase the patient's discomfort, the nurse instructs the patient to elevate the hand to heart level with pillows. If the patient is ambulatory, the arm is supported in a conventional sling with the hand elevated at heart level (see Chapter 37, Fig. 37-15).

During the first few days after surgery, independent self-care is impaired. The patient may need to arrange for assistance with feeding, bathing, dressing, and toileting. Within a few days, the patient develops skills in one-handed ADLs and is usually able to function with minimal help and assistive devices. The nurse encourages the patient to use the involved hand, unless contraindicated, within the limits of discomfort. As rehabilitation progresses, the patient resumes use of the limb. Physical or occupational therapy–directed exercises may be prescribed.

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care

After the patient has undergone surgery, the nurse instructs the patient how to monitor neurovascular status and the signs of complications that need to be reported to the surgeon (e.g., paresthesia, paralysis, uncontrolled pain, coolness of fingers, extreme swelling, excessive bleeding, purulent drainage, foul odor, fever). The nurse discusses prescribed medications and their side effects with the patient. In addition, the nurse instructs the patient how to elevate the extremity and to apply ice (if prescribed) to control swelling. The use of assistive devices is demonstrated if such devices would be helpful in promoting accomplishment of ADLs. For bathing, the nurse instructs the patient to keep the dressing dry by covering it with a secured plastic bag. Generally, the wound is not redressed until the patient's follow-up visit with the surgeon (see Chart 36-4). The nurse identifies any perceived barriers to being able to attend to this plan (such as childcare needs). The patient is referred to community-based resources as appropriate.

Common Foot Problems

Disorders of the foot may be caused by poorly fitting shoes, which distort normal anatomy while inducing deformity and pain. Dermatologic problems commonly affect the feet in the form of fungal infections and plantar warts. Several systemic diseases affect the feet. Patients with diabetes are prone to develop corns and peripheral neuropathies with diminished sensation, leading to diabetic ulcers at pressure points of the foot. Patients with peripheral vascular disease and arteriosclerosis complain of burning and itching feet, resulting in scratching and skin breakdown. Foot deformities may occur with RA. Obesity can cause a host of foot anomalies, including adult-onset pes planus (i.e., "fallen arches") and plantar fasciitis.

The discomforts of foot strain are treated with rest, elevation, physiotherapy, supportive taping, and orthotic devices (Luffy, Grosel, Thomas, et al., 2018). The patient must inspect the foot and skin under pads and orthotic devices for pressure and skin breakdown daily. If a "window" is cut into shoes to relieve pressure over a bony deformity, the skin must be monitored daily for breakdown from pressure exerted at the window area. Active foot exercises promote circulation and help strengthen the feet. Walking in properly fitting shoes is considered the ideal exercise.

Chart 36-4 HOME CARE CHECKLIST

Hand or Foot Surgery

At the completion of education, the patient and/or caregiver will be able to:

- Name the procedure that was performed and identify any permanent changes in anatomic structure or function as well as changes in ADLs, IADLs, roles, relationships, and spirituality.
- Identify modification of home environment, interventions, and strategies (e.g., durable medical equipment, adaptive equipment) used in safely adapting to changes in structure or function and promote effective recovery and rehabilitation.
- Describe ongoing postoperative therapeutic regimen, including diet and activities to perform (e.g., immobilization) and to limit or avoid (e.g., lifting weights, driving a car, contact sports).
  - Describe methods to prevent wound infection (e.g., keeping dressing clean and dry during activities of daily living).
  - Demonstrate how to assess neurovascular status.
  - Demonstrate control of edema by elevating extremity and applying ice intermittently if prescribed.
  - Observe prescribed weight-bearing, activity and exercise limits.
  - Demonstrate safe use of assistive devices, if appropriate.
  - Consume a healthy diet to promote healing.
- State the name, dose, side effects, frequency, and schedule for all prescribed therapeutic and prophylactic medications (e.g., antibiotics and analgesic agents).
- State indicators of wound infections (e.g., redness, swelling, tenderness, purulent drainage, fever, signs of systemic infection) to report promptly to the provider.
- State indicators of other potential complications to report promptly to the provider (e.g., uncontrolled swelling and pain; cool, pale fingers or toes; paresthesia; paralysis; purulent drainage; signs of deep vein thrombosis or pulmonary embolism).
- Relate how to reach the providers with questions or complications.
- Verbalize the need to keep appointment with surgeon for initial dressing change.
  - State time and date of follow-up appointments and testing.
- Identify the need for health promotion (e.g., weight reduction, smoking cessation, stress management), disease prevention and screening activities.

Resources

See Chapter 2, Chart 2-6 for additional information related to durable medical equipment, adaptive equipment, and mobility skills.

ADLs, activities of daily living; IADLs, instrumental activities of daily living.

Callus

A callus is a thickened area of the skin that has been exposed to persistent pressure or friction. Faulty foot mechanics usually precede the formation of a callus. Treatment consists of eliminating the underlying causes and having a painful callus treated by a podiatrist. A keratolytic ointment may be applied and a thin plastic cup worn over the heel if the callus is on this area. Felt padding with an adhesive backing is also used to prevent and relieve pressure. Prevention of the callus is best, with attention to well-fitting socks and shoes. Orthotic devices can be made to remove the pressure from bony protuberances, or the protuberance may be excised (van Netten, Sacco, Lavery, et al., 2020).

Corn

A corn is an area of hyperkeratosis (overgrowth of a horny layer of epidermis) produced by internal pressure (the underlying bone is prominent because of a congenital or acquired abnormality, commonly arthritis) or external pressure (ill-fitting shoes). The fifth toe is most frequently involved, but any toe may be involved.

Corns are treated by a podiatrist by soaking and scraping off the horny layer, by application of a protective shield or pad, or by surgical modification of the underlying offending osseous structure. Early intervention is required for patients with diabetes.

Soft corns are located between the toes and are kept soft by moisture. Treatment consists of drying the affected spaces and separating the affected toes with lamb's wool or gauze. A wider shoe and toe box may be helpful (Malhotra, Davda, & Singh, 2017).

Hammer Toe

Hammer toe is a flexion deformity of the interphalangeal joint, which may involve several toes (see Fig. 36-6**A**). Tight socks or shoes may push an overlying toe back into the line of the other toes. The toes usually are pulled upward, forcing the metatarsal joints (ball of the foot) downward. Corns develop on top of the toes, and tender calluses develop under the metatarsal area. Treatment consists of conservative measures: wearing open-toed sandals (unless the patient has diabetes) or shoes that conform to the shape of the foot with a round toe box, carrying out manipulative exercises, and protecting the protruding joints with pads. **Osteotomy** (surgical cutting of the bone) may be used to correct a resulting deformity. There is little evidence to support treatment of hammer toe when the patient does not report pain or other symptoms (Malhotra et al., 2017). Orthotics may help prevent hammer toe in people with high arches. Attention is required for patients with diabetes who may develop friction points, causing wounds.

Onychocryptosis

Onychocryptosis (ingrown toenail) is a condition in which the free edge of a nail plate penetrates the surrounding skin. A secondary infection or granulation tissue may develop. This painful condition is caused by improper self-treatment, external pressure (tight shoes or stockings), internal pressure (deformed toes, growth under the nail), trauma, or infection. Trimming the nails properly (clipping them straight across and filing the corners consistent with the contour of the toe) can prevent this problem. Active treatment consists of washing the foot twice a day and relieving the pain by decreasing the pressure of the nail plate on the surrounding soft tissue. Warm, wet soaks help drain an infection. A toenail may need to be excised by the podiatrist or primary provider if there are recurrent infections (Malhotra et al., 2017).

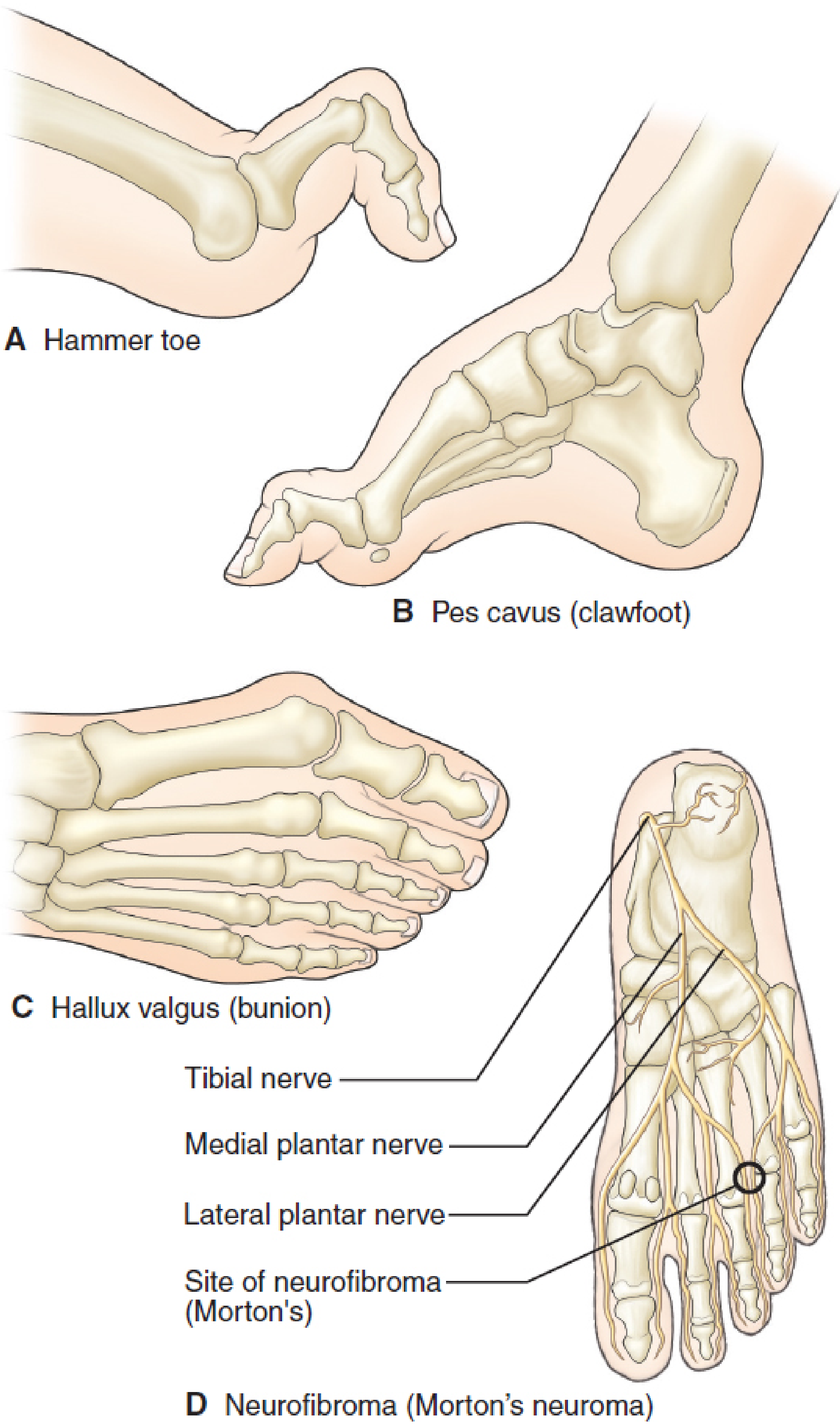

Figure 36-6 • Common foot deformities.

Pes Cavus

Pes cavus (clawfoot) refers to a foot with an abnormally high arch and a fixed equines deformity of the forefoot (see Fig. 36-6**B**). The shortening of the foot and increased pressure produce calluses on the metatarsal area and on the dorsum of the foot. Charcot–Marie–Tooth disease (a peripheral neuromuscular disease associated with a familial degenerative disorder), diabetes, and progressive neurologic disorders are common causes (Alderson & Ghosh, 2019). Exercises are prescribed to manipulate the forefoot into dorsiflexion and relax the toes. Orthotic devices alleviate pain and can protect the foot. In severe cases, arthrodesis (fusion) is performed to reshape and stabilize the foot.

Hallux Valgus

Hallux valgus (bunion) is a deformity in which the great toe deviates laterally (see Fig. 36-6**C**). There is a marked prominence of the medial aspect of the first metatarsophalangeal joint. There is also osseous enlargement (exostosis) of the medial side of the first metatarsal head, over which a bursa may form (secondary to pressure and inflammation). Acute bursitis symptoms include a reddened area, edema, and tenderness.

Factors contributing to bunion formation include heredity, ill-fitting shoes, osteoarthritis, and the gradual lengthening and widening of the foot associated with aging. Treatment depends on the patient’s age, the degree of deformity, and the severity of symptoms. In uncomplicated cases, wearing a shoe that conforms to the shape of the foot, or that is molded to the foot to prevent pressure on the protruding portions, may be the only treatment needed. Corticosteroid injections control acute inflammation. In advanced cases, surgical removal of the exostosis and toe realignment may be required to improve function, appearance, and symptoms. If surgery is required in an athlete, at least 3 months of rest is required before returning to play (Fournier, Saxena, & Maffuli, 2019).

Morton Neuroma

Morton neuroma (plantar digital neuroma, neurofibroma) is a swelling near the third (lateral) branch of the median plantar nerve (see Fig. 36-6**D**). Microscopically, digital artery changes cause an ischemia within the third intermetatarsal (web) space. The result is a throbbing, burning pain in the foot that is usually relieved with rest and massage.

Conservative treatment consists of inserting innersoles and metatarsal pads designed to spread the metatarsal heads and balance the foot posture.

Local injections of a corticosteroid and a local anesthetic may provide relief. If these fail, surgical excision of the neuroma is necessary. Pain relief and loss of sensation are immediate and permanent with surgery. The risk of falls is increased because of the loss of all sensation (Matthews, Hum, Harding, et al., 2019).

Pes Planus

Pes planus (flatfoot) is a common disorder in which the longitudinal arch of the foot is diminished. It may be caused by congenital abnormalities or associated with bone or ligament injury, excessive weight, muscle fatigue, poorly fitting shoes, or arthritis. Signs and symptoms include a burning sensation, fatigue, clumsy gait, edema, and pain. Exercises to strengthen the muscles and to improve posture and walking habits are helpful (Unver, Erdem, & Akbas, 2019). Foot orthoses can give the foot additional support.

Plantar Fasciitis

Plantar fasciitis, an inflammation of the foot-supporting fascia, presents as an acute onset of heel pain experienced with the first steps in the morning. The pain is localized to the anterior medial aspect of the heel and diminishes with gentle stretching of the foot and Achilles tendon. Management includes stretching exercises, wearing shoes with support and cushioning to relieve pain, orthotic devices (e.g., heel cups, arch supports, night splints), and corticosteroid injections. Unresolved plantar fasciitis may progress to fascial tears at the heel and eventual development of heel spurs (Luffy et al., 2018).

Nursing Management of the Patient Undergoing Foot Surgery

Surgery of the foot may be necessary because of various conditions, including neuromas and foot deformities (bunion, hammer toe, clawfoot). Generally, foot surgery is performed on an outpatient basis. Before surgery, the nurse assesses the patient’s gait and balance, as well as the neurovascular status of the foot. Additionally, the nurse considers the availability of assistance at home and the structural characteristics of the home in planning for care during the days after surgery.

Postoperative and home care follows the same principles as discussed earlier for hand surgery (see Chart 36-4). After surgery, neurovascular assessment of the exposed toes (every 1 to 2 hours for the first 24 hours) is essential to monitor the function of the nerves and the perfusion of the tissues. The nurse educates the patient and family about how to assess for edema and neurovascular status at home (circulation, motion, sensation). The affected foot is compared to the unaffected foot to determine differences in neurovascular function. Compromised neurovascular function can increase the patient's pain (see Chapter 35, Chart 35-4).

Pain experienced by patients who undergo foot surgery is related to inflammation and edema. Formation of a hematoma may contribute to the discomfort. To control the anticipated edema, the foot should be elevated on several pillows when the patient is sitting or lying. Support of the entire limb under the knee is preferable. Ice packs applied intermittently to the surgical area during the first 24 to 48 hours may be prescribed to control edema and provide some pain relief. As activity increases, the patient may find that dependent positioning of the foot is uncomfortable. Simply elevating the foot often relieves the discomfort. Oral analgesic agents may be used to control the pain. The nurse instructs the patient and family about appropriate use of these medications.

After surgery, the patient will have a bulky dressing on the foot, protected by a light cast or a special protective boot. Limits for weight bearing on the foot will be prescribed by the surgeon (Malhotra et al., 2017). Some patients are allowed to walk on the heel and progress to weight bearing as tolerated; other patients are restricted to non–weight-bearing activities. Assistive devices (e.g., crutches, walker) may be needed. The choice of the devices depends on the patient's general condition and balance and on the weight-bearing prescription. Safe use of the assistive devices must be ensured through adequate patient education and practice before discharge (see Chapter 2). Strategies to move around the house safely while using assistive devices are also discussed with the patient. As healing progresses, the patient gradually resumes ambulation within prescribed limits. The nurse emphasizes adherence to the therapeutic regimen.

The immobility of lower extremity surgery increases the risk of venous thromboembolism (VTE) development. See Chapter 26 for VTE risk assessment and treatment. Other postoperative complications may include limited range of motion, paresthesia, tendon injury, and recurrence of deformity. In addition, if percutaneous pins were used to hold bones in position, these pins may serve as potential sites of infection. Patient education concerning aseptic wound care and pin care may be necessary. See Chapter 37 for further discussion on pin care and infection prophylaxis. Care must be taken to protect the surgical wound from dirt and moisture. When bathing, the patient can secure a plastic bag over the dressing to prevent it from getting wet.

Osteoarthritis (Degenerative Joint Disease)

Osteoarthritis (OA) is a noninflammatory degenerative disorder of the joints. It is the most common form of joint disease and is sometimes also called degenerative joint disease. OA is classified as either primary (idiopathic), with no prior event or disease related to the OA, or secondary, resulting from previous joint injury or inflammatory disease, similar to RA (see Chapter 34). The pathophysiology of primary OA does not involve autoimmunity or inflammation. It can occur as an end result of an autoimmune disorder where joint destruction occurs. Another distinguishing characteristic of OA is that it is limited to the affected joints; there are no systemic symptoms associated with it (McCance & Huether, 2019).

OA often begins in the third decade of life and peaks between the fifth and sixth decades. By 40 years of age, 90% of the population has degenerative joint changes in their weight-bearing joints, even though clinical symptoms are usually absent (CDC, 2018). Women, especially those who are Hispanic or African American, are more commonly affected. The incidence of OA increases with age. It is estimated that over 85% of the general population over 65 years of age has radiographic changes indicating OA. Although OA is usually thought of as a disease of aging, it can affect younger patients resulting in significant loss of work-related productivity (CDC, 2018).

Pathophysiology

All joints consist of bone, particularly **subchondral bone** or the bony plate to which the articular cartilage is attached. This articular cartilage is a lubricated, smooth tissue that protects the bone from damage with physical activity. Between the articular cartilage of the bones forming the joint is a space (called the *joint space*) that allows for movement. To aid in fluidity, each joint contains synovial fluid to help lubricate and protect the joint's movement. With OA, the articular cartilage breaks down, leading to progressive damage to the underlying bone and eventual formation of **osteophytes** (bone spurs) that protrude into the joint space. The result is that the joint space is narrowed, leading to decreased joint movement and the potential for more damage. Consequently, the joint can progressively degenerate (see Fig. 36-7). Understanding of OA pathophysiology has been greatly expanded beyond what was previously thought of as simply "wear and tear" related to aging. The basic degenerative process in the joint exemplified in OA is presented in Figure 36-8. In addition to the degeneration, an infectious arthritis can occur. See later discussion of septic (infectious) arthritis.

Risk factors for the disease and its progression include older age, female gender, and obesity. In addition, certain occupations (e.g., those requiring laborious tasks); engaging in sport activities; and a history of previous injuries, muscle weakness, genetic predisposition, and certain diseases can also place patients at risk for joint destruction. The most prominent modifiable risk factor for OA is obesity. In fact, both quality and quantity of life are reduced with OA, especially when obesity and OA are combined. A program of diet and exercise can help minimize symptoms of OA in patients with obesity (CDC, 2018).

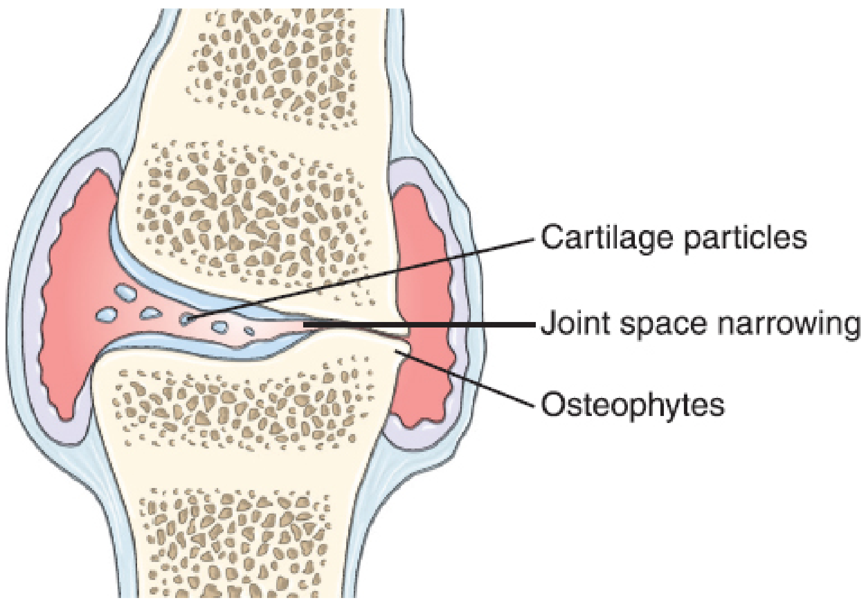

Figure 36-7 • Joint space narrowing and osteophytes (bone spurs) are characteristic of degenerative changes in joints.

Clinical Manifestations

The main clinical manifestations of OA are pain, stiffness, and functional impairment. The joint pain is usually aggravated by movement or exercise and relieved by rest. If morning stiffness is present, it is usually brief, lasting less than 30 minutes. The onset is routinely insidious, progressing over multiple years.

On physical examination, the affected joint may be enlarged with a decreased range of motion. Although OA occurs most often in weight-bearing joints (hips, knees, cervical and lumbar spine), the proximal interphalangeal (PIP) and distal interphalangeal (DIP) joints are also often involved causing bony enlargements of the DIP (Heberden's nodes) and PIP

(Bouchard's nodes) joints. Crepitus may be palpated, especially over the knee. Joint effusion, a sign of inflammation, is usually mild. No systemic manifestations are found.

Physiology/Pathophysiology

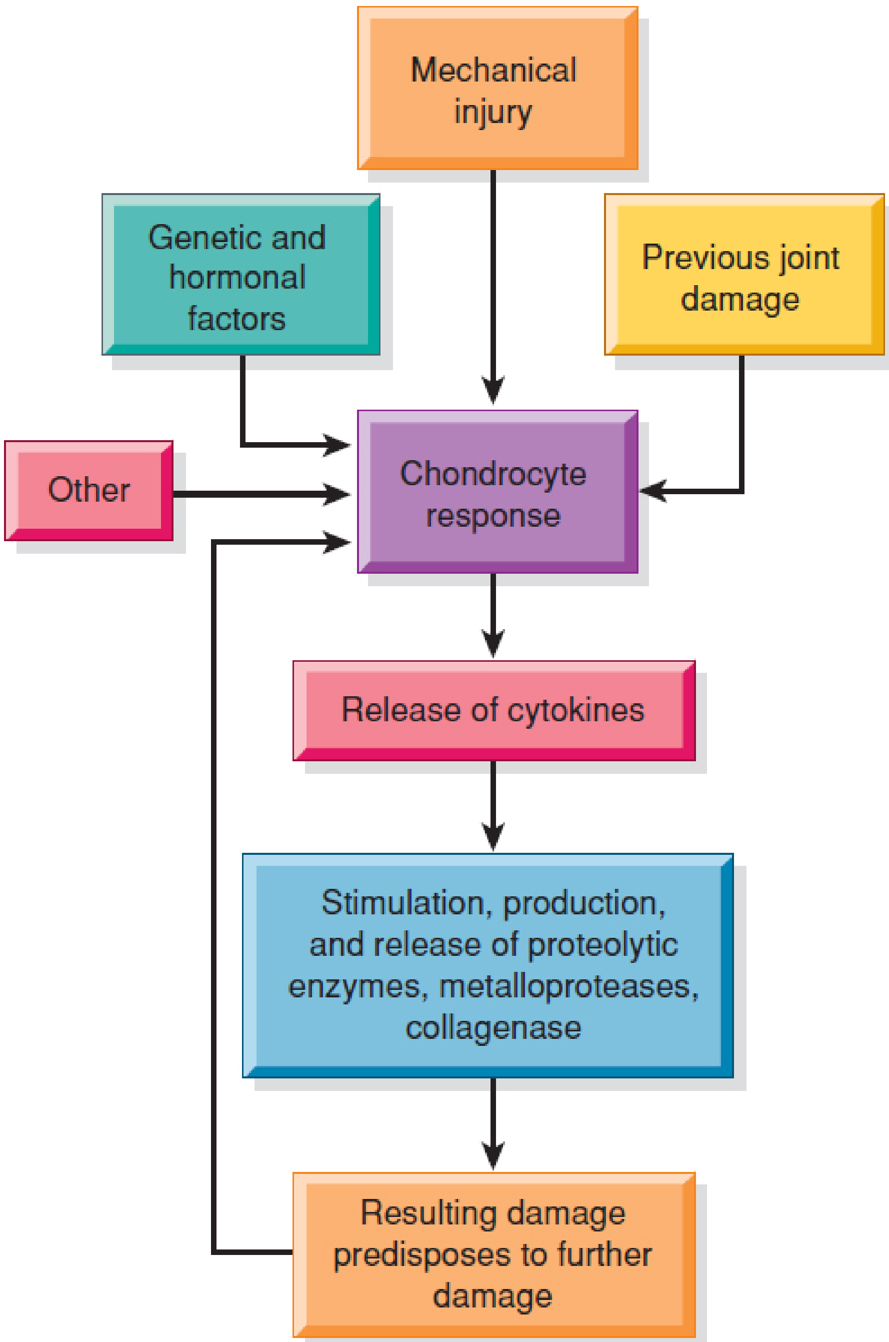

Figure 36-8 • Pathophysiology of osteoarthritis.

Assessment and Diagnostic Findings

Blood tests and examination of joint fluid are not useful in the diagnosis of OA but are occasionally indicated to rule out an autoimmune cause for the joint pain, such as RA. X-rays may show a narrowing of the joint space; osteophyte formation; and dense, thickened subchondral bone (O'Neill & Felson, 2018).

Medical Management

The goals of management are to decrease pain and stiffness and to maintain or, when possible, improve joint mobility. Exercise, especially in the form of cardiovascular aerobic exercise and lower extremity strength training, has been found to prevent OA progression and decrease symptoms of OA. Along with exercise, weight loss, which in turn decreases excess load on the joint, can also be extremely beneficial. Occupational and physical therapy can help the patient adopt self-management strategies (Schmidt, 2018).

Wedged insoles, knee braces, and other modalities are being evaluated as possible therapies aimed at treating the abnormalities in biomechanics found in OA. The use of orthotic devices (e.g., splints, braces) and walking aids (e.g., canes) can improve pain and function by decreasing force on the affected joint (Schmidt, 2018). Patients with arthritis often use complementary, alternative, and integrative health therapies, such as massage, yoga, pulsed electromagnetic fields, transcutaneous electrical nerve stimulation (TENS), and music therapy. These therapies may also include herbal and dietary supplements, other special diets, acupuncture, acupressure, wearing copper bracelets or magnets, and participation in T'ai chi. Research is under way to determine the effectiveness of many of these treatments. To date, there is no definitive evidence showing their superiority to standard care; the American College of Rheumatology (ACR) has encouraged the use of these therapies only if they do not interfere with medications and are found to increase comfort, mobility, and function for patients (Kolasinski, Neogi, Hochberg, et al., 2020).

Pharmacologic Therapy

Pharmacologic management of OA is directed toward symptom management and pain control. Selection of medication is based on the patient's needs, the stage of disease, and the risk of side effects. Medications are used in conjunction with nonpharmacologic strategies. In most patients with OA, the initial analgesic therapy is acetaminophen. Some patients respond to the nonselective NSAIDs and COX-2 enzyme blockers; however, COX-2 enzyme blockers must be used with caution because of the associated risk of cardiovascular disease and little to no decrease in GI upset. Other medications that may be considered are nonopioids, such as tramadol, opioids in severe cases, and intra-articular corticosteroids (Cooper, Chapurlat, Al-Daghri, et al., 2019; Kolasinski et al., 2020). Topical analgesic agents such as capsaicin and methylsalicylate are also used. Topical diclofenac sodium gel has been FDA approved for the use of osteoarthritic joint pain in the hands and knees (Cooper et al., 2019; Kolasinski et al., 2020). Methotrexate and colchicine, typically prescribed for treating RA and gout, respectively, may also be considered for some patients with OA who are refractory to other treatments. The pathophysiologic antecedents of these diseases are similar to those in OA, and it is believed that may explain the effectiveness of these medications in some select patients with OA (Kolasinski et al., 2020; Raman, FitzGerald, & Murphy, 2018).

Other therapeutic approaches include glucosamine and chondroitin. Although it has been suggested that these substances modify cartilage structure, studies have not shown them to be effective (Kolasinski et al., 2020; Runhaar, Rozendaal, Middlekoop, et al., 2017). Viscosupplementation, the injection of gel-like substances (hyaluronates) into a joint (intra-articular), is thought to supplement the viscous properties of synovial fluid. These viscosupplements aim to prevent the loss of cartilage and repair chondral defects but lack strong evidence that support their use (Kolasinski et al., 2020; Raman, Henrontin, Chevalier, et al., 2018).

Nursing Management

Pain management and optimal functional ability are the major goals of nursing interventions. With those goals in mind, nursing management of the patient with OA includes pharmacologic and nonpharmacologic approaches as well as education. The patient's understanding of the disease process and symptom pattern is critical to the plan of care. Because patients with OA usually are older, they may have other health problems. Commonly they are overweight, and they may have a sedentary lifestyle. Weight loss and exercise are important approaches to lessen pain and disability. Canes or other assistive devices for ambulation should be considered, and any stigma about the use of these devices should be explored. Exercises such as walking should be begun in moderation and increased gradually. Patients should plan their daily exercise for a time when the pain is least severe or plan to use an analgesic agent, if appropriate, before exercising. Adequate pain management is important for the success of an exercise program. Open discussion regarding the use of complementary, alternative, and integrative health therapies is important to maintain safe and effective practices for patients looking for relief.

The Patient Undergoing Arthroplasty

In moderate to severe OA, when pain is severe or because of loss of function, surgical intervention may be used. The procedures most commonly used are osteotomy (to alter the distribution of weight within the joint) and arthroplasty. Joint **arthroplasty** refers to the surgical removal of an unhealthy joint and replacement of joint surfaces with metal or synthetic materials.

Patients with OA and with severe joint pain and disability may undergo arthroplasty. Other conditions contributing to joint degeneration that might require arthroplasty include RA, trauma, and congenital deformity. Some fractures (e.g., femoral neck fracture) may cause disruption of the blood supply and subsequent **avascular necrosis** (death of tissue due to insufficient blood supply); management with joint replacement may be elected over open reduction internal fixation (ORIF) (see Chapter 37). Joints frequently replaced include the hip, knee (see Fig. 36-9), and finger joints. More complex joints (shoulder, elbow, wrist, ankle) are replaced less frequently.

Total joint arthroplasty, also known as total joint replacement, involves the replacement of all components of an articulating joint. Most joint replacements consist of metal (e.g., stainless steel, cobalt-chromium, titanium) and high-density polyethylene components. In order to achieve fixation of components, the material can be cemented, cementless, or a hybrid of both of these materials. Cemented fixation uses a fast-curing bone cement (polymethylmethacrylate [PMMA]) to hold implants in place. Cementless fixation relies on new bone growing into the surface of the implant by using a press-fit, porous-coated prosthesis. There is also a hybrid fixation technique for total knee arthroplasty (TKA) where the femoral component is inserted without cement, and the tibial and patellar components are inserted with cement. Use of each of these materials and techniques have different benefits and risks. Current research evidence supports the use of either component fixation methods (cemented or cementless) because postoperative functional outcomes, rates of complications, and rates of reoperations are similar (Quinn, Murray, Pezold, et al., 2018). Identifying patient-specific factors that may inform the decision to utilize a particular fixation technique is important. Considerations include gender, age, diagnosis, weight and activity level as well as the presence of healthy bone with adequate blood supply. Issues of cost and cost-effectiveness should also be considered (Quinn et al., 2018).

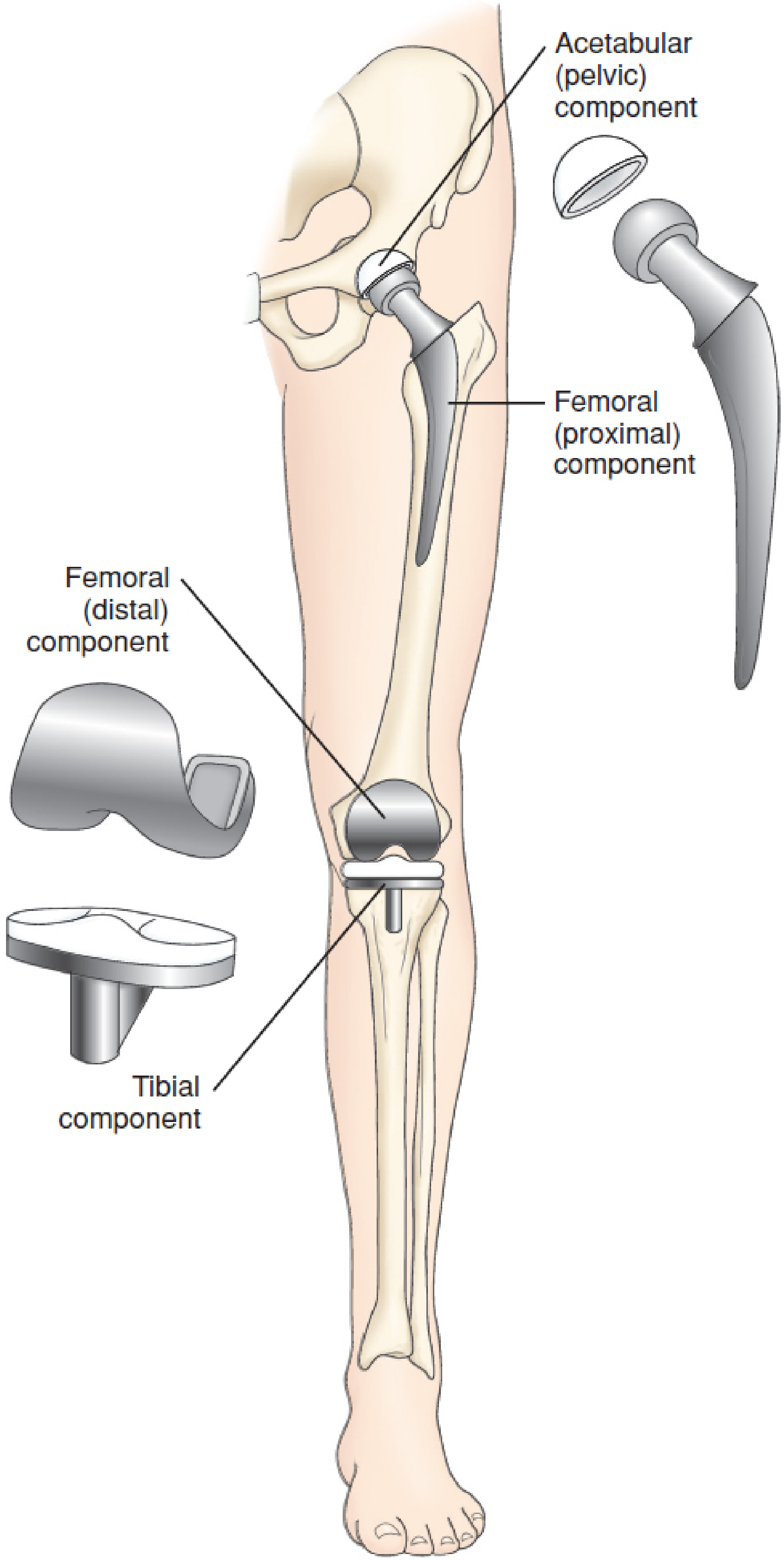

Figure 36-9 • Examples of Hip and Knee Replacement.

With joint replacement, patients may expect pain relief, return of joint motion, and improved functional status and quality of life. The scope of these improvements depends in part on patients' preoperative soft tissue condition and general muscle strength. Serious complications seldom occur, and recent innovations in total joint replacement surgery have made this a safer and more routinely performed surgery. Rehabilitation with physical therapy that is initiated within the first 24 hours is associated with decreased hospital length of stay and improved balance and gait function (Quinn et al., 2018). In addition, minimally invasive surgical techniques, biomaterials, postoperative rehabilitation protocols, and multimodal analgesia strategies have led to earlier hospital discharge and quicker recovery (Lee, 2016). The American Joint Replacement Registry (AJRR) monitors the performance of devices and evaluates the cost-effectiveness of procedures. The data generated from the AJRR and other registries provide orthopedic researchers and practitioners with the information necessary to improve the quality of health care among patients in need of knee and hip replacement procedures (Dy, Bumpass, Makhni, et al., 2016). Annual reports are provided to hospital system members to facilitate quality improvement programs (American Academy of Orthopaedic Surgeons [AAOS], 2020).

Preoperative and Intraoperative Nursing Management

Preoperative and intraoperative assessment and management of the patient having arthroplasty are aimed at having the patient in optimal health for surgery (see Chapters 14 and 15). Risks for bleeding, VTE, infection, and pain are managed proactively.

Preventing and Managing Blood Loss

Until recently, acute postoperative anemia due to perioperative blood loss was a common occurrence in patients having total hip arthroplasty (THA) and TKA; allogeneic blood transfusions (i.e., blood transfused from a donor) were required in up to 50% of patients who had THA and TKA (Rasouli, Maltenfort, Erkocak, et al., 2016). Recent research findings suggest that rate has dropped significantly, to approximately 9% of patients who have THA and 4% for patients who have TKA (Bedard, Pugely, Lux, et al., 2017). This diminished demand for allogeneic blood transfusions is attributable to the following interventions (Alexander & Frew, 2017; Loftus, Spratling, Stone, et al., 2016; Martin & Harris, 2020; Stalenhag & Sterner, 2019):

- Appropriate preoperative assessment and treatment of patients with anemia (i.e., low red blood cell counts) with pharmacologic agents, such as epoetin alfa or iron supplements
- Application of pneumatic tourniquets during orthopedic limb surgery (e.g., TKA), which not only minimizes bleeding but also helps maintain a clean surgical field
- Employment of intraoperative red blood cell salvage systems, as appropriate, during procedures when a large volume of blood is lost. This is effectively a type of autologous transfusion; that is, the patient's own blood is salvaged during the operative procedure and re-transfused back to the patient.
- Intraoperative administration of the antifibrinolytic agent tranexamic acid, which is thought to have significantly reduced overall blood loss and the need for blood transfusions in patients having THA or TKA.

Preventing Venous Thromboembolism

Patients having orthopedic surgery are particularly at risk for VTE, including deep vein thrombosis (DVT) and pulmonary embolism (PE). Therefore, factors that compound or further increase this risk are assessed preoperatively. Increasing age (older than age 40), obesity, taking prescription hormonal medications, preoperative leg edema, previous history of any VTE, and varicose veins increase the risk for postoperative DVT and PE (Menaka & Douketis, 2019). The use of medications that increase the risk of clotting, such as certain hormones and NSAIDs, may be discontinued a week before surgery. Prophylactic low-molecular-weight heparin (LMWH) or another anticoagulant agent may be prescribed prior to or after surgery (Quinn et al., 2018).

Assessing the neurovascular status of the extremity undergoing joint replacement is important, because postoperative assessment data are compared with preoperative assessment data to identify changes and any arterial impairment to the affected extremity. For example, an absent pulse postoperatively is of concern unless the pulse was also absent preoperatively. Nerve palsy could occur as a result of surgery.

Preventing Infection

Preoperative assessment of the patient for recent or active infections, including urinary tract infection, is necessary because of the risk for postoperative infection. Any infection presenting 2 to 4 weeks before planned surgery may result in postponement of surgery. Preoperative skin preparations, such as showers with antiseptic soap, are recommended the evening before and the morning of surgery. Scrubbing of the surgical site with a prescribed antiseptic soap the night before or on the morning of surgery decreases bacterial count on the skin and helps lower the chance of infection (Berrios-Torres, Umscheid, Bratzler, et al., 2017; Papas, Conguista, Scuderi, et al., 2018).

Research findings suggest that prophylactic broad-spectrum antibiotics given 60 minutes prior to skin incision and discontinued within 24 hours postoperatively are effective in preventing surgical site infections (De Francesco, Fu, Kalenberg, et al., 2019).

The use of antibiotic-loaded bone cement and preoperative nasal swabbing to screen for patients who are carriers of methicillin-resistant *Staphylococcus aureus* (MRSA) or methicillin-sensitive *Staphylococcus aureus* (MSSA) may help in further reducing postoperative infections; the effectiveness of these modalities is under research as is the use of dual antibiotic therapy (Villa, Pannu, Riesgo, et al., 2020). Culture of the joint during surgery may be important in identifying and treating subsequent infections.

Managing Pain

Assessment of the patient's pain preoperatively and any cultural and personal preferences are important components related to the control of pain following joint surgery. Assessing the patient's level of understanding of the surgery and explaining what to expect in the postoperative period (e.g., incentive spirometry, pain control methods, activity limits) can improve outcomes. Research findings suggest that patients who are supported and educated telephonically in the preoperative period report better quality of life and well-being postoperatively (Allsop, Fairhall, & Morphet, 2019) (see Nursing Research Profile in Chart 36-5). However, high anxiety and severe pain prior to surgery may have an impact on these outcomes (Jones, Al-Naseer, Bodger, et al., 2018) (see Chapter 9).

Total Hip Arthroplasty

THA is the replacement of a severely damaged hip with an artificial joint. Indications for this surgery include OA, as well as RA, femoral neck fractures (i.e., hip fracture; see Chapter 37), failure of previous reconstructive surgeries, such as a failed prosthesis with osteotomy, and conditions resulting from developmental dysplasia or Legg–Calvé–Perthes disease (avascular necrosis of the hip in childhood). A variety of total hip prostheses are available. Most consist of a metal femoral component topped by a spherical ball made of metal, ceramic, or plastic that is fitted into a plastic or metal acetabular socket (see Fig. 36-9).

The surgeon selects the prosthesis that is best suited to the individual patient, considering various factors including skeletal structure and activity level. The patient has irreversibly damaged hip joints, and the potential benefits, including improved quality of life, outweigh the surgical risks. With the advent of improved prosthetic materials and operative techniques, the life of the prosthesis has been extended, and today younger patients with severely damaged and painful hip joints are undergoing total hip replacement.

Nursing Management

The nurse must be aware of and monitor for specific potential complications associated with THA (Gabbert, Filson, Bodden, et al., 2019). Complications that may occur include dislocation of the hip prosthesis, excessive wound drainage, VTE, infection, and heel pressure injury (see Chart 36-6). The nurse also monitors for complications associated with immobility. Long-term complications include **heterotopic ossification** (formation of bone in the periprosthetic space), avascular necrosis, and loosening of the prosthesis.

Chart 36-5 NURSING RESEARCH PROFILE

Preoperative Telephone Support for Patients Having Total Knee Arthroplasty

Allsop, S., Fairhill, R., & Morphet, J. (2019). The impact of pre-operative telephone support and education on symptoms of anxiety, depression, pain and quality of life post total knee replacement. *International Journal of Orthopaedic and Trauma Nursing*, *34*, 21–27.

Purpose

Patients scheduled to have elective total knee arthroplasty (TKA) can experience anxiety and depression during the preoperative waiting period which may negatively impact postoperative outcomes. The purpose of this study was to determine whether preoperative patient support and education delivered via telephone would impact postoperative reports of quality of life (QOL), depression, anxiety and pain among patients having total knee replacement surgery.

Design

This mixed methods study explored the effects of a support intervention in a sample of participants (N = 18) who underwent unilateral total knee replacements. Pre-tests were administered up to 6 weeks prior to elective surgery in the clinic setting. Those with infections, malignancy, or repeat interventions were excluded. Baseline data included demographics and Patient Reported Outcomes Measures (PROMS) which assessed QOL, psychological distress, and pain; using scales previously validated in this population.

Two phone calls were made by the same researcher to address open- and closed-ended questions based on information considered essential for patients to understand before surgery. The researcher individualized content that was delivered to the participants in response to their unique questions and concerns. A thematic analysis was undertaken to identify patterns in responses. The PROMS scales were readministered 6 weeks after surgery, either during a clinic visit or by telephone.

Findings

Of the 18 enrolled participants, 16 completed the study. One third were men; 19% lived alone; half of the participants were under 65 years of age and 69% of them were not actively employed. Depression and anxiety (rated as high or very high) were reported by 31% of the patients preoperatively.

Participants' concerns related to the administrative processes of admission and discharge and the psychological processing of having a major surgery; some expressed fears of being awake with spinal anesthetic approaches. Participants voiced concerns about their caregivers, the potential for infection, and the wish to return home quickly.

Many favorable comments were made concerning the positive impact of the program.

Fewer participants experienced anxiety and depression post-surgery; however, this change was not significant. There were significant improvements in QOL scores ($p = 0.008$) and pain scores ($p < 0.001$). However, compared to previous studies (most of which had longer duration of interventions and follow-up), the improvement in QOL, anxiety, and pain scores was not as substantial.

Nursing Implications

Findings from this study suggest that preoperative telephone support and education of patients scheduled for TKA can improve QOL and pain postoperatively. This study only spanned a 6-week postoperative period, potentially limiting the ability to capture change in study outcomes. This was a single site study which warrants replication in a greater number of facilities with greater attention to the optimal time period required to assess outcomes in this population. In addition, greater attention to more comprehensive psychological interventions preoperatively may also be required for better success in the long term.

Chart 36-6 PLAN OF NURSING CARE

The Patient with a Total Hip Arthroplasty

NURSING DIAGNOSIS: Acute pain associated with total hip arthroplasty
GOAL: Relief of pain

Nursing Interventions	Rationale	Expected Outcomes
1. Assess patient for pain using a standard pain intensity scale. 2. Ask patient to describe discomfort. 3. Acknowledge existence of pain; inform patient of available analgesic agents or muscle relaxants. a. Use pain-modifying techniques. Administer analgesic agents as prescribed. b. Change position within prescribed limits. c. Modify environment. d. Notify primary provider about	1. Pain is expected after a surgical procedure because of the surgical trauma and tissue response. Muscle spasms occur after total hip replacements. Immobility causes discomfort at pressure points. 2. Pain characteristics may help to determine the cause of discomfort. Pain may be due to complications (hematoma, infection, dislocation). Pain is an individual experience—it means different things to different people. 3. The nurse can reduce the stress experienced by patient by communicating concern and availability of assistance to help the patient deal with the pain. a. Patient will require parenteral opioids during the first 24–48 hours and then will progress to	• Describes discomfort • Expresses confidence in efforts to control pain • States pain is reduced; pain intensity scores are decreasing • Appears comfortable and relaxed • Uses physical, psychological, and pharmacologic measures to reduce pain and discomfort

persistent pain. 4. Evaluate and record discomfort and effectiveness of pain-modifying techniques.	oral analgesic agents. b. The use of pillows to provide adequate support and relief of pressure on bony prominences assists in minimizing pain. c. Interactions with others, distractions, and sensory overload or deprivation may affect pain experience. d. Surgical intervention may be necessary if pain is due to hematoma or excessive edema. 4. Effectiveness of action is based on experience; data provide a baseline about pain experiences, pain management, and pain relief.	

Nursing Diagnosis: Impaired mobility associated with positioning, weight bearing, and activity restrictions after total hip arthroplasty
Goal: Achieves pain-free, functional, stable hip joint

Nursing Interventions	Rationale	Expected Outcomes
1. Maintain proper positioning of hip joint (abduction, neutral rotation, limited flexion). 2. Keep pressure off heel. 3. Instruct and assist in position changes and transfers. 4. Instruct and supervise isometric quadriceps and gluteal setting exercises. 5. In consultation with physical therapist, instruct and supervise progressive safe ambulation within limitations of weight-bearing prescription. 6. Offer encouragement and support exercise regimen.	1. Prevents dislocation of hip prosthesis. 2. Prevents pressure injury on heel. 3. Encourages patient's active participation while preventing dislocation. 4. Strengthens muscles needed for walking. 5. Amount of weight bearing depends on patient's condition and prosthesis; ambulatory aids are used to assist the patient with non–weight-bearing and partial weight-bearing ambulation. 6. Reconditioning exercises can be uncomfortable and fatiguing; encouragement helps patient comply with exercise program. 7. Prevents injury from unsafe use and prevents falls.	• Maintains prescribed position • No heel pressure • Assists in position changes • Shows increased independence in transfers • Exercises hourly while awake • Participates in progressive ambulation program • Actively participates in exercise regimen • Uses ambulatory aids correctly and safely

7. Instruct and supervise safe use of ambulatory aids.		

Collaborative Problems: Hemorrhage; neurovascular compromise; dislocation of prosthesis; venous thromboembolism; infection associated with surgery
Goal: Absence of complications

Nursing Interventions	Rationale	Expected Outcomes
Hemorrhage		
1. Monitor vital signs, observing for shock. 2. Note character and amount of drainage. 3. Notify primary provider if patient develops shock or excessive bleeding, and prepare for administration of fluids, blood component therapy, and medications. 4. Monitor hemoglobin and hematocrit values.	1. Changes in pulse, blood pressure, and respirations may indicate development of shock. Blood loss and stress of surgery may contribute to development of shock. 2. Within 48 hours, bloody drainage collected in portable suction device, if in use, should decrease to 25–30 mL per 8 hours. Excessive drainage (>250 mL in first 8 hours after surgery) and bright-red drainage may indicate active bleeding. 3. Corrective measures need to be instituted.	• Vital signs stabilize within normal limits • Amount of drainage decreases • No bright-red bloody drainage • Hematology values are within normal limits

	4. Anemia due to blood loss may develop. Blood replacement or iron supplementation may be needed.	

Neurovascular Dysfunction

1. Assess affected extremity for color and temperature. 2. Assess toes for capillary refill response. 3. Assess extremity for edema and swelling. Report patient complaints of leg tightness. 4. Elevate lower extremity. Keep elevated extremity lower than hip when in chair. 5. Assess for deep, throbbing, unrelenting pain. 6. Assess for pain on passive flexion of foot.	1. The skin becomes pale and feels cool with decreased tissue perfusion. Venous congestion may produce cyanosis. 2. After compression of the nail, rapid return of pink color indicates good capillary perfusion. 3. The trauma of surgery will cause edema. Excessive swelling and hematoma formation can compromise circulation and function. 4. Minimizes dependent edema. Hip is never flexed more than 90 degrees to prevent dislocation. 5. Surgical pain can be controlled with pharmacologic and nonpharmacologic interventions; pain due to neurovascular	• Color normal • Extremity warm • Normal capillary refill • Moderate edema and swelling; tissue not palpably tense • Pain controllable • No pain with passive dorsiflexion • Normal sensations • No paresthesia • Normal motor abilities • No paresis or paralysis • Pulses strong and equal

7. Assess for change in sensations and numbness. 8. Assess ability to move foot and toes. 9. Assess pedal pulses in both feet. 10. Notify surgeon if altered neurovascular status is noted.	compromise typically does not respond to traditional postoperative pain management strategies. 6. With nerve ischemia, there will be pain on passive stretch. Additionally, pain or tenderness may indicate deep vein thrombosis. 7. Diminished pain and sensory function may indicate nerve damage. Sensation in web between great and second toe–peroneal nerve; sensation on sole of foot–tibial nerve. 8. Dorsiflexion of ankle and extension of toes indicate function of peroneal nerve. Plantar flexion of ankle and flexion of toes indicate function of tibial nerve. 9. Indicator of extremity circulation. 10. Function of extremity needs to be preserved.

Dislocation of Prosthesis

1. Position patient as prescribed. 2. Use abductor splint or pillows to maintain position and to support extremity. 3. Support leg and place pillows between legs when patient is turning and side-lying; turn to the unaffected side. 4. Avoid acute flexion of hip (head of bed ≤90 degrees). 5. Avoid crossing legs. 6. Assess for dislocation of prosthesis (extremity shortens, internally or externally rotated, severe hip pain, patient unable to move extremity). 7. Notify surgeon of possible dislocation.	1. Hip component positioning (femoral component in acetabular component) needs to be maintained. 2. Keeps hip in abduction and in a neutral rotation to prevent dislocation. 3. Prevent dislocation. 4. Findings may indicate dislocation of prosthesis. 5. Joint dislocations compromise neurovascular status and future function of extremity.	• Prosthesis not dislocated • Adheres to recommendations to prevent dislocation
Venous Thromboembolism		
1. Use anti-	1. Aids in venous	• Wears anti-

embolism stocking and sequential compression device as prescribed. 2. Remove stocking for 20 minutes twice a day and provide skin care. 3. Assess popliteal, dorsalis pedis, and posterior tibial pulses. 4. Assess skin temperature of legs. 5. Assess for unilateral calf pain or tenderness every 8 hours. 6. Avoid pressure on popliteal blood vessels from equipment (e.g., abductor splint straps, sequential compression stockings) or pillows. 7. Change position and increase activity as prescribed. 8. Supervise ankle exercises hourly.	blood return and prevents stasis. 2. Aids in venous blood return and prevents stasis. 3. Skin care is necessary to avoid breakdown. Extended removal of stocking defeats purpose of stocking. 4. Pulses indicate arterial perfusion of extremity. 5. Local inflammation will increase local skin temperature. 6. Pain or tenderness may indicate deep vein thrombosis. 7. Compression of blood vessels diminishes blood flow. 8. Activity promotes circulation and diminishes venous stasis. 9. Muscle exercise promotes circulation. 10. Body temperature increases with inflammation. 11. Dehydration increases blood viscosity.	embolism stocking; uses compression device • No skin breakdown • Pulses equal and strong • Skin temperature normal • No calf pain or tenderness • Changes position with assistance and supervision • Participates in exercise regimen • Well hydrated • No chest pain; lungs clear to auscultation; no evidence of pulmonary emboli

9. Monitor body temperature.		
10. Encourage fluids.		
Infection		
1. Monitor vital signs.	1. Temperature, pulse, and respirations increase in response to infection. (Magnitude of response may be minimal in older adults.)	• Vital signs normal • Well-approximated incision without drainage or excessive inflammatory response • Minimal discomfort; no hematoma • Tolerates antibiotics
2. Use aseptic technique for dressing changes and emptying of portable drainage.	2. Avoids introducing organisms.	
3. Assess wound appearance and character of drainage.	3. Red, swollen, draining incision is indicative of infection.	
4. Assess complaints of pain.	4. Pain may be due to wound hematoma–a possible locus of infection–that needs to be surgically evacuated.	
5. Administer prophylactic antibiotics if prescribed, and observe for side effects.	5. Infected prosthesis is avoided.	

Figure 36-10 • An abduction pillow may be used after a total hip arthroplasty to prevent dislocation of the prosthesis.

Preventing Dislocation of the Hip Prosthesis

For patients undergoing a posterior or posterolateral approach for THA, maintenance of the femoral head component in the acetabular cup is essential. The risk for dislocation is more common with this approach and may occur when the hip is in full flexion, adducted (legs together), and internally rotated. Therefore, correct positioning is maintained at all times. The patient should be in a supine position with the head slightly elevated and the affected leg in a neutral position. The use of an abduction splint, a wedge pillow (see Fig. 36-10), or two or three pillows placed between the legs prevent adduction beyond the midline of the body. A cradle boot may be used to prevent leg rotation and to support the heel off the bed, preventing development of a pressure injury. When the nurse turns the patient in bed to the unaffected side, it is important to keep the operative hip in **abduction** (movement away from the center or median line of the body) (Gabbert et al., 2019). The patient should not be turned to the operative side, which could cause dislocation, unless specified by the surgeon.

The patient's hip is never flexed more than 90 degrees. When using a fracture bedpan, the nurse instructs the patient to flex the unaffected hip and to use the trapeze to lift the pelvis onto the pan. The patient is also reminded not to flex the affected hip.

Limited flexion is maintained during transfers and when sitting. When the patient is initially assisted out of bed, an abduction splint or pillows are kept between the legs. The nurse encourages the patient to keep the affected hip in extension, instructing the patient to pivot on the unaffected leg with assistance by the nurse, who protects the affected hip from **adduction** (movement toward the center or median line of the body), flexion, internal or external rotation, and excessive weight bearing.

High-seat (orthopedic) chairs with arm rests, semi-reclining chairs, and raised toilet seats are used to minimize hip joint flexion. When sitting, the patient's hips should be higher than the knees. The patient's affected leg should not be elevated when sitting. The patient may flex the knee.

The nurse educates the patient about protective positioning, which includes maintaining abduction and avoiding internal and external rotation, hyperextension, and acute flexion, as described previously. At no time should the patient cross the legs or bend at the waist past 90 degrees (e.g., to put on shoes and socks). Occupational therapists can provide the patient with devices to assist with dressing below the waist. Hip precautions for patients who had a posterior or posterolateral approach for THA should be enforced for 4 months or longer after surgery (see Chart 36-7). A patient who has had an anterior surgical approach may not need these precautions. Several studies have reported an anterolateral approach to THA results in a lower rate of dislocation than a posterior approach owing to its ease of access, superior visualization, and a predictable healing pattern. Using a less restrictive mobility protocol in these patients can lead to earlier and better resumption of ADL, earlier return to work, a shorter length of hospital stay, and improved patient satisfaction (Morris, Fornit, Marchoni, et al., 2018).

Dislocation may occur with positioning that exceeds the limits of the prosthesis. The nurse must monitor for signs and symptoms of dislocation of the prosthesis, which include:

- Increased pain at the surgical site, swelling, and immobilization
- Acute groin pain in the affected hip or increased discomfort
- Shortening of the affected extremity
- Abnormal external or internal rotation of the affected extremity
- Restricted ability or inability to move the leg
- Reported "popping" sensation in the hip

If any of these clinical manifestations occur, the nurse (or the patient, if at home) immediately notifies the surgeon, because the hip must be reduced and stabilized promptly so that the leg does not sustain circulatory and nerve damage. After closed reduction, the hip may be stabilized with Buck's traction or a brace to prevent recurrent dislocation (see Chapter 37, Fig. 37-11). As the muscles and joint capsule heal, the chance of dislocation diminishes. Stresses to the new hip joint should be avoided for the first 8 to 12 weeks, when the risk of dislocation is greatest (Gabbert et al., 2019).

Promoting Ambulation

Patients begin ambulation with the assistance of a walker or crutches within a day after surgery. The nurse and the physical therapist assist the patient in achieving the goal of independent ambulation. At first, the patient may be able to stand for only a brief period because of orthostatic hypotension. Specific weight-bearing limits on the prosthesis are based on the patient's condition, the procedure, and the fixation method. Weight bearing immediately after surgery may be limited to minimize micromotion of the prosthesis in the bone. As the patient is able to tolerate more activity, the nurse encourages transferring to a chair several times a day for short periods and walking for progressively greater distances.

Monitoring Wound Drainage

Fluid and blood accumulating at the surgical site, which could contribute to discomfort and provide a source for infection, may be drained with a closed suction portable suction device. The efficacy of using a wound drainage system is controversial, especially since the system can be a potential source for infection (Keeney, Austin, & Jevsevar, 2019; Mujagic, Hoffmann, Soysal, et al., 2019). In particular, drains that remain in place for longer than 24 hours create an increased risk for contamination and infection (Keeney et al., 2019; Mujagic et al., 2019). The nurse should monitor the amount of drainage and measure output each shift; the surgeon must be promptly notified of excessive or foul-smelling drainage. After the drain is removed, the drain tube site is cleaned with an antiseptic solution and a small gauze dressing is applied if there is oozing at the site (Gabbert et al., 2019).

Chart 36-7 PATIENT EDUCATION

Avoiding Hip Dislocation After Arthroplasty with Posterior or Posterolateral Approach

The nurse instructs the patient to:
Until the hip prosthesis stabilizes after hip replacement surgery, it is necessary to follow instructions for proper positioning so that the prosthesis remains in place. Dislocation of the hip is a serious complication of surgery that causes pain and loss of function and necessitates reduction under anesthesia to correct the dislocation. Desirable positions include abduction, neutral rotation, and flexion of less than 90 degrees. When you are seated, the knees should be lower than the hip.

The nurse notes the following methods for avoiding displacement:

- Keep the knees apart at all times.
- Put a pillow between the legs when sleeping.
- Never cross the legs when seated.
- Avoid bending forward when seated in a chair.
- Avoid bending forward to pick up an object on the floor.
- Use a high-seated chair and a raised toilet seat.
- Do not flex the hip to put on clothing such as pants, stockings, socks, or shoes. Positions to avoid after total hip replacement are shown in the illustrations.

Affected leg should not cross the center of the body

Hip should not bend more than 90 degrees

Affected leg should not turn inward

Preventing Venous Thromboembolism

Without prophylaxis, DVT formation can develop within 7 to 14 days following surgery and lead to PE, which can be fatal. Early identification of the patient's VTE risk, ensuring that the patient receives the appropriate prophylaxis, instituting preventive measures, and monitoring the patient closely for clinical signs of the development of DVT and PE are key. However, the nurse should also be aware that VTE prevention may increase the postoperative risk for bleeding and stay alert for this potential complication (Erens & Walter, 2019).

Physical signs of DVT include pain and tenderness at or below the area of the clot, swelling or tightness of the affected leg, possibly with pitting edema, with either warmth or cooling, and skin discoloration; PE symptoms may include acute onset of dyspnea, tachycardia, confusion, and pleuritic chest pain (McCance & Huether, 2019).

Intermittent compression devices are applied either intraoperatively or immediately postoperatively; these devices must remain on the legs at all times, even when the patient is out of bed. Patients should be instructed to dorsi- and plantar flex the ankles and the toes 10 to 20 times every half hour while awake. In addition, patients who are post-THA should be mobilized as soon as possible to assist with decreasing venous stasis; even patients with epidural catheters should stand and ambulate when they are physically able (Erens & Walter, 2019).

Aspirin, LMWH and synthetic pentasaccharides (fondaparinux) can be used as prophylaxis for VTE. They typically are continued for up to 35 days following surgery based on surgeon preference and patient risk level (Menaka & Douketis, 2019) (see Chapter 26 for further discussion of VTE and VTE prophylaxis).

Preventing Infection

Infection—a serious complication of THA—may necessitate removal of the prosthesis. Patients who are older, poorly nourished, smoke cigarettes, or use corticosteroid medications and patients who have obesity, diabetes, RA, concurrent infections (e.g., urinary tract infection, dental abscess), carry MRSA, or have hematomas are at high risk for infection (Beam & Osmon, 2018). Use of two types of antibiotics is being investigated as a method to decrease MRSA infections both in THA and TKA (Villa et al., 2020).

Over time, one in five patients with THA will undergo revision of the prosthesis, most commonly because of aseptic loosening, infection, instability, or a mechanical complication. Because these joint infections are difficult to treat, strategies for preventing infections should be implemented at various steps of the process of care. Strict hand hygiene and utilization of appropriate infection control practices can prevent transmission of infectious organisms. Appropriate antibiotic administration and discontinuation, as well as thorough patient education regarding subsequent antibiotic use are important.

Chart 36-8

Providing Home Care After Total Hip Arthroplasty

Considerations

- Pain management
- Wound care
- Mobility
- Self-care (activities of daily living)
- Potential complications

Nursing Interventions

Discuss with patient the following methods to reduce pain:

- Periodic rest
- Distraction and relaxation techniques
- Medication therapy (e.g., nonsteroidal anti-inflammatory drugs, opioid analgesic agents): actions of medications, administration, schedule, side effects

Instruct patient in the following:

- Keeping incision clean and dry
- Cleansing incision daily with soap and water and changing the dressing
- Recognizing signs of wound infection (e.g., pain, increased redness, swelling, purulent drainage, fever)

Explain that sutures or staples will be removed 10 to 14 days after surgery.

Educate patient about the following:

- Safe use of assistive devices
- Weight-bearing limits
- How to change positions frequently
- Limitations on hip flexion and adduction (e.g., avoid acute flexion and crossing legs)
- How to stand without flexing hip acutely
- Avoidance of low-seated chairs and toilets
- Sleeping with pillow between legs to prevent adduction
- Gradual increase in activities and participation in prescribed exercise regimen
- Use of important medications such as warfarin and aspirin

Assess home environment for physical barriers.

Instruct patient to use elevated toilet seat and to use reachers to aid in dressing.

Encourage patient to accept assistance with activities of daily living during early convalescence until mobility and strength improve.

Arrange services and accommodations to address the patient's disability or illness, as appropriate.

Assess patient for development of potential problems, and instruct patient to report signs of potential complications:

- Dislocation of prosthesis (e.g., increased pain, shortening of leg, inability to move leg, popping sensation in hip, abnormal rotation)
- Deep vein thrombosis (e.g., calf pain, swelling, redness)
- Wound infection (e.g., pain, increased redness, swelling, purulent drainage, fever)
- Pulmonary emboli (e.g., shortness of breath, tachypnea, pleuritic chest pain)

Discuss with patient the need to continue regular health care (routine physical examinations) and screenings.

Adapted from Erens, G. A., Walter, B., & Crowley, M. (2020). Total hip arthroplasty. *UpToDate*. Retrieved on 3/16/2020 at: www.uptodate.com/contents/total-hip-arthroplasty

Acute infections may occur within 3 months after surgery and are associated with progressive superficial infections or hematomas. Delayed surgical infections may appear 4 to 24 months after surgery and may cause return of discomfort in the hip. Routine use of antibiotic prophylaxis prior to dental procedures for patients with total joint prostheses remains controversial and is not recommended (Goff, Mangino, Glassman, et al., 2019). Antibiotic prophylaxis can still be prescribed for patients who are immunosuppressed.

Infections occurring more than 2 years after surgery are attributed to the spread of infection through the bloodstream from another site in the body. If an infection occurs, antibiotics are prescribed. Severe infections may require surgical débridement or removal of the prosthesis. (See sections on Septic Arthritis and Osteomyelitis later in this chapter.)

Promoting Home, Community-Based, and Transitional Care

Educating the Patient About Self-Care

Before the patient leaves the acute care setting, the nurse provides thorough education to promote continuity of the therapeutic regimen and active participation in the rehabilitation process (see Chart 36-8). The patient may be discharged to the home, a rehabilitation unit, a transitional care unit, or a long-term care facility. The nurse advises the patient of the importance of a daily exercise program in maintaining the functional motion of the hip joint and strengthening the abductor muscles of the hip, and reminds the patient that it will take time to strengthen and retrain the muscles.

Most patients benefit from physical therapy to regain mobility. Assistive devices (crutches, walker, or cane) may be used for a time. After sufficient muscle tone has developed to permit a normal gait without discomfort, these devices are not necessary. In general, by 3 months, the patient can resume routine ADLs. Stair climbing typically may resume within 3 to 6 weeks following surgery. Some discomfort with activity and at night is common for several weeks. Frequent walks, swimming, and the use of a high rocking chair are excellent for hip exercises.

Restrictions must be kept in mind when resuming sexual activity. Patients should be questioned about concerns and counseled on physical and functional aspects of sexual activity. Sexual activity can be resumed based upon the surgeon's recommendation (typically 3 to 6 months postoperatively). Attention to positioning and comfort may enhance the intimacy of the experience.

At no time during the first 4 months should the patient cross the legs or flex the hip more than 90 degrees. Assistive devices should be used for dressing, such as long-handled shoehorns or dressing sticks for putting on shoes and socks. The patient should avoid low chairs and sitting for longer than 45 minutes at a time. These precautions minimize hip flexion and the risks of prosthetic dislocation, hip stiffness, and flexion contracture. Driving requires sufficient range of motion and muscle strength; most patients are given permission to drive 4 to 6 weeks postoperatively. Traveling long distances should be avoided unless frequent position changes are possible. Other activities to avoid include tub baths, jogging, lifting heavy loads, and excessive bending and twisting (e.g., lifting, shoveling snow, forceful turning). The surgeon may give the patient a card indicating that they have had a joint replacement; this card may be used to alert security personnel who use screening devices at airports or malls.

Continuing and Transitional Care

A nurse may assess the patient's home for potential problems and monitor wound healing (see Chart 36-9). The nurse, physical therapist, or occupational therapist assesses the home environment for physical barriers that may impede the patient's rehabilitation. In addition, the nurse or therapist may need to assist the patient in acquiring devices such as reachers and long-handled shoehorns or tongs to help with dressing, or a toilet seat extender to elevate the toilet seat. The home rehabilitation program came be done via telehealth (Eichler, Salzwedel, Rabe, et al., 2019). After successful surgery and rehabilitation, the patient can expect a hip joint that is free or almost free of pain, has good motion, is stable, and permits normal or near-normal ambulation and function.

Gerontologic Considerations

The older adult patient who has had THA merits special postoperative care considerations. Early THA surgery for hip fractures (within 24 to 36 hours) is recommended for most patients once a medical assessment has been made and the patient's condition has been stabilized appropriately. If there are no contraindications (e.g., history of a bleeding disorder), these patients should receive LMWH for VTE prophylaxis; mechanical devices should be used for patients in whom anticoagulants and antiplatelet agents are contraindicated. Providing an appropriate postoperative analgesic regimen for older adults can be challenging in the presence of impaired cognition, medical comorbidities, and possible drug interactions. Consulting with a pain management specialist to specifically tailor the analgesic type and dose may be helpful (see Chapter 9).

All older adult patients who are post-THA should be placed on a higher-specification, foam pressure-relieving mattress rather than an air-bed hospital mattress (Morris et al., 2018). A major goal following surgery in this patient population is early mobilization, in an effort to prevent the complications associated with prolonged immobility and to return the patient to functional activity (Gabbert et al., 2019). Early assisted mobilization and ambulation on the day of surgery can decrease hospital length of stay, complications, and hospital costs and can prepare patients to care for themselves at home with a higher level of independent functioning. Patients who are assigned to restricted hip precautions have slower rehabilitation and return to usual ADLs (Morris et al., 2018) (see Chapter 37 for general discussion of the Postoperative Care of the Patient Undergoing Orthopedic Surgery). Research suggests that use of a telehealth connection to provide rehabilitation remotely has the same level of outcomes as traditional home physical therapy programs (Eichler et al., 2019). Patients who are assigned to restricted hip precautions have slower rehabilitation and return to usual ADLs (Morris et al., 2018).

Chart 36-9 HOME CARE CHECKLIST

The Patient Who Has Had Orthopedic Surgery

At the completion of education, the patient and/or caregiver will be able to:

- Name the procedure that was performed and identify any permanent changes in anatomic structure or function as well as changes in ADLs, IADLs, roles, relationships, and spirituality.
- Identify modification of home environment, interventions, and strategies (e.g., durable medical equipment, adaptive equipment) used in safely adapting to changes in structure or function and promote effective recovery and rehabilitation.
- Describe ongoing postoperative therapeutic regimen, including diet and activities to perform (e.g., exercises) and to limit or avoid (e.g., lifting weights, driving a car, contact sports)
  - Consume a healthy diet to promote wound and bone healing.
  - Observe prescribed weight-bearing and activity limits.
  - Participate in prescribed exercise regimen to promote circulation and mobility.
  - Demonstrate safe use of mobility aid.
- State the name, dose, side effects, frequency, and schedule for all prescribed therapeutic and prophylactic medications (e.g., antibiotics, anticoagulants, analgesic agents).
- State how to obtain medical supplies and carry out dressing changes, wound care, and other prescribed regimens.
- State indicators of wound infections (e.g., redness, swelling, tenderness, purulent drainage, fever).
- State indicators of complications to report promptly to primary provider (e.g., uncontrolled swelling and pain; cool, pale fingers or toes; paresthesia; paralysis; purulent drainage; signs of systemic infection; signs of deep vein thrombosis or pulmonary embolism).
- State time and date of follow-up appointments and testing.
- Relate how to reach primary provider with questions or complications.
- State understanding of community resources and referrals as appropriate.
- Identify the need for health promotion (e.g., weight reduction, smoking cessation, stress management), disease prevention, and screening activities.

Resources

See Chapter 2, Chart 2-6 for additional information related to durable medical equipment, adaptive equipment, and mobility skills.

ADLs, activities of daily living; IADLs, instrumental activities of daily living.

Total Knee Arthroplasty

A TKA is considered for patients whose joint pain cannot be managed by nonsurgical treatment and who have severe pain and functional disability related to destruction of joint surfaces by OA, RA, or posttraumatic (osteonecrotic) arthritis. When activity and mobility severely prevent patients from participating in ADLs, TKA is a successful, cost-effective, low-risk therapy that offers significant pain relief and restores quality of life and function (Quinn et al., 2018). If the patient's ligaments have weakened, a fully constrained (hinged) or semi-constrained prosthesis may be used to provide joint stability. Selection of a nonconstrained prosthesis, characterized by components that are not linked, is dependent upon the patient having healthy and functional ligaments to provide joint stability (Quinn et al., 2018).

Nursing Management

Postoperatively, the knee is dressed with a compression bandage. Ice or cold packs may be applied to reduce postoperative swelling and bleeding. The nurse assesses the neurovascular status (movement, sensation, color, pulse, capillary refill) of the surgical extremity and compares it with the contralateral extremity every 2 to 4 hours. It is important to encourage active flexion of the foot every hour when the patient is awake. Postoperative efforts are directed at preventing complications (VTE, peroneal nerve palsy, infection, bleeding, limited range of motion).

Similar to hip surgery, a wound suction drain may be used to remove fluid accumulating in the joint. It is more likely to be used in patients with a body mass index (BMI) over 35 kg/m^2 (Keeney et al., 2019). If a drain is used, it is usually left in place for only 24 to 48 hours to reduce the risk of infection (Keeney et al., 2019). Antibiotics are given prophylactically and continued for 24 hours postoperatively. The color, type, and amount of drainage are documented, and any excessive drainage or change in characteristics of the drainage is promptly reported to the provider.

Research findings suggest that continuous passive motion devices (CPMs) have no influence on functional recovery, drainage, pain, or decreasing adverse outcomes in patient's post-TKA. However, they still may be used by some surgeons.

The physical therapist supervises exercises for strength and range of motion and educates the patient about how to use assistive devices based on weight-bearing restrictions. The goal is eventual flexion around 125 degrees to allow normal motion at the end of rehabilitation. If satisfactory flexion is not achieved, gentle manipulation of the knee joint under general anesthesia may be necessary about 2 weeks after surgery (Newman, Herschmiller, Attarian, et al., 2018).

Patients who are postoperative for TKA should mobilize and ambulate by the first postoperative day (Quinn et al., 2018). The patient's weight-bearing status is determined by the surgeon. The knee is usually protected with a knee immobilizer and is elevated when the patient sits in a chair. The typical requirements for discharge to home may include evidence of wound stability (e.g., no erythema, discharge, or redness), appropriate anticoagulation status by laboratory results (i.e., international normalized ratio [INR] between 1.5 and 2), progress toward physical therapy goals (e.g., appropriate use of walker), and satisfactory pain control with oral medications.

Acute rehabilitation usually takes about 1 to 2 weeks; length of time and discharge destination (e.g., home, acute rehabilitation unit) depend on the age and tolerance of the patient. If discharge is to home, the patient may undergo physical therapy on an outpatient basis. Total recovery takes 6 weeks or longer, especially for those older than 75 years. Late complications that may occur include **osteolysis** (polyethylene-induced breakdown infection), periprosthetic joint infections, and aseptic loosening of prosthetic components (Mar, Tan, Song, et al., 2019).

More than 82% of patients who have TKA will still have a functioning prosthesis 25 years after surgery (Evans, Walker, Evans, et al., 2019). TKA is a viable option for improving both disease-specific and generic health-related quality of life, especially pain and function, leading to positive patient satisfaction. Patients usually can achieve a pain-free, functional joint and participate more fully in life activities than before the surgery (Quinn et al., 2018). The nurse provides ongoing education and psychosocial support throughout the perioperative period to help facilitate these positive outcomes (see Chart 36-5).

Metabolic Bone Disorders

Osteoporosis

Osteoporosis is the most prevalent bone disease in the world. More than 1.5 million osteoporotic fractures occur every year. Fractures requiring hospitalization have risen significantly over the past two decades (International Osteoporosis Foundation [IOF], 2017). More than 10 million

Americans have osteoporosis, and an additional 33.6 million have **osteopenia** (i.e., low bone mineral density [BMD])—the precursor to osteoporosis (IOF, 2017). The consequence of osteoporosis is bone fracture. It is projected that one of every three women and one of every five men over the age of 50 will have an osteoporosis-related fracture at some point in their lives (IOF, 2017).

Prevention

Peak adult bone mass is achieved between the ages of 18 and 25 years in both women and men and is affected by genetic factors, nutrition, physical activity, medications, endocrine status, and general health (IOF, 2017). Men typically develop larger, heavier bones than women; therefore, they manifest osteoporosis at more advanced ages.

Primary osteoporosis occurs in women after menopause (usually by age 51) but it is not merely a consequence of aging. Failure to develop optimal peak bone mass and low vitamin D levels contribute to the development of osteopenia without associated bone loss (Drezner, 2019). Early identification of at-risk teenagers and young adults, increased calcium and vitamin D intake, participation in regular weight-bearing exercise, and modification of lifestyle (e.g., reduced use of caffeine, tobacco products, carbonated soft drinks, and alcohol) are interventions that decrease the risk of fractures and associated disability later in life (Black, Cauley, Wagman, et al., 2017) (see Chart 36-10).

Secondary osteoporosis is the result of medications or diseases that affect bone metabolism. Men are more likely than women to have secondary causes of osteoporosis, including the use of corticosteroids (especially if they receive doses in excess of 5 mg of prednisone daily for more than 3 months) and excessive alcohol intake. Specific disease states (e.g., celiac disease, hypogonadism) and medications such as anticonvulsants (e.g., phenytoin), thyroid replacement agents (e.g., levothyroxine), antiestrogens (e.g., medroxyprogesterone), androgen inhibitors (e.g., leuprolide), selective serotonin receptor inhibitors (SSRIs; e.g., fluoxetine) and proton pump inhibitors (e.g., esomeprazole) place patients at risk; these diseases and medications need to be identified and therapies instituted to halt the development of osteoporosis (Robinson, 2020). The degree of bone loss is related to the duration of medication therapy. When the drugs are discontinued or the metabolic problem is corrected, the progression is halted but restoration of lost bone mass may not occur.

Chart 36-10 HEALTH PROMOTION

Strategies for Preventing Osteoporosis

Adolescents and Young Adults

- Educate so that they can:
  - Characterize risk factors for osteoporosis.
  - Consume diet with adequate calcium (1000–1300 mg/day) and vitamin D.
  - Engage in weight-bearing exercise daily.
  - Identify calcium- and vitamin D–rich foods.
  - Modify lifestyle choices—avoid smoking, alcohol, caffeine, and carbonated beverages.

Women Who Are Menopausal and Postmenopausal (in addition to above)

- Educate so that they can:
  - Assess home environment for hazards contributing to falls.
  - Demonstrate good body mechanics.
  - Describe appropriate calcium supplements and pharmacologic agents to maintain and enhance bone mass.
  - Engage in exercise that improves balance to reduce risk of falls.
  - Review concurrent medical conditions and medications with primary provider to identify factors that contribute to bone mass loss.

Men (in addition to above)

- Educate so that they can:
  - Characterize risk factors associated with osteoporosis in men, including medications (e.g., corticosteroids, anticonvulsants, aluminum-containing antacids), chronic diseases (e.g., kidney, lung, gastrointestinal), and undiagnosed low testosterone levels.
  - Participate in screening for osteoporosis.
  - Talk with primary provider about the use of medications (e.g., alendronate) to enhance bone mass or to correct testosterone deficiency.

COVID-19 Considerations

An important source of vitamin D is through direct sunlight exposure. The National Osteoporosis Foundation (NOF) and IOF, in collaboration with other relevant stakeholders, have raised concerns that government initiated stay-at-home orders enacted in response to the coronavirus disease 2019

(COVID-19) pandemic may have reduced the amount of time adults were spending outside, potentially limiting exposure to sunlight (American Society for Bone and Mineral Research [ASBMR], 2020). Subsequently, a joint statement was published to reinforce the importance of vitamin D to bone health and highlight current recommendations for vitamin D intake; these include that adults should obtain 15 to 30 minutes of direct skin exposure to sunlight daily, and, when they cannot meet this recommendation, they should consume between 400 to 1000 IU of vitamin D daily through diet or supplements (ASBMR, 2020). Research is ongoing to better understand the relationship between vitamin D and COVID-19 (ASBMR, 2020).

Gerontologic Considerations

The prevalence of osteoporosis in women older than 80 years is 50%. The average 75-year-old woman has lost 25% of her cortical bone and 40% of her trabecular bone. Most residents of long-term care facilities have a low BMD and are at risk for bone fracture. One third of all hip fractures occur among men, and men have a higher mortality rate than women after sustaining a hip fracture (Rapp, Büchele, Dreinhőfer, et al., 2019). It is estimated that the number of hip fractures and their associated costs will at least double by the year 2040 because of the projected aging of the U.S. population.

A fragility fracture is defined as one that occurs when a person falls from their natural height (or less) or with low velocity. Frequently, an underlying disease or metabolic alteration makes the bone more likely to fracture. Osteoporosis and osteopenia are the most frequently cited risks of fragility fractures. The aging of the population, the increased use of medications that contribute to falls risk, and a lack of caregivers contribute to the rising risk of fragility fractures. Inadequate staffing related to a worsening nursing shortage may result in gaps in care that increase the incidence of fragility fractures; decreased staffing may delay nursing assessments and follow-up and increase the likelihood that patients try to get up unsupervised, resulting in falls (Brent, Hommel, Maher, et al., 2018).

Routine vertebral fracture screenings are not recommended for older adults. However, 80% to 90% of these fractures can be seen incidentally on chest x-rays taken for other purposes. It is estimated that only one third of vertebral fractures are diagnosed. Vertebral fracture risk is five times higher among patients who have had prior fractures. Furthermore, 20% of women who are postmenopausal and have a vertebral fracture will have another one within 1 year (Pouresmaeili, Kamalidehghan, Kamerehei, et al., 2018).

Nurses are the team members who frequently are first to uncover vertebral fractures by identifying a change in a patient's height during routine exams conducted in office or clinic settings.

Older adults absorb dietary calcium less efficiently and excrete it more readily through their kidneys. Women who are postmenopausal and older adults need to consume approximately 1200 mg of daily calcium. Quantities larger than this may place patients at heightened risk of renal calculi or cardiovascular disease (United States Preventive Services Task Force [USPSTF], 2018). Though bone density increases with calcium intake, the rate of fractures does not decrease in women who are postmenopausal and who routinely take calcium supplements (Bailey, Zou, Wallace, et al., 2020).

Pathophysiology

Osteoporosis is characterized by reduced bone mass, deterioration of bone matrix, and diminished bone architectural strength. Normal homeostatic bone turnover is altered; the rate of bone resorption that is maintained by osteoclasts is greater than the rate of bone formation that is maintained by osteoblasts, resulting in a reduced total bone mass. The bones become progressively porous, brittle, and fragile. They fracture easily under stresses that would not break normal bone. This occurs most commonly as compression fractures (see Fig. 36-11) of the thoracic and lumbar spine, hip fractures, and Colles fractures of the wrist. These fractures may be the first clinical manifestation of osteoporosis (Black et al., 2017).

Figure 36-11 • Progressive osteoporotic bone loss and compression fractures. Reprinted with permission from Rubin, E., Gorstein, F., Schwarting, R., et al. (2004). *Pathology* (4th ed.). Philadelphia, PA: Wolters Kluwer.

The gradual collapse of a vertebra may be asymptomatic. With the development of kyphosis (i.e., Dowager hump), there is an associated loss of height (see Fig. 36-12). The postural changes result in relaxation of the abdominal muscles and a protruding abdomen. The deformity may also produce pulmonary insufficiency and increase the risk for falls related to balance issues.

Age-related loss begins soon after the peak bone mass is achieved (i.e., in the fourth decade). Calcitonin, which inhibits bone resorption and promotes bone formation, is decreased. Estrogen, which inhibits bone breakdown, also decreases with aging. On the other hand, parathyroid hormone (PTH) increases with aging, thus increasing bone turnover and resorption. The consequence of these changes is net loss of bone mass over time.

The withdrawal of estrogens at menopause or with oophorectomy causes an accelerated bone resorption within the first 5 years after cessation of menses. Most women lose 10% of their bone mass. More than half of all women older than 50 years show evidence of osteopenia (Black et al., 2017; MQIC, 2020).

Risk Factors

Small-framed women are at greatest risk for osteoporosis. In terms of ethnicity, Asian and Caucasian women are at highest risk. Although African American women tend to have higher mineral mass when younger, they are still at risk due to the prevalence of sickle cell and autoimmune diseases in this population. In addition, many African American women also have poor calcium intake due to lactose intolerance (National Institute of Arthritis and Musculoskeletal and Skin Diseases [NIAMSD], 2018). The use of aromatase inhibitors is an additional risk for women with breast cancer (Robinson, 2020).

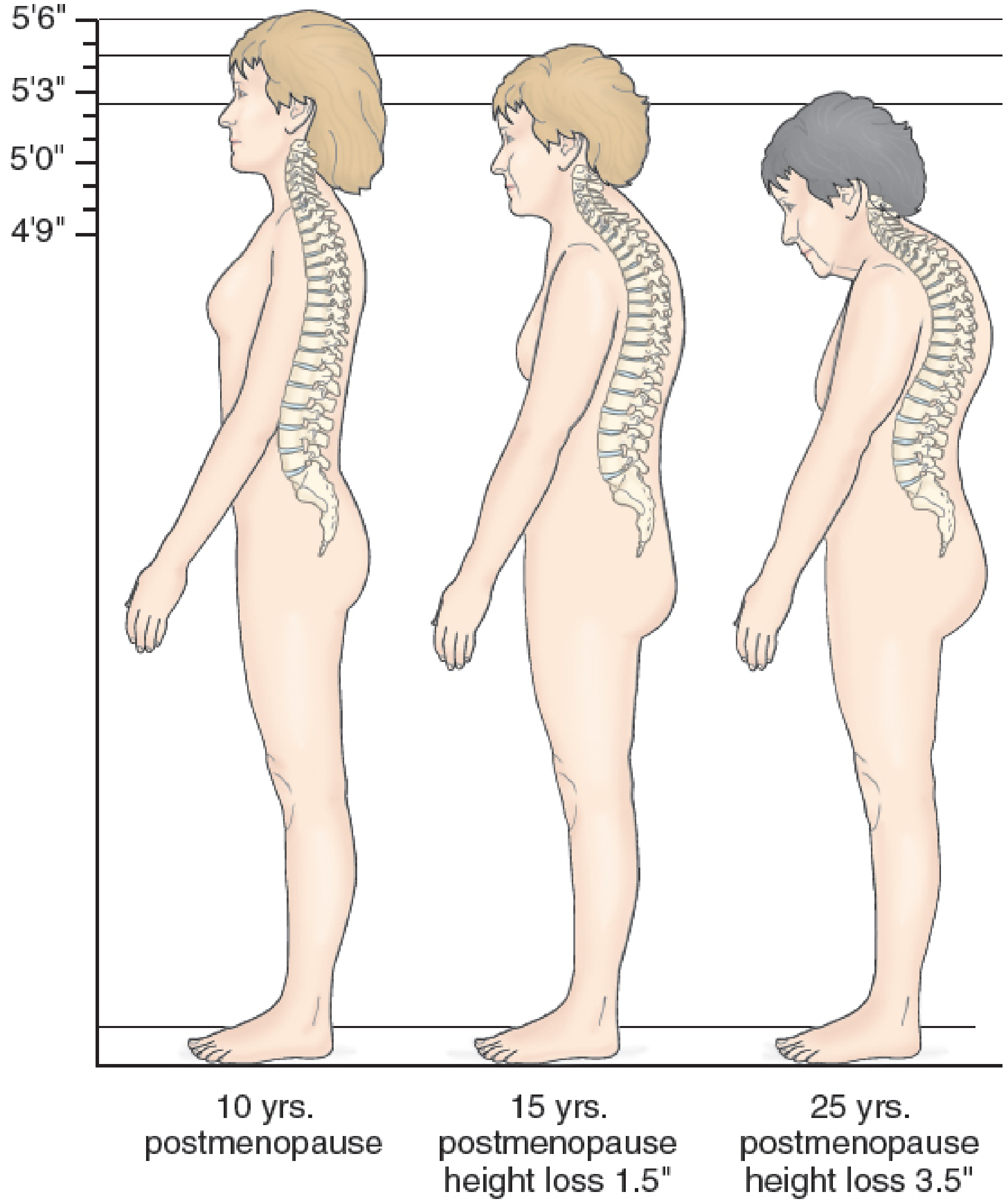

Figure 36-12 • Typical loss of height associated with osteoporosis and aging.

Men have a greater peak bone mass and do not experience a sudden midlife estrogen reduction. As a result, osteoporosis occurs about one decade later, but one in four men still sustain an osteopenic fracture (Pouresmaeili et al., 2018). It is believed that both testosterone and estrogen are important in achieving and maintaining bone mass in men, although the risk profile for men is not as well established as it is for women (Pouresmaeili et al., 2018) (see Chart 36-11).

Nutritional factors contribute to the development of osteoporosis. A diet that includes adequate calories and nutrients needed to maintain bone, calcium, and vitamin D must be consumed. Patients who have had bariatric surgery are at increased risk for osteoporosis as the duodenum is bypassed, which is the primary site for absorption of calcium. Patients who have gastrointestinal (GI) diseases that cause malabsorption (e.g., celiac disease, alcoholism) may benefit from additional magnesium supplements (Rondanelli, Faliva, Gasparri, et al., 2019). However, in adults who follow a strict gluten free diet, magnesium supplements are currently not recommended.

Autoimmune diseases also contribute to poor bone health. Many of them are associated with nutritional deficiencies (e.g., celiac, autoimmune liver disease). Furthermore, many patients with autoimmune diseases are prescribed corticosteroid medications and, as a consequence of their disease processes, are relatively sedentary. These factors also can cause weak bones (Arase, Tsuruya, Hirose, et al., 2020).

Chart 36-11 RISK FACTORS

Osteoporosis

- Alcohol intake of 3 or more drinks daily
- Corticosteroid prescription (e.g., prednisone) for longer than 3 months
- Current use of tobacco products
- Family history
- History of bone fracture during adulthood
- History of impaired glucose tolerance and diabetes
- History of rheumatoid disease
- Inactive or sedentary lifestyle
- Inadequate calcium and vitamin D intake
- Low body mass index
- Malabsorption disorders (e.g., eating disorder, celiac disease, bariatric surgery)
- Men older than 60 years of age
- Women who are postmenopausal

Adapted from Fasolino, T., & Whitright, T. (2015). A pilot study to identify modifiable and non-modifiable variables associated with osteopenia and osteoporosis in men. *Orthopaedic Nursing 34*(5), 289–293; International Osteoporosis Foundation. (2017). Retrieved on 3/7/2020 at: www.iofbonehealth.org/facts-statistics; Robinson, M. (2020). Drugs affecting the bones and joints. In T. Woo & M. Robinson (Eds.). *Pharmacotherapeutics for advanced practice prescribers* (5th ed.). Philadelphia, PA: F. A. Davis.

Bone formation is enhanced by the stress of weight and muscle activity. When immobilized by casts, general inactivity, paralysis, or other disability, the bone is resorbed faster than it is formed, and osteoporosis results (McCance & Huether, 2019). Immobility contributes to the development of osteoporosis. Resistance and impact exercises are most beneficial in developing and maintaining bone mass.

Assessment and Diagnostic Findings

Osteoporosis may be undetectable on routine x-rays until there has been significant demineralization, resulting in radiolucency of the bones (Black et al., 2017). When the vertebrae collapse, causing compression fractures, the thoracic vertebrae become wedge shaped and the lumbar vertebrae become biconcave. Osteoporosis is diagnosed by dual-energy x-ray absorptiometry (DEXA), which provides information about BMD at the spine and hip (see Chapter 35). The DEXA scan data are analyzed and reported as T-scores (the number of standard deviations above or below the average BMD value for a 30-year-old healthy adult of the same sex).

Baseline DEXA testing is recommended for all women older than 65 years, for women who are postmenopausal older than 50 years with osteoporosis risk factors, and for all people who have had a fracture thought to occur as a consequence of osteoporosis (Black et al., 2017). BMD studies are also useful in assessing response to therapy and are recommended 3 months post any osteoporotic fracture. There is no evidence to support basic screening of men younger than 70 years of age or to determine the optimal time interval to repeat studies in either gender following a normal baseline report (USPSTF, 2019).

Female fracture risk can be estimated using the World Health Organization (WHO) Fracture Risk Assessment Tool (FRAX) (Cass, Shepard, Asirot, et al., 2016). These FRAX tables typically underestimate the bone loss risk in men. The Male Osteoporosis Risk Estimation Score (MORES) generates a more gender-specific evaluation than the standard FRAX score in men. Treatment for both genders is now reserved for those with a 10-year risk of more than 3% for hip fracture or 20% risk for other major fractures. Risk scores are based on BMD, personal and family history of fractures, BMI, gender, age, and secondary factors such as medication use, smoking, and history of rheumatoid disease. Impaired glucose tolerance and diabetes are now also recognized as additional risk factors (Robinson, 2020).

Laboratory studies (e.g., serum calcium, serum phosphate, serum alkaline phosphatase [ALP], urine calcium excretion, urinary hydroxyproline excretion, hematocrit, erythrocyte sedimentation rate [ESR]), and x-ray studies are used to exclude other possible disorders (e.g., multiple myeloma, osteomalacia, hyperparathyroidism, malignancy) that contribute to bone loss. In men, low testosterone levels may be part of the cause.

Medical Management

A diet rich in calcium and vitamin D throughout life, with an increased calcium intake during adolescence and the middle years, protects against skeletal demineralization. Such a diet includes three glasses of skimmed vitamin D–enriched milk or other foods high in calcium (e.g., cheese and other dairy products, steamed broccoli, canned salmon with bones) daily. A cup of milk or calcium-fortified orange juice contains about 300 mg of calcium. The recommended adequate intake level of calcium for men 50 to 70 years is 1000 mg daily, and for women aged 51 and older and men aged 71 and older is 1200 mg daily (USPSTF, 2018). Some researchers are challenging these levels as too low for patients with low baseline values, while others express concern of administering higher dosages, noting that they are associated with adverse events (e.g., renal calculi). The recommended vitamin D intake for most adults, which can be acquired from food or supplements, is between 400 and 1000 IU daily; however optimal vitamin D intake is influenced by a patient's age and sex (ASBMR, 2020).

Regular weight-bearing exercise promotes bone formation. Recommendations include 20 to 30 minutes of aerobic, bone-stressing exercise daily (e.g., not swimming). Weight training stimulates an increase in BMD. In addition, exercise improves balance, reducing the incidence of falls and fractures. Women who are postmenopausal and men aged 50 and older should be advised to avoid excessive intake of alcohol. Those who use tobacco products should be advised to quit. However, additional research is needed to better understand the relationship between smoking and bone health (Strozyk, Gress, & Brietling, 2018). Current guidelines recommend that hormone therapy with estrogen not be used for primary prevention of bone loss in women who are postmenopausal (USPSTF, 2017).

Pharmacologic Therapy

To ensure adequate calcium intake, a calcium supplement with vitamin D may be prescribed and taken with meals or with a beverage high in vitamin C to promote absorption. The recommended daily dose should be split and not taken as a single dose (Drezner, 2019). Common side effects of calcium supplements are abdominal distention and constipation. Calcium from foods is better absorbed, but calcium supplements may be necessary for patients who are lactose intolerant. Meta-analysis findings demonstrate that vitamin D taken alone is not effective in primary prevention of fractures. However, vitamin D plus calcium does reduce the risk of fractures in patients who are found to be vitamin D deficient by laboratory testing (USPSTF, 2018). Calcium and vitamin D should be taken as supplements to drugs prescribed to treat osteoporosis. These types of drugs include bisphosphonates, estrogen agonist/antagonists, and receptor activator of nuclear factor kappa-B ligand (RANKL) inhibitors (see Table 36-1). Salmon egg based PTH is no longer a therapy, but synthetic human PTH analogues are used in patients with advanced osteoporosis or who are treatment resistant (Robinson, 2020).

TABLE 36-1 Select Osteoporosis Medications

Medication	Therapeutic Effects and Indications	Key Nursing Considerations
Bisphosphonates	Inhibit osteoclasts, causing decreased bone loss and increased bone mass	Adequate calcium and vitamin D intake is needed to assure maximum effect; however, these supplements should not be taken at the same time as the bisphosphonates Side effects include gastrointestinal symptoms, including dyspepsia, nausea, flatulence, diarrhea, and constipation Adverse effects may include esophageal or gastric ulcers, osteonecrosis of the jaw, and atypical femur fractures; these effects may be mitigated by instituting a 1–2 yr drug-free holiday in patients with mild osteoporosis after 4–5 yrs of treatment, and in patients with higher fracture risk after 10 yrs of treatment
Alendronate Risedronate	• Treatment of osteoporosis in women who are postmenopausal • Treatment of osteoporosis in men, and in women and men taking corticosteroids	Administer PO, either daily or weekly Advise patient to take in AM on empty stomach with 250 mL of water while sitting upright and to remain upright for at least 30 min Effects of alendronate may be diminished in older adult patients who take proton pump inhibitors
Ibandronate	• Treatment of osteoporosis in women who are postmenopausal • IV dosing may be good option for patients either intolerant of PO bisphosphonates or nonadherent to prescribed therapy	May be given PO monthly or IV every 3 mo
Zoledronic acid		Administer IV once yearly for

	• Treatment of osteoporosis in women who are postmenopausal • Treatment of osteoporosis in men and in both men and women taking corticosteroids for at least 12 mo	osteoporosis treatment or once every 2 yrs for osteoporosis prevention This is the most potent bisphosphonate and is associated with acute kidney injury; therefore it is contraindicated in patients with creatinine clearances less than 35 mL/min or in patients with chronic kidney disease
Estrogen Agonist/Antagonist (formerly called selective estrogen receptor modulator [SERM]) Raloxifene	Promotes estrogenic effects on bone, preserving BMD, with concomitant antiestrogenic effects on the uterus and breasts • Prevention and treatment of osteoporosis in women who are postmenopausal, particularly those with breast cancer • May also reduce the risk of breast cancer in patients at risk	Administer PO once daily. May be given in tandem with calcium and vitamin D Side effects include hot flashes and leg cramps Adverse effects include VTE formation
RANKL Inhibitor Denosumab	Monoclonal antibody that increases BMD and reduces the porosity of cortical bone by inhibiting the effects of TNF on osteoclasts, inhibiting their activity • Treatment of osteoporosis in men and women who are postmenopausal at high risk of fracture; also indicated for women with osteoporosis and breast cancer receiving aromatase inhibitors and for men with osteoporosis and prostate cancer receiving	Given once every 6 mo SQ Side effects include skin rashes Adverse effects include hypocalcemia, cellulitis, osteonecrosis of the jaw, and atypical femur fracture Note: when treatment with denosumab is stopped, loss of BMD can be rapid; other drugs should be started to mitigate this response

	gonadotropin-reducing hormones	
PTH Analogue Teriparatide	Synthetic parathyroid hormone which increases bone strength and density • Treatment of osteoporosis in men and women who are postmenopausal at high risk of fracture	Must be refrigerated Daily self-administered SQ injections for up to 2 yrs

BMD, bone mineral density; IV, intravenously; PO, orally; PTH, parathyroid hormone; SQ, subcutaneous; TNF, tissue necrosis factor; VTE, venous thromboembolism.

Adapted from International Osteoporosis Foundation. (2017). Retrieved on 3/7/2020 at: www.iofbonehealth.org/facts-statistics; Robinson, M. (2020). Drugs affecting the bones and joints. In T. Woo, & M. Robinson (Eds.). *Pharmacotherapeutics for advanced practice prescribers* (5th ed.). Philadelphia, PA: F. A. Davis.

Bisphosphonate therapy is no longer recommended for patients who only have evidence of osteopenia without reaching the precise DEXA scores that define osteoporosis. These medications must be given on an empty stomach, only with water, and the person must sit upright for at least 30 minutes after ingestion. There are many gastric and esophageal risks, including gastritis, ulceration, and GI bleeding. Contradictions include previously known Barrett esophagus (see Chapter 39), low serum calcium levels, and pregnancy (Robinson, 2020). Atrial fibrillation has been reported after chronic use of these medications. Two rare side effects include osteonecrosis of the jaw (more likely with intravenous [IV] preparations of these medications) and subtrochanteric fractures. Concerns about these rare adverse effects must be addressed to ensure the patient will adhere to the therapeutic plan and take the medication (Robinson, 2020).

Fracture Management

Fractures of the hip that occur as a consequence of osteoporosis are managed surgically by joint replacement or by closed or open reduction with internal fixation (e.g., hip pinning) as described in Chapter 37. Management of Colles fractures is also described in Chapter 37.

Osteoporotic compression fractures of the vertebrae are managed conservatively. Patients with these findings should be referred to an osteoporosis specialist. Most patients who experience these fractures are asymptomatic and do not require acute care management; for those who experience pain, acute care management is indicated as outlined in the following Nursing Process section. Percutaneous vertebroplasty or kyphoplasty (injection of polymethylmethacrylate [PMMA] bone cement into the fractured vertebra, followed by inflation of a pressurized balloon to restore the shape of the affected vertebra) can provide rapid relief of acute pain and improve quality of life, but might contribute to other complications resulting from alterations in spinal mechanics. These procedures are contraindicated in the presence of infection, multiple old fractures, and certain coagulopathies. The use of vertebroplasty is highly contested in the medical literature (De Leacy, Chandra, Barr, et al., 2020).

NURSING PROCESS

The Patient with a Spontaneous Vertebral Fracture Related to Osteoporosis

Assessment

Recognition of risks and problems associated with osteoporosis form the basis for nursing assessment. The health history focuses on family history, previous fractures, dietary consumption of calcium, exercise patterns, onset of menopause, and the use of certain medications (e.g., corticosteroids), as well as alcohol, smoking, and caffeine intake. Any symptoms the patient is experiencing, such as back pain, constipation, or altered body image, are explored.

Physical examination may disclose localized pain, kyphosis of the thoracic spine, or shortened stature. Problems in mobility and breathing may exist as a result of changes in posture and weakened muscles.

Diagnosis

NURSING DIAGNOSES

Based on the assessment data, major nursing diagnoses may include the following:

- Lack of knowledge about the osteoporotic process and treatment regimen
- Acute pain associated with fracture and muscle spasm
- Risk for constipation associated with immobility or development of ileus (intestinal obstruction)
- Risk for injury: additional fractures associated with osteoporosis

Planning and Goals

The major goals for the patient may include knowledge about osteoporosis and the treatment regimen, relief of pain, improved bowel elimination, and absence of additional fractures.

Nursing Interventions

PROMOTING UNDERSTANDING OF OSTEOPOROSIS AND THE TREATMENT REGIMEN

Patient education focuses on factors influencing the development of osteoporosis, interventions to arrest or slow the process, and measures to relieve symptoms. The nurse emphasizes that people of any age need sufficient calcium, vitamin D, and weight-bearing exercise to slow the progression of osteoporosis (Drezner, 2019). Patient education related to medication therapy as described previously is important. Patients must understand that having one fracture increases the probability of sustaining another.

Relieving Pain

Relief of back pain resulting from compression fracture may be accomplished by short periods of resting in bed in a supine or side-lying position. The mattress should be supportive. Knee flexion increases comfort by relaxing back muscles. Intermittent local heat and backrubs promote muscle relaxation. The nurse instructs the patient to move the trunk as a unit and to avoid twisting. When the patient is assisted out of bed, a trunk orthosis (e.g., lumbosacral corset) may be worn for temporary support and immobilization, although such a device is frequently uncomfortable and is poorly tolerated by many older adults. The patient gradually resumes activities as pain diminishes.

Improving Bowel Elimination

Constipation is a problem related to immobility and medications. Early institution of a high-fiber diet, increased fluids, and the use of prescribed stool softeners help prevent or minimize constipation. If the vertebral collapse involves the T10–L2 vertebrae, the patient may develop a paralytic ileus. The nurse therefore monitors the patient’s intake, bowel sounds, and bowel activity.

Preventing Injury

Physical activity is essential to strengthen muscles, improve balance, prevent disuse atrophy, and retard progressive bone demineralization. Isometric exercises can strengthen trunk muscles. The nurse encourages walking, good body mechanics, and good posture. Daily weight-bearing activity, preferably outdoors in the sunshine to enhance the body’s ability to produce vitamin D, is encouraged. Sudden bending, jarring, and strenuous lifting are avoided.

Gerontologic Considerations. Older adults fall frequently as a result of environmental hazards, diminished senses and cardiovascular responses, and responses to medications. The patient and family need to be included in planning for care and preventive management regimens. For example, the home environment should be assessed for elimination of potential hazards (e.g., scatter rugs, cluttered rooms and stairwells, toys on the floor, pets underfoot). A safe environment can then be created (e.g., well-lighted staircases with secure handrails, grab bars in the bathroom, properly fitting footwear). Adequate nurse–patient ratios are also critical for fall prevention in inpatient settings (Brent et al., 2018).

Evaluation

Expected patient outcomes may include:

1. Acquires knowledge about osteoporosis and the treatment regimen
   a. States relationship of calcium and vitamin D intake and exercise to bone mass
   b. Consumes adequate dietary calcium and vitamin D
   c. Takes prescribed medications, following instructions for administration
   d. Increases level of exercise
   e. Adheres to prescribed screening and monitoring procedures
2. Achieves pain relief
   a. Experiences pain relief at rest
   b. Experiences minimal discomfort during ADLs
   c. Demonstrates diminished tenderness at fracture site
3. Demonstrates usual pattern of bowel elimination
   a. Has active bowel sounds
   b. Reports regular pattern of bowel movements
4. Experiences no new fractures
   a. Maintains good posture
   b. Uses good body mechanics
   c. Engages in weight-bearing exercises (walks daily)
   d. Creates a safe home environment
   e. Accepts assistance and supervision as needed

Osteomalacia

Osteomalacia is a metabolic bone disease characterized by inadequate mineralization of bone. As a result, the skeleton softens and weakens, causing pain, tenderness to touch, bowing of the bones, and pathologic fractures. On physical examination, skeletal deformities (spinal kyphosis and bowed legs) give patients an unusual appearance and a waddling gait. These patients may be uncomfortable with their appearance and are at risk for falls and pathologic fractures, particularly of the distal radius and the proximal femur (McCance & Huether, 2019).

Pathophysiology

The major defect in osteomalacia is a deficiency of activated vitamin D, which promotes calcium absorption from the GI tract and facilitates mineralization of bone. The supply of calcium and phosphate in the extracellular fluid is low and does not move to calcification sites in bones.

Osteomalacia may result from failed calcium absorption or from excessive loss of calcium from the body (e.g., kidney failure). GI disorders (e.g., celiac disease, chronic biliary tract obstruction, chronic pancreatitis, small bowel resection) in which fats are inadequately absorbed are likely to produce osteomalacia through loss of vitamin D (along with other fat-soluble vitamins) and calcium, the latter being excreted in the feces with fatty acids. In addition, liver and kidney diseases can produce a lack of vitamin D because these are the organs that convert vitamin D to its active form.

Severe renal insufficiency results in acidosis. The body uses available calcium to combat the acidosis, and PTH stimulates the release of skeletal calcium in an attempt to reestablish a physiologic pH. During this continual drain of skeletal calcium, bony fibrosis occurs, and bony cysts form. Chronic glomerulonephritis, obstructive uropathies, and heavy metal poisoning result in a reduced serum phosphate level and demineralization of bone.

Hyperparathyroidism leads to skeletal decalcification and thus to osteomalacia by increasing phosphate excretion in the urine. Prolonged use of anticonvulsant medication (e.g., phenytoin, phenobarbital) poses a risk of osteomalacia, as does insufficient vitamin D (dietary, sunlight).

Osteomalacia that results from malnutrition (deficiency in vitamin D often associated with poor intake of calcium) is a result of poverty, poor dietary habits, and lack of knowledge about nutrition. It occurs most frequently in parts of the world where vitamin D is not added to food, where dietary deficiencies exist, and where sunlight is rare (McCance & Huether, 2019).

Gerontologic Considerations

A nutritious diet is particularly important in older adults. Adequate intake of calcium and vitamin D is promoted. Because sunlight is necessary for synthesizing vitamin D, patients should be encouraged to spend 15 to 30 minutes each day in the sun, if not contraindicated and while avoiding sunburn (ASBMR, 2020). Prevention, identification, and management of osteomalacia in older adults are essential to reduce the incidence of fractures. When osteomalacia is combined with osteoporosis, the risk of fracture increases.

Assessment and Diagnostic Findings

On x-ray studies, generalized demineralization of bone is evident. Studies of the vertebrae may show a compression fracture with indistinct vertebral end plates. Laboratory studies show low serum calcium and phosphorus levels and a moderately elevated ALP. Urine excretion of calcium and creatinine is low. Bone biopsy demonstrates an increased amount of osteoid, a demineralized, cartilaginous bone matrix that is sometimes referred to as prebone.

Medical Management

Physical, psychological, and pharmaceutical measures are used to reduce the patient's discomfort and pain. If the underlying cause of osteomalacia is corrected, the disorder may resolve. If kidney disease prevents activation of absorbed vitamin D, then supplementation requires the activated form (calcitriol). If osteomalacia is caused by malabsorption, increased doses of vitamin D, along with supplemental calcium, are usually prescribed. Exposure to sunlight may be recommended; ultraviolet radiation transforms a cholesterol substance (7-dehydrocholesterol) present in the skin into vitamin D (McCance & Huether, 2019).

If osteomalacia is dietary in origin, the interventions are akin to those discussed previously in the discussion on osteoporosis. Long-term monitoring of the patient is appropriate to ensure stabilization or reversal of osteomalacia. Some persistent orthopedic deformities may need to be treated with braces or surgery (e.g., osteotomy may be performed to correct long bone deformity).

Paget Disease of the Bone

Paget disease (osteitis deformans) is a disorder of localized rapid bone turnover, most commonly affecting the skull, femur, tibia, pelvic bones, and vertebrae. The disease occurs in about 2% to 3% of the population older than 50 years. The incidence is slightly greater in aging men than in women. A family history has been noted, with siblings often developing the disease. The cause of Paget disease is not known (Ralston, Corral-Gudino, Cooper, et al., 2019).

Pathophysiology

In Paget disease, a primary proliferation of osteoclasts occurs, which induces bone resorption. This is followed by a compensatory increase in osteoblastic activity that replaces the bone. As bone turnover continues, a classic mosaic (disorganized) pattern of bone develops. Because the diseased bone is highly vascularized and structurally weak, pathologic fractures occur. Structural bowing of the legs causes malalignment of the hip, knee, and ankle joints, which contributes to the development of arthritis and back and joint pain (Cundy, 2017).

Clinical Manifestations

Paget disease is insidious. Some patients do not experience symptoms but only have skeletal deformity. The condition is most frequently identified on x-ray studies performed during a workup for another problem. Sclerotic changes and cortical thickening of the long bones occur.

In most patients, skeletal deformity involves the skull. The skull may thicken, and the patient may report that a hat no longer fits. In some cases, the cranium, but not the face, is enlarged. This gives the face a small, triangular appearance. Most patients with skull involvement have impaired hearing from cranial nerve compression and dysfunction. Other cranial nerves may also be similarly affected.

The femurs and tibiae tend to bow, producing a waddling gait. The spine is bent forward and is rigid; the chin rests on the chest. The thorax becomes immobile during respiration. The trunk is flexed on the legs to maintain balance and the arms are bent outward and forward, appearing long in relation to the shortened trunk (McCance & Huether, 2019).

Tenderness and warmth over bones may be noted due to increased bone vascularity. Patients with large, highly vascular lesions may develop high-output cardiac failure due to the increased vascular bed and metabolic demands (McCance & Huether, 2019). The pain is mild to moderate, deep, and aching. It increases with weight bearing. Pain and discomfort may precede skeletal deformities of Paget disease by years and are often wrongly attributed by the patient to old age or arthritis (Cundy, 2017).

Assessment and Diagnostic Findings

Elevated serum ALP concentration and urinary hydroxyproline excretion reflect increased osteoblastic activity. Higher values suggest more active disease. Patients with Paget disease have normal blood calcium levels. X-rays confirm the diagnosis of Paget disease by revealing local areas of demineralization and bone overgrowth in the characteristic mosaic patterns. Bone scans demonstrate the extent of the disease. Bone biopsy may aid in the differential diagnosis with other bone diseases (Cundy, 2017).

Medical Management

Pain usually responds to NSAIDs. Gait problems from bowing of the legs are managed with walking aids, shoe lifts, and physical therapy. Weight is controlled to reduce stress on weakened bones and misaligned joints. Patients who are asymptomatic may be managed with diets adequate in calcium and vitamin D and periodic monitoring.

Fractures, arthritis, and hearing loss are complications of Paget disease. Fractures are managed according to location. Healing occurs if fracture reduction, immobilization, and stability are adequate. Severe degenerative arthritis may require total joint replacement; however, the afflicted "soft" bones do not make ideal surgical sites and are thus prone to complications. Loss of hearing is managed with hearing aids and communication techniques used with people who have hearing impairments (e.g., speech reading, body language) (see Chapter 59).

Pharmacologic Therapy

Patients with moderate to severe disease may benefit from specific antiosteoclastic therapy. These medications reduce bone turnover, reverse the course of the disease, relieve pain, and improve mobility.

Bisphosphonates are the cornerstone of Paget therapy in that they stabilize the rapid bone turnover (Ralston et al., 2019). Their use may not suppress all Paget symptoms, but they reduce serum ALP and urinary hydroxyproline levels. See earlier discussion on bisphosphonates.

Plicamycin, a cytotoxic antibiotic, may be used to control the disease. This medication is reserved for severely affected patients with neurologic compromise and for those whose disease is resistant to other therapy. This medication has dramatic effects on pain reduction and on serum calcium, ALP, and urinary hydroxyproline levels; however, there are significant side effects. It is given by IV infusion; hepatic, kidney, and bone marrow function must be monitored during therapy. Clinical remissions may continue for months after the medication is discontinued.

Gerontologic Considerations

Because Paget disease tends to affect older adults, patients and their families and caregivers should be educated about how to compensate for altered musculoskeletal functioning with an emphasis on the risk of falls. The home environment is assessed for safety to prevent falls and to reduce the risk of fracture. Strategies for coping with a chronic health problem and its effect on quality of life need to be developed. If age-related hearing loss is exacerbated by Paget disease, alternative communication devices (e.g., text telephone, telecommunication device for the deaf) and home safety alarms may be indicated.

Musculoskeletal Infections

Osteomyelitis

Osteomyelitis is an infection of the bone that results in inflammation, necrosis, and formation of new bone. Osteomyelitis is classified as follows (McCance & Huether, 2019):

- Hematogenous osteomyelitis (i.e., due to bloodborne spread of infection)
- Contiguous-focus osteomyelitis, from contamination from bone surgery (especially with hardware insertion), open fracture, or traumatic injury (e.g., gunshot wound)
- Osteomyelitis with vascular insufficiency, seen most commonly among patients with diabetes and peripheral vascular disease, most commonly affecting the feet

Patients who are at high risk for osteomyelitis include older adults and those who are poorly nourished or obese. Other patients at risk include those with impaired immune systems, those with chronic illnesses (e.g., diabetes, RA), those receiving long-term corticosteroid therapy or immunosuppressive agents, and those who use illicit IV drugs (Lalani & Schmidt, 2019).

Postoperative surgical wound infections typically occur within 30 days after surgery. They are classified as incisional (superficial, located above the deep fascia layer) or deep (involving tissue beneath the deep fascia). If an implant has been used, deep postoperative infections may occur within a year. Osteomyelitis may become chronic and may affect the patient's quality of life.

Pathophysiology

More than 50% of bone infections are caused by *Staphylococcus aureus* and increasingly of the variety that is methicillin resistant (i.e., MRSA) (Lalani & Schmidt, 2019). Surgical site ink markers have been linked to infections by cross contamination between preoperative patients who use their markers; therefore, these items are now considered one patient or one-time use items (Driessche, 2012). Other pathogens include the gram-positive organisms *streptococci* and *enterococci,* followed by gram-negative bacteria, including *pseudomonas* (Lalani & Schmidt, 2019).

The initial response to infection is inflammation, increased vascularity, and edema. After 2 or 3 days, thrombosis of the local blood vessels occurs, resulting in ischemia with bone necrosis. The infection extends into the medullary cavity and under the periosteum and may spread into adjacent soft tissues and joints. Unless the infective process is treated promptly, a bone abscess forms. The resulting abscess cavity contains **sequestrum** (i.e., dead bone tissue), which does not easily liquefy and drain. Therefore, the cavity cannot collapse and heal, as it does in soft tissue abscesses. New bone growth, the **involucrum**, forms and surrounds the sequestrum. Although healing appears to take place, a chronically infected sequestrum remains and produces recurring abscesses throughout the patient's life. This is referred to as chronic osteomyelitis.

Clinical Manifestations

When the infection is bloodborne, the onset is usually sudden, occurring often with the clinical and laboratory manifestations of sepsis (e.g., chills, high fever, rapid pulse, general malaise). The systemic symptoms at first may overshadow the local signs. As the infection extends through the cortex of the bone, it involves the periosteum and the soft tissues. The infected area becomes painful, swollen, and extremely tender. The patient may describe a constant, pulsating pain that intensifies with movement as a result of the pressure of the collecting purulent material (i.e., pus). When osteomyelitis occurs from spread of adjacent infection or from direct contamination, there are no manifestations of sepsis. The surface area that lies over the infected bone is swollen, warm, painful, and tender to touch. The patient with chronic osteomyelitis presents with a nonhealing ulcer that overlies the infected bone with a connecting sinus that will intermittently and spontaneously drain pus (Lalani & Schmidt, 2019).

Diabetic osteomyelitis can occur without any external wounds. It may present as a nonhealing fracture. Microvascular and macrovascular pathophysiologic changes, along with an impaired immune response by patients with diabetes who have poor glycemic control can exacerbate the spread of infection from other sources. Any foot ulcer more than 2 cm in diameter is highly suspicious for osteomyelitis (Lalani & Schmidt, 2019).

Assessment and Diagnostic Findings

In acute osteomyelitis, early x-ray findings demonstrate soft tissue edema. In about 2 to 3 weeks, areas of periosteal elevation and bone necrosis are evident. Radioisotope bone scans and MRI help with early definitive diagnosis. Blood studies reveal leukocytosis and an elevated ESR. Wound and blood culture studies are performed, although they are only positive in 50% of cases. Therefore, treatment with antibiotics may be prescribed without isolating the organism and then refined after results are obtained. IV antibiotics and bone biopsies are preferably done prior to starting the antibiotics (Osmon & Tande, 2019).

With chronic osteomyelitis, large, irregular cavities, raised periosteum, sequestrum, or dense bone formations are seen on x-ray. Bone scans may be performed to identify areas of infection. The ESR and the WBC count are usually normal. Anemia, associated with chronic infection, may be evident. Cultures of blood specimens and drainage from the sinus tract are frequently unreliable for isolating the organisms involved. Bone cultures are aspirated through uninfected skin (Lalani & Schmidt, 2019).

Prevention

Prevention of osteomyelitis is the goal. Elective orthopedic surgery should be postponed if the patient has a current infection (e.g., urinary tract infection, sore throat that may suggest a *Streptococcal* infection). During surgery, careful attention is paid to the surgical environment. Prophylactic antibiotics, given to achieve adequate tissue levels at the time of surgery and for 24 hours after surgery, are helpful. Urinary catheters and drains are removed as soon as possible to decrease the incidence of hematogenous spread of infection.

Aseptic postoperative wound care reduces the incidence of superficial infections and osteomyelitis. Prompt management of soft tissue infections reduces extension of infection to the bone or hematogenous spread.

Medical Management

The initial goal of therapy is to control and halt the infective process. General supportive measures (e.g., hydration, diet high in vitamins and protein, correction of anemia) are instituted. The area affected with osteomyelitis is immobilized to decrease discomfort and to prevent pathologic fracture of the weakened bone.

Pharmacologic Therapy

Bone infections are more difficult to eradicate than soft tissue infections because bone is mostly avascular and less accessible to the body's natural immune response. Because there is decreased penetration by medications, antibiotic therapy is longer term than with other infections; typically, it continues for 6 to 12 weeks. After the infection appears to be controlled, the antibiotic may be given orally. However, there is little evidence to support optimal length of therapy (Li, Romach, Zabellas, et al., 2019).

Surgical Management

If the infection is chronic and does not respond to antibiotic therapy, surgical débridement is indicated. The infected bone is surgically exposed, the purulent and necrotic material is removed, and the area is irrigated with sterile saline solution. A sequestrectomy (removal of enough involucrum to enable the surgeon to remove the sequestrum) is performed. In many cases, sufficient bone is removed to convert a deep cavity into a shallow saucer (saucerization). All dead, infected bone and cartilage must be removed before permanent healing can occur. A closed suction irrigation system may be used to remove debris. Wound irrigation using sterile physiologic saline solution may be performed for extended periods if the debris remains. Typically, irrigation does not need to extend beyond a week.

The wound is either closed tightly to obliterate the dead space or packed and closed later by granulation or possibly by grafting. The débrided cavity may be packed with cancellous bone graft to stimulate healing. With a large defect, the cavity may be filled with a vascularized bone transfer or muscle flap (in which a muscle is moved from an adjacent area with blood supply intact). These microsurgery techniques enhance the blood supply. The improved blood supply facilitates bone healing and eradication of the infection. These surgical procedures may be staged over time to ensure healing. Because surgical débridement weakens the bone, internal fixation or external supportive devices may be needed to stabilize or support the bone to prevent pathologic fracture (Rüschenschmidt, Glombitza, Dahmen, et al., 2019). Original orthopedic hardware may need to be removed.

NURSING PROCESS

The Patient with Osteomyelitis

Assessment

The patient reports an acute onset of signs and symptoms (e.g., localized pain, edema, erythema, fever) or recurrent drainage of an infected sinus with associated pain, edema, and low-grade fever. The nurse assesses the patient for risk factors (e.g., older age, diabetes, long-term corticosteroid therapy) and for a history of previous injury, infection, or orthopedic surgery. The gait may be altered as the patient avoids pressure and movement of the area. In acute hematogenous osteomyelitis, the patient exhibits generalized weakness due to the systemic reaction to the infection.

Physical examination reveals an inflamed, markedly edematous, warm area that is tender. Purulent drainage may be noted. The patient has an elevated temperature. With chronic osteomyelitis, the temperature elevation may be minimal, occurring in the afternoon or evening.

Diagnosis

Nursing Diagnoses

Based on the assessment data, nursing diagnoses may include the following:

- Acute pain associated with inflammation and edema
- Impaired mobility associated with pain, use of immobilization devices, and weight-bearing limitations
- Risk for infection: bone abscess formation
- Lack of knowledge associated with the treatment regimen

Planning and Goals

The patient's goals may include relief of pain, improved physical mobility within therapeutic limitations, control and eradication of infection, and knowledge of the treatment regimen.

Nursing Interventions

Relieving Pain

The affected part may be immobilized with a splint to decrease pain and muscle spasm. The nurse monitors the skin and neurovascular status of the affected extremity. The wounds are frequently very painful, and the extremity must be handled with great care and gentleness. Elevation reduces swelling and associated discomfort. Pain is controlled with prescribed analgesic agents and other pain-reducing techniques.

Improving Physical Mobility

Treatment regimens restrict weight-bearing activity. The bone is weakened by the infective process and must be protected by avoidance of stress on the bone. The patient must understand the rationale for the activity restrictions. The joints above and below the affected part should be gently moved through their range of motion. The nurse encourages full participation in ADLs within the prescribed physical limitations to promote general well-being. Caution around external fixation devices is required (see Chapter 37 for discussion of external fixation devices).

Controlling the Infectious Process

The nurse monitors the patient’s response to antibiotic therapy and observes the IV access site for evidence of phlebitis, infection, or infiltration. With long-term, intensive antibiotic therapy, the patient is monitored for signs of superinfection (e.g., oral or vaginal candidiasis, loose or foul-smelling stools). The nurse carefully monitors for the development of additional sites that are painful or for sudden increases in body temperature.

If surgery is necessary, the nurse takes measures to ensure adequate circulation to the affected area (wound suction to prevent fluid accumulation, elevation of the area to promote venous drainage, avoidance of pressure on the grafted area), to maintain needed immobility, and to ensure the patient’s adherence to weight-bearing restrictions. Dressings are changed using aseptic technique to promote healing and to prevent cross contamination.

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care. The patient and family are educated about the importance of strictly adhering to the therapeutic regimen of antibiotics. Patients and families often need to learn to maintain and manage the IV access and IV administration equipment in the home. Education includes the medication name, dosage, frequency, administration rate, safe storage and handling, adverse reactions, and necessary laboratory monitoring. In addition, the nurse provides education on aseptic dressing and warm compression techniques.

Continuing and Transitional Care. The patient must be medically stable and physically able and motivated to adhere strictly to the therapeutic regimen of antibiotic therapy. The transitional care environment needs to be conducive to the promotion of health and to the requirements of the therapeutic regimen.

If warranted, the nurse completes a home assessment to determine the patient’s and family’s abilities regarding continuation of the therapeutic regimen. If the patient’s support system is questionable or if the patient lives alone, a home health nurse may be needed to assist with IV administration of the antibiotics, monitoring for response to the treatment and evaluation of signs and symptoms of superinfections, and adverse drug reactions. This can also be done via telehealth (Eichler et al., 2019). The nurse stresses the importance of follow-up health care appointments (see Chart 36-12).

Evaluation

Expected patient outcomes may include:

1. Experiences pain relief
    a. Reports decreased pain at rest
    b. Experiences no tenderness at site of previous infection
    c. Experiences minimal discomfort with movement
2. Increases in safe physical mobility
    a. Participates in self-care activities within restrictions
    b. Maintains full function of unimpaired extremities
    c. Demonstrates safe use of immobilizing and assistive devices
    d. Modifies environment to promote safety and to avoid falls
3. Shows absence of infection
    a. Takes antibiotic as prescribed
    b. Reports normal temperature
    c. Exhibits no edema
    d. Reports absence of drainage
    e. Laboratory results indicate normal WBC count and ESR
    f. Wound cultures are negative
4. Adheres to therapeutic plan
    a. Takes medications as prescribed
    b. Protects weakened bones
    c. Demonstrates proper wound care
    d. Reports signs and symptoms of complications promptly
    e. Consumes a healthy diet
    f. Keeps follow-up health care appointments

Chart 36-12 HOME CARE CHECKLIST

The Patient with Osteomyelitis

At the completion of education, the patient and/or caregiver will be able to:

- State the impact of osteomyelitis on physiologic functioning, ADLs, IADLs, roles, relationships, and spirituality.
- Identify modification of home environment, interventions, and strategies (e.g., durable medical equipment, adaptive equipment) used in safely adapting to changes in structure or function and promote effective recovery and rehabilitation.
- State how to obtain medical supplies and carry out dressing changes, wound care, and other prescribed regimens.
- Describe ongoing postoperative therapeutic regimen, including diet and activities to perform (e.g., exercises) and to limit or avoid (e.g., lifting weights, driving a car, contact sports).
    - Consume a healthy diet to promote wound and bone healing.
    - Observe prescribed weight-bearing and activity limits.
    - Demonstrate proper wound care.
    - Demonstrate safe use of ambulatory aids and assistive devices.
- State the name, dose, side effects, frequency, and schedule for all medications.
    - Demonstrate accurate and safe administration of medications.
- When indicated, identify the benefits and expected outcomes of intravenous antibiotic therapy and IV access management.
    - Demonstrate how to prepare, infuse, maintain, and clean IV access and equipment.
    - Identify adverse effects of antibiotic therapy and actions to take for adverse effects.
    - Describe to whom, how, and when to report adverse effects.
- Relieve pain with pharmacologic and nonpharmacologic interventions.
- State indicators of wound infections (e.g., redness, swelling, tenderness, purulent drainage, fever) and systemic infection (e.g., fever, chills, rapid pulse, general malaise) to report promptly to primary provider.
- Relate how to reach primary provider with questions or complications.
- State time and date of follow-up appointments and testing.
- Identify the need for health promotion (e.g., weight reduction, smoking cessation, stress management), disease prevention,

and screening activities.

Resources

See Chapter 2, Chart 2-6 for additional information related to durable medical equipment, adaptive equipment, and mobility skills.

ADLs, activities of daily living; IADLs, instrumental activities of daily living; IV, intravenous.

Septic (Infectious) Arthritis

Joints can become infected through spread of pathogens from other parts of the body (hematogenous spread) or directly through trauma, injection, or surgical instrumentation, causing septic arthritis. People at greatest risk include older adults, particularly those older than 80 years; people with comorbid conditions such as diabetes, RA, skin infection, or alcoholism; and people with a history of a joint replacement or other joint surgery or IV drug abuse. *S. aureus* is the most common cause of joint infections in all age groups, followed by other gram-positive bacteria, including streptococci. Gonococcal infection may cause septic arthritis through hematogenous spread. *Pseudomonas aeruginosa* is a commonly implicated pathogen in those who use illicit IV drugs (Goldenberg & Sexton, 2019).

Single knee or hip joints are most commonly infected in patients with septic arthritis, although up to 20% of cases involve more than one joint (i.e., polyarticular disease). Prompt recognition and treatment of an infected joint are important because accumulating purulent material may result in chondrolysis (destruction of hyaline cartilage), and continued hematogenous spread may lead to sepsis and death. See Chapter 11 for further discussion of sepsis. The overall mortality rate for single joint infections is about 11%, but it approaches 50% in patients with polyarticular disease or in those who are immunocompromised (Oh, Wurcel, Tybor, et al., 2018).

Clinical Manifestations

The patient with acute septic arthritis presents with a warm, painful, swollen joint with decreased range of motion. Systemic chills, fever, and leukocytosis are sometimes present. Fever may not occur in older patients. Although any joint may be infected, approximately half of all cases involve a knee (Goldenberg & Sexton, 2019).

Assessment and Diagnostic Findings

An assessment for the source and cause of infection is performed. Diagnostic studies include aspiration, examination, and culture of the synovial fluid. Computed tomography (CT) and MRI scans may reveal damage to the joint lining. Radioisotope scanning may be useful in localizing the infectious process. There may not be any external wound or reported recent trauma.

Medical Management

Prompt treatment is essential and may save the prosthesis for patients who have had joint replacement surgery or may prevent sepsis. Broad-spectrum IV antibiotics are started promptly and then changed to organism-specific antibiotics after culture results are available (Goldenberg & Sexton, 2019). The IV antibiotics are continued until symptoms resolve. The synovial fluid is aspirated and analyzed periodically for sterility and decrease in WBCs.

Aspiration of the joint with a needle to remove excessive joint fluid, exudate, and debris promotes comfort and decreases joint destruction caused by the action of proteolytic enzymes in the purulent fluid. Arthrotomy or arthroscopy is used to drain the joint and remove dead tissue (Oh et al., 2018).

The inflamed joint is supported and immobilized in a functional position by a splint that increases the patient's comfort. Analgesic agents are prescribed to relieve pain. The patient's nutrition and fluid status is monitored. Progressive range-of-motion exercises are prescribed as soon as the patient can begin movement without exacerbating symptoms of acute pain. If septic joints are treated promptly, recovery of normal function is expected. If the articular cartilage was damaged during the inflammatory reaction, joint fibrosis and diminished function may result. The patient is assessed periodically for recurrence over the next year.

Nursing Management

The nurse educates the patient and family about the septic arthritis physiologic process and explains the importance of supporting the affected joint, adhering to the prescribed antibiotic regimen, inspecting the skin under any splints that may be prescribed, and observing weight-bearing and activity restrictions. The patient must understand that recurrence of infection in the near and far future is possible and is educated about signs and symptoms to observe and report to the primary provider. The same interventions used for the patient with osteomyelitis are planned for the patient with septic arthritis. See previous discussion.

Bone Tumors

Neoplasms of the musculoskeletal system are of various types, including osteogenic, chondrogenic, fibrogenic, muscle (rhabdomyogenic), and marrow (reticulum) cell tumors as well as nerve, vascular and fatty cell tumors. They may be primary tumors or metastatic tumors from cancers elsewhere in the body (e.g., breast, lung, prostate, kidney).

Benign Bone Tumors

Benign tumors of the bone and soft tissue are more common than malignant primary bone tumors. Benign bone tumors generally are slow growing, well circumscribed, and encapsulated; present few symptoms; and are not a cause of death. Benign masses include osteochondroma, enchondroma, bone cysts, osteoid osteoma, rhabdomyoma, and fibroma. Some benign tumors have the potential to become malignant.

Osteochondroma is the most common benign bone tumor. It usually occurs as a large projection of bone at the end of long bones (at the knee or shoulder), developing during growth. It then becomes a static bony mass. In fewer than 1% of patients, the cartilage cap of the osteochondroma may undergo malignant transformation after trauma, and a chondrosarcoma or osteosarcoma may develop (Czerniak, 2016).

Bone cysts are expanding lesions within the bone. Aneurysmal (widening) bone cysts are seen in young adults, who present with a painful, palpable mass of the long bones, vertebrae, or flat bone. Unicameral (single cavity) bone cysts occur more often in the first two decades of life and cause mild discomfort and possible pathologic fractures of the upper humerus and femur, which may heal spontaneously.

An osteoid osteoma is a painful tumor that occurs in children and young adults. The neoplastic tissue is surrounded by reactive bone formation that can be identified by x-ray. Enchondroma is a common tumor of the hyaline cartilage that develops in the hand, femur, tibia, or humerus. Usually, the only symptom is a mild ache. Pathologic fractures may occur in both types of tumors.

Giant cell tumors (osteoclastomas) are benign for long periods but may invade local tissue and cause destruction. They occur in young adults and are soft and hemorrhagic. Eventually, giant cell tumors may undergo malignant transformation and metastasize (Czerniak, 2016).

Malignant Bone Tumors

Primary malignant musculoskeletal tumors are relatively rare and arise from connective and supportive tissue cells (sarcomas) or bone marrow elements (multiple myeloma; see Chapter 30). Malignant primary musculoskeletal tumors include osteosarcoma, chondrosarcoma, Ewing sarcoma, and fibrosarcoma. Soft tissue sarcomas include liposarcoma, fibrosarcoma of soft tissue, and rhabdomyosarcoma. Bone tumor metastasis to the lungs is common (Davis, James, & Saifuddin, 2015).

Osteosarcoma is the most common and most often fatal primary malignant bone tumor. Prognosis depends on whether the tumor has metastasized to the lungs at the time the patient seeks health care. It appears most frequently in children, adolescents and young adults (in bones that grow rapidly), in older adults with Paget disease of the bone, and in people with a prior history of radiation exposure. Clinical manifestations typically include localized bone pain that may be accompanied by a tender, palpable soft tissue mass. The primary lesion may involve any bone, but the most common sites are the distal femur, the proximal tibia, and the proximal humerus.

Malignant tumors of the hyaline cartilage are called *chondrosarcomas.* These tumors are the second most common primary malignant bone tumors affecting middle aged and older adults (Hornicek, 2019). They may grow and metastasize slowly or very fast, depending on the characteristics of the tumor cells involved (i.e., grade). Patients with low-grade chondrosarcomas tend to have a much better prognosis than those with high-grade chondrosarcomas. See Chapter 12 for a discussion of tumor grades. The usual tumor sites include the pelvis, femur, humerus, spine, scapula, and tibia. Metastasis to the lungs occurs in fewer than half of patients. These tumors may recur after excision.

Metastatic Bone Disease

Metastatic bone disease (secondary bone tumor) is more common than primary bone tumors (Mu, Shen, Liang, et al., 2018). Tumors arising from tissues elsewhere in the body may invade the bone and produce localized bone destruction (lytic lesions) or bone overgrowth (blastic lesions). The most common primary sites of tumors that metastasize to bone are the kidney, prostate, lung, breast, ovary, and thyroid (Mu et al., 2018). Metastatic tumors are most frequently found in the skull, spine, pelvis, femur, and humerus and often involve more than one bone (polyostotic).

Pathophysiology

A tumor in the bone causes the normal bone tissue to react by osteolytic response (bone destruction) or osteoblastic response (bone formation). Adjacent normal bone responds to the tumor by altering its normal pattern of remodeling. The bone's surface changes, and the contours enlarge in the tumor area.

Malignant bone tumors invade and destroy adjacent bone tissue (Mu et al., 2018). Benign bone tumors, in contrast, have a symmetric, controlled growth pattern and place pressure on adjacent bone tissue. Malignant bone tumors invade and weaken the structure of the bone until it can no longer withstand the stress of ordinary use; pathologic fracture commonly results.

Clinical Manifestations

Patients with metastatic bone tumor may have a wide range of associated clinical manifestations. They may be symptom free or have pain that ranges from mild and occasional to constant and severe, varying degrees of disability, and, at times, obvious bone growth. Weight loss, malaise, and fever may be present. The tumor may be diagnosed only after pathologic fractures occur or as an incidental finding.

With spinal metastasis, spinal cord compression may occur. It can progress rapidly or slowly. Neurologic deficits (e.g., progressive pain, weakness, gait abnormality, paresthesia, paraplegia, urinary retention, loss of bowel or bladder control) must be identified early and treated with decompression laminectomy to prevent permanent spinal cord injury.

Assessment and Diagnostic Findings

The differential diagnosis is based on the history, physical examination, and diagnostic studies, including CT, myelography, arteriography, MRI, biopsy, and biochemical assays of the blood and urine. General bone scans lack specificity. Positron emission tomography (PET) scans, although more expensive than other diagnostic tests, are assuming a larger role in whole body surveys after the initial diagnosis (Hornicek, 2019). PET scans generate images of the metabolic activity of cells and highlight metastatic bone disease when an increase uptake of radioactive substances is noted. A surgical or core needle biopsy is performed for histologic identification. Extreme care is taken during the biopsy to prevent seeding and resultant recurrence after excision of the tumor. Chest x-rays are performed to determine the presence of lung metastasis. Surgical staging of musculoskeletal tumors is based on tumor grade and site (intra- or extracompartmental), as well as on metastasis. Staging is used for planning treatment (see Chapter 12).

Serum ALP levels are frequently elevated with osteogenic sarcoma or bone metastasis. Hypercalcemia is also present with bone metastases from breast, lung, or kidney cancer. Symptoms of hypercalcemia include muscle weakness, fatigue, anorexia, nausea, vomiting, polyuria, cardiac arrhythmias, seizures, and coma. Hypercalcemia must be identified and treated promptly.

During the diagnostic period, the nurse explains the diagnostic tests and provides psychological and emotional support to the patient and family. The nurse assesses coping behaviors and encourages the use of support systems. Because the terminology associated with benign and malignant growths sound similar, the nurse can clarify the meaning of these in terms of treatment and prognosis and may allay fears.

Medical Management

Primary Bone Tumors

The goal of primary bone tumor treatment is to destroy or remove the tumor rapidly. This may be accomplished by surgical excision, radiation therapy if the tumor is radiosensitive, and chemotherapy for possible micrometastases. Survival and quality of life are important considerations in procedures that attempt to save the involved extremity; however, surgical removal of the tumor may require amputation of the affected extremity, with the amputation extending well above the tumor to achieve local control of the primary lesion (see Chapter 37).

If possible, limb-sparing (salvage) procedures are used to remove the tumor and adjacent tissue. A customized prosthesis, total joint arthroplasty, or bone tissue from the patient (autograft) or from a cadaver donor (allograft) replaces the resected tissue. Soft tissue and blood vessels may need grafting because of the extent of the excision. Complications may include infection, loosening or dislocation of the prosthesis, allograft nonunion, fracture, devitalization of the skin and soft tissues, joint fibrosis, and recurrence of the tumor.

Because of the danger of metastasis with malignant bone tumors, chemotherapy is started before and continued after surgery in an effort to eradicate micrometastatic lesions. The goal of combined chemotherapy is greater therapeutic effect at a lower toxicity rate with reduced resistance to the medications. Soft tissue sarcomas are treated with radiation, limb-sparing excision, and adjuvant chemotherapy (see Chapter 12).

Secondary Bone Tumors

The treatment of advanced metastatic bone cancer is palliative. The therapeutic goal is to relieve the patient's pain and discomfort while promoting quality of life. If the bone is weakened, structural support and stabilization are needed to prevent pathologic fracture. Bones are strengthened by prophylactic internal fixation, arthroplasty, or PMMA (bone cement) reconstruction. Patients with metastatic disease are at higher risk than other patients for postoperative pulmonary congestion, hypoxemia, VTE, and hemorrhage.

Hematopoiesis is frequently disrupted by tumor invasion of the bone marrow or by treatment (chemotherapy, surgery, or radiation). Blood component therapy restores hematologic factors. Additional therapies may be used to treat the original cancer. Radiation, chemotherapy, and hormonal therapy may also be effective in promoting healing of osteolytic lesions (see Chapter 12). Bisphosphonates are effective in stabilizing bone and may prevent cancer spread, as are the RANKL drugs (see Table 36-1).

Nursing Management

The nurse asks the patient about the onset and course of symptoms. During the interview, the nurse assesses the patient's understanding of the disease process, how the patient and the family have been coping, and how the patient has managed the pain. Palpation of the mass is limited to decrease any potential seeding process. The mass size and associated soft tissue swelling, pain, and tenderness are noted. Assessment of the neurovascular status and range of motion of the extremity provides baseline data for future comparisons. Evaluation of the patient's mobility and ability to perform ADLs is also documented.

The nursing care of a patient who has undergone excision of a bone tumor is similar to that of other patients who have had skeletal surgery. Explanation of diagnostic tests, treatments (e.g., wound care), and expected results (e.g., decreased range of motion, numbness, change of body contours) helps the patient deal with the procedures and changes and adhere to the therapeutic regimen. The nurse can most effectively reinforce and clarify information provided by the surgeon by being present during these discussions.

Pain can result from multiple factors. Oncology-associated bone pain is recognized as difficult to control. Pain must be assessed accurately and managed with adequate interventions. External-beam radiation to involved metastatic sites may be used. Patients with multiple bony metastases may achieve pain control with systemically given "bone-seeking" isotopes (e.g., strontium 89). (See Chapter 9 for more information about pain management.)

Bone tumors weaken the bone to a point at which normal activities or even position changes can result in fracture. During nursing care, the affected extremities must be supported and handled gently. External supports (e.g., splints) may be used for additional protection. Surgery (e.g., open reduction with internal fixation, joint replacement) may be done in an attempt to prevent pathologic fracture. Prescribed weight-bearing restrictions must be followed. The nurse and physical therapist must educate the patient about using assistive devices safely and strengthening unaffected extremities.

The nurse encourages the patient and family to verbalize their fears, concerns, and feelings. They need to be supported as they deal with the impact of the malignant bone tumor. Referral to a psychiatric advanced practice nurse, psychologist, counselor, or spiritual advisor may be indicated for specific psychological help and emotional support.

Monitoring and Managing Potential Complications

Delayed Wound Healing

Wound healing may be delayed because of tissue trauma from surgery, previous radiation therapy, inadequate nutrition, or infection. The nurse minimizes pressure on the wound site to promote circulation to the tissues. An aseptic, nontraumatic wound dressing promotes healing. Monitoring and reporting of laboratory findings facilitate initiation of interventions to promote homeostasis and wound healing.

Repositioning the patient at frequent intervals reduces the incidence of skin breakdown and pressure injuries. Special therapeutic beds or mattresses may be needed to prevent skin breakdown and to promote wound healing after extensive surgical reconstruction and skin grafting.

Inadequate nutrition impairs healing as well. Antiemetic agents and relaxation techniques reduce the adverse GI effects of chemotherapy. Stomatitis is controlled with anesthetic or antifungal mouthwash (see Chapter 12). Adequate hydration is essential. Nutritional supplements or parenteral nutrition may be prescribed to achieve adequate nutrition.

Osteomyelitis and Wound Infections

Prophylactic antibiotics and strict aseptic dressing techniques are used to diminish the occurrence of osteomyelitis and wound infections. During healing, other infections (e.g., upper respiratory infections) need to be prevented so that healing efforts are not divided between the cancer and the new, acute process. If the patient is receiving chemotherapy, the nurse monitors the WBC count and instructs the patient to avoid contact with people who have colds or other infections.

Hypercalcemia

Hypercalcemia is a dangerous complication of bone cancer or any process involved with breakdown of bone. Symptoms include muscular weakness, incoordination, anorexia, nausea and vomiting, constipation, electrocardiographic changes (e.g., shortened QT interval and ST segment, bradycardia, heart blocks), and altered mental states (e.g., confusion, lethargy, psychotic behavior). Treatment includes hydration with IV administration of normal saline solution, diuresis, mobilization, and medications such as IV bisphosphonates (e.g., zoledronic acid). Because inactivity leads to additional loss of bone mass and increased calcium in the blood, the nurse assists the patient to increase activity and ambulation. Denosumab may be prescribed if the calcium levels are not responsive to the IV bisphosphonates (see Table 36-1). See Chapters 10 and 12 for further discussion of hypercalcemia and its management.

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care

Preparation for and coordination of continuing health care are begun early as a multidisciplinary effort. Patient education addresses medication, dressing changes, treatment regimens, and the importance of physical and occupational therapy programs. The nurse educates the patient about weight-bearing limitations and special handling to prevent pathologic fractures. The patient and family must be educated about the signs and symptoms of possible complications as well as resources available for continuing care (see Chart 36-13).

Continuing and Transitional Care

Arrangements may be made for home, community-based, or transitional care. A home visit allows the nurse to assess the patient's and family's abilities to meet the patient's needs and determine whether other services are needed. The nurse advises the patient to have telephone numbers readily available so that providers can be contacted in case concerns arise.

The nurse emphasizes the need for long-term health monitoring to ensure cure or to detect tumor recurrence or metastasis and the need for recommended health screening. If the patient has metastatic disease, end-of-life issues may need to be explored. Referrals for hospice and palliative care are made if appropriate.

Chart 36-13 HOME CARE CHECKLIST

The Patient with a Bone Tumor

At the completion of education, the patient and/or caregiver will be able to:

- State the impact of the bone tumor growth process and treatment on physiologic functioning, ADLs, IADLs, roles, relationships, and spirituality.
- Identify modification of home environment, interventions, and strategies (e.g., durable medical equipment, wound care/dressings, adaptive equipment, ADL assistance) used in safely adapting to changes in structure or function and promote effective recovery and rehabilitation.
- Describe ongoing therapeutic regimen, including diet and activities to perform (e.g., exercises) and to limit or avoid (e.g., lifting weights, driving a car, contact sports).
    - Consume a healthy diet to promote healing and health.
    - State weight-bearing and activity restrictions.
    - Support affected musculoskeletal area, position to decrease risk of skin breakdown.
    - Demonstrate safe use of ambulatory aids and assistive devices.
    - Engage in exercise that improves balance to reduce risk of falls.
- State the name, dose, side effects, frequency, and schedule for all prescribed therapeutic and prophylactic medications (e.g., antibiotics, analgesic agents).
- Control pain with pharmacologic and nonpharmacologic interventions.
- State indicators of complications to report promptly to the provider such as:
    - Wound infection/delayed wound healing (e.g., redness, swelling, tenderness, purulent drainage, fever).
    - Osteomyelitis (e.g., localized pain, edema, erythema, fever).
    - Hypercalcemia (e.g., muscular weakness, anorexia, decreased coordination, nausea, vomiting, constipation).
- Relate how to reach the primary provider with questions or complications.
- State time and date of follow-up appointments, therapy, and testing.
- Identify community resources for peer and caregiver/family support:
    - Identify sources of support (e.g., friends, relatives, faith community).
    - Identify the contact details for support services for patients and their caregivers/families.

- Identify the need for health promotion, disease prevention, and screening activities.

Resources

See Chapter 2, Chart 2-6 for additional information related to durable medical equipment, adaptive equipment, and mobility skills.

ADLs, activities of daily living; IADLs, instrumental activities of daily living.

CRITICAL THINKING EXERCISES

1 ebp A patient is being scheduled for a total knee arthroplasty. He shares with you that many years ago his mother had a total hip arthroplasty and experienced ongoing issues related to pain and infection. He is concerned that he may also experience postoperative complications. He asks you to explain to him common complications and how they can be prevented. What evidence-based practice guidelines support your patient education? Explain the strength of the evidence that supports various nursing interventions to prevent infection and venous thromboembolism and to promote improved physical mobility.

2 pq You work as a nurse at a college's student health center. A student presents to the health center after a very busy final exam schedule and end of semester paper writing session. She is a varsity basketball player and is having issues with grabbing the ball. In the past, she has had episodes where she "jammed" a finger playing basketball, but this has not occurred recently. She is complaining of severe wrist pain and numbness in her fingers. Describe the priority assessment process that you would follow when you examine her hands. What is the expected care for a possible carpel tunnel disorder and how would you prioritize nursing interventions?

3 ipc A patient with a history of profound deafness, poor nutritional habits, and a significantly increased body mass index is status post total knee arthroplasty. The patient lives on the second floor of an apartment building. Develop an interprofessional plan of care that addresses the patient's care needs, both during hospitalization and upon discharge.

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*Asterisk indicates nursing research.

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Resources

American Cancer Society, www.cancer.org
American Joint Replacement Registry, www.aaos.org/registries/registry-program/american-joint-replacement-registry
Arthritis Foundation, www.arthritis.org
National Cancer Institute, www.cancer.gov
National Institute of Arthritis and Musculoskeletal and Skin Diseases, www.niams.nih.gov
National Osteoporosis Foundation Bone Source®, www.nbha.org
National Osteoporosis Foundation, www.nof.org
The Paget Foundation, www.paget.org
Vitamin D Council, www.vitamindcouncil.org
World Anti-Doping Agency, www.wada-ama.org/en

37 Management of Patients with Musculoskeletal Trauma

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Differentiate between contusions, strains, sprains, dislocations, and subluxations.
2. Identify the clinical manifestations, common treatment modalities, complications, and rehabilitation needs of patients with common types of fractures.
3. Describe the nursing management including the health education needs of the patient with a cast, splint, or brace, or who is in traction.
4. Use the nursing process as a framework for care of the older adult patient with a fracture of the hip.
5. Recognize sports- and occupation-related musculoskeletal disorders and their signs, symptoms, and treatments.
6. Apply the nursing process as a framework for care of the patient with an amputation.

NURSING CONCEPTS

Mobility
Tissue Integrity

GLOSSARY

allograft: tissue harvested from a donor for use in another person

amputation: removal of a body part, usually a limb or part of a limb

arthroscope: surgical scope inserted into a joint to examine or repair

autograft: tissue harvested from one area of the body and used for transplantation to another area of the same body

avascular necrosis (AVN): death of tissue secondary to a decrease or lack of perfusion; also called osteonecrosis

brace: externally applied device to support the body or a body part, control movement, and prevent injury

cast: rigid external immobilizing device molded to contours of body part

contusion: blunt force injury to soft tissue (*synonym:* bruise)

crepitus: a grating sound or sensation made by rubbing bony fragments together

débridement: surgical removal of contaminated and devitalized tissues and foreign material

delayed union: prolongation of expected healing time for a fracture

disarticulation: amputation through a joint

dislocation: complete separation of joint surfaces

external fixator: external metal frame attached to bone fragments to stabilize them

fracture: a break in the continuity of a bone

fracture reduction: restoration of fracture fragments into anatomic alignment

heterotopic ossification: misplaced formation of bone

malunion: healing of a fractured bone in a malaligned position

neurovascular status: assessment of the neurologic (motor and sensory components) and circulatory functioning of a body part

nonunion: failure of fractured bones to heal together

osteomyelitis: infection of the bone

paresthesia: an abnormal sensation of tingling or numbness or burning

phantom limb pain: pain perceived in an amputated section

RICE: acronym for *r*est, *i*ce, *c*ompression, *e*levation

sling: bandage used to support an arm

splint: device designed specifically to support and immobilize a body part in a desired position

sprain: an injury to ligaments and muscles and other soft tissues at a joint

strain: a musculotendinous stress injury

subluxation: partial separation of joint surfaces

traction: application of a pulling force to a part of the body
trapeze: overhead assistive device to promote patient mobility in bed

Unintentional injury is the third leading cause of death in the United States (Kochanek, Murphy, Xu, et al., 2019). Unintentional injuries are commonly called *accidents;* however, this term is considered inaccurate by trauma professionals. The term *accident* infers that there is no potential for prevention; yet, health care professionals understand that prevention plays a major role in decreasing the rate of unintentional injuries. The implementation of evidence-based primary prevention policies (e.g., mandatory use of seat belts for drivers and passengers in motor vehicles) may prevent many unintentional injuries from occurring.

Trauma is a frequent cause of musculoskeletal injury and is among the most common reasons for people to seek medical attention (Centers for Disease Control and Prevention [CDC], National Center for Health Statistics, 2017). Therefore, nurses who work in emergency departments (EDs), critical care units, and inpatient medical-surgical units frequently encounter patients who have experienced musculoskeletal trauma. The management of musculoskeletal injuries frequently includes the use of casts, splints, braces, traction, surgery, or a combination of these. Nursing care is planned to maximize the effectiveness of these treatment modalities and to prevent potential complications associated with each of the interventions. However, upon discharge from the hospital, many of these patients require extensive periods of rehabilitation and follow-up. Thus, nurses who work in rehabilitation centers, long-term care facilities, ambulatory surgery centers, occupational health settings, and primary care clinics may all care for patients with musculoskeletal injuries.

Contusions, Strains, and Sprains

A **contusion** is a soft tissue injury produced by blunt force, such as a blow, kick, or fall, causing small blood vessels to rupture and bleed into soft tissues (ecchymosis or bruising). A hematoma develops from bleeding at the site of impact, leaving a characteristic “black and blue” appearance. Contusions can be minor or severe, isolated or in conjunction with additional injuries (e.g., fracture). Local symptoms include pain, swelling, and discoloration. Contusions can limit joint range of motion (ROM) near the injury, and the injured muscle may feel weak and stiff (American Academy of Orthopedic Surgeons [AAOS], 2019a). Most contusions resolve in 1 to 2 weeks; severe contusions may take longer to heal.

A **strain** is an injury to a muscle or tendon from overuse, overstretching, or excessive stress; it is commonly known as a muscle pull (Babarinde, Ismail, &

Schellack, 2018). Tendons are fibrous cords that attach muscle to a bone; strains often occur in tendons of the foot, leg (e.g., hamstring), and back. Strains can be categorized as acute or chronic and are graded along a continuum based on postinjury symptoms and loss of function. Acute strains can result from a single injurious incident; whereas, chronic strains result from repetitive injuries. Chronic strains can result from improper management of acute strains. Depending on the severity of muscle fiber damage, three degrees of strains can be classified (Babarinde et al., 2018):

- **A first-degree** strain is mild stretching of the muscle or tendon with no loss of ROM. Signs and symptoms may include the gradual onset of palpation-induced tenderness and mild muscle spasm.
- **A second-degree** strain involves moderate stretching and/or partial tearing of the muscle or tendon. Signs and symptoms include acute pain during the precipitating event, followed by tenderness at the site with increased pain with passive ROM (PROM), edema, significant muscle spasm, and ecchymosis.
- **A third-degree** strain is severe muscle or tendon stretching with rupturing and complete tearing of the involved tissue. Signs and symptoms include immediate pain described as tearing, snapping, or burning, muscle spasm, ecchymosis, edema, and loss of function. An x-ray should be obtained to rule out bone injury, because an avulsion fracture (in which a bone fragment is pulled away from the bone by a tendon) may be associated with a third-degree strain. X-rays do not reveal injuries to soft tissue or muscles, tendons, or ligaments, but magnetic resonance imaging (MRI) and ultrasound can identify tendon injury.

A **sprain** is an injury to the ligaments and tendons that surround a joint. It is caused by a twisting motion or hyperextension (forcible) of a joint (Babarinde et al., 2018). While tendons connect muscle to bone, ligaments connect bone to bone. The function of a ligament is to stabilize and support the body's joints while permitting mobility. An injured ligament causes joint instability, with the most vulnerable areas of the body being the ankles, knees, and wrists. The severity of a sprain is graded according to how badly the ligament has been damaged and whether or not the joint has been made unstable (Maughan, 2019):

- A Grade I sprain is stretching or slight tearing in some fibers of the ligament and mild, localized hematoma formation. Manifestations include mild pain, edema, and local tenderness.
- A Grade II sprain is more severe and involves partial tearing of the ligament. Manifestations include increased pain with motion, edema, tenderness, joint instability, ecchymosis, and partial loss of normal joint function.

- A Grade III sprain is a complete tear or rupture of the ligament. A Grade III sprain may also cause an avulsion of the bone. Symptoms include severe pain, edema, tenderness, ecchymosis, and abnormal joint motion.

Management

The treatment for contusions, strains, and sprains is guided by the severity of injury and the goal of protecting from further injury. Protection from further injury is accomplished through support of the affected area (e.g., sling, brace) and/or splinting, taping, or compression bandages. To control pain, bleeding, and inflammation, most contusions, strains, and sprains are managed with the **RICE** method, an acronym that refers to ***r***est, ***i***ce, ***c***ompression, and ***e***levation (AAOS, 2019a). Rest prevents additional injury and promotes healing. Intermittent application of cold or ice packs during the first 24 to 72 hours after injury produces vasoconstriction, which decreases bleeding, edema, and discomfort. Cold packs should not be in place for longer than 20 minutes at a time, and care must be taken to avoid skin and tissue damage from excessive cold (AAOS, 2019a). An elastic compression bandage controls bleeding, reduces edema, and provides support for the injured tissues. Elevation at or just above the level of the heart controls the swelling (AAOS, 2019a). If the sprain or strain is the most severe grade or degree, immobilization by a splint, brace, or cast may be necessary so that the joint will not lose its stability (see later discussions). Nonsteroidal anti-inflammatory drugs (NSAIDs) may be prescribed for pain management (AAOS, 2019a). The **neurovascular status**, a type of focused assessment of the neurologic (motor and sensory) and vascular function of the injured extremity, is monitored at frequent intervals (e.g., every 15 minutes for the first 1 to 2 hours after injury) and then at lesser intervals (e.g., every 30 minutes) until stable. Decreases in sensation or motion and increases in pain level should be documented and reported to the patient's primary provider immediately so that acute compartment syndrome can be prevented (see later discussion).

Joint Dislocations

A **dislocation** of a joint is a condition in which the articular surfaces of the distal and proximal bones that form the joint are no longer in anatomic alignment. A **subluxation** is a partial or incomplete dislocation and does not cause as much deformity as a complete dislocation. In complete dislocation, the bones are literally "out of joint." Acute traumatic dislocations are orthopedic emergencies because the associated joint structures, blood supply, and nerves are displaced and may be entrapped with extensive pressure on them. If a dislocation or subluxation is not reduced immediately, **avascular necrosis (AVN)** may develop. AVN of bone is caused by ischemia, which leads to necrosis or death of the bone cells.

Signs and symptoms of a traumatic dislocation include acute pain, change in or awkward positioning of the joint, and decreased ROM. Bilateral assessment will usually make apparent the abnormality in the affected joint. X-rays are usually taken to confirm the diagnosis and reveal any associated fracture (DeBerardino, 2018).

Medical Management

When a joint is dislocated, the main treatment priorities are to avoid neurovascular complications and reduce the joint as atraumatically as possible (DeBerardino, 2018). The affected joint needs to be immobilized at the scene and during transport to the hospital. Informed consent for the procedure is obtained and the dislocation is promptly reduced so that displaced parts are placed back in proper anatomic position to preserve joint function (see Chart 37-1). Analgesia, muscle relaxants, and possibly anesthesia are used to facilitate closed reduction. The joint is immobilized by splints, casts, or traction and is maintained in a stable position. Neurovascular status is assessed at a minimum of every 15 minutes until stable. After reduction, if the joint is stable, gentle, progressive, active and passive movement is begun to preserve ROM and restore strength. The joint is supported between exercise sessions.

Nursing Management

The focus of nursing care is on frequent assessment and evaluation of the injury, including complete neurovascular assessment with proper documentation and communication with the primary provider. The patient and family members are educated regarding proper exercises and activities as well as danger signs and symptoms to look for, such as increasing pain (even with analgesic agents), numbness or tingling, and increased edema in the extremity. These signs and symptoms may indicate acute compartment syndrome; if acute compartment syndrome is not identified and communicated to the primary provider, it may lead to disability or loss of the extremity (see later discussion).

Injuries to the Tendons, Ligaments, and Menisci

Rotator Cuff Tears

A rotator cuff tear is a rip in a tendon that connects one of the rotator muscles to the humeral head. The rotator cuff stabilizes the humeral head and keeps the arm in the shoulder socket. The rotator cuff is composed of four muscles that come together as tendons (supraspinatus, infraspinatus, teres minor, and subscapularis) that cover the head of the humerus, helping to raise and rotate the arm (AAOS, 2019b).

Rotator cuff tears may result from acute or chronic stresses on the joint and from intrinsic (e.g., age-related) or extrinsic (e.g., overuse, fracture, etc.) factors. Physical examination should include bilateral evaluation of the joint. The patient complains of aching pain that is typically insidious in nature (unless related to an acute injury) and worsens with use. The patient will complain of tenderness to palpation and difficulty sleeping on the affected side and will exhibit decreased ROM and decreased strength. A thorough physical examination and imaging studies, including x-ray, MRI scan and musculoskeletal ultrasound, aid in confirming diagnosis and extent of injury (AAOS, 2019b; Simons, Dixon, & Kruse, 2019). Arthrography with MRI or computed tomography (CT) scan may be more sensitive for certain tears but is usually reserved for cases when a labral injury is suspected (Simons et al., 2019).

Treatment options depend upon several factors, including the duration of symptoms, hand dominance, the type of tear, and patient characteristics such as age, general health, and activity level. Initial conservative management consists primarily of physical therapy, injury surveillance, NSAIDs, rest with modification of activities, and corticosteroid injections into the shoulder joint (Simons et al., 2019). If conservative methods fail, surgical management is warranted. Multiple surgical approaches (e.g., open, mini-open, and arthroscopic) can be employed. Selection of surgical modality is based upon the factors discussed above and the surgeon's preference as there is limited evidence whether surgery provides clinically important benefits (Karjalainen, Jain, Heikkinen, et al., 2019). Postoperatively, the shoulder is immobilized with a **sling**, a supportive arm bandage, for 4 to 6 weeks; length of time of immobilization depends on the severity of injury. Physical therapy with shoulder exercises is begun as prescribed, and the patient is educated on how to perform the exercises at home. The course of rehabilitation is lengthy (e.g., 3 to 6 months); functionality post rehabilitation depends on the patient's commitment to the rehabilitation regimen (AAOS, 2019b).

Lateral and Medial Epicondylitis

Epicondylitis is a chronic, painful condition that is caused by excessive, repetitive extension, flexion, pronation, and supination motions of the forearm. These motions result in inflammation (tendonitis) and minor tears in the tendons at the origin of the muscles on the lateral or medial epicondyles. Lateral epicondylitis (e.g., tennis elbow) is frequently identified in someone who repeatedly extends the wrist with supination of the forearm. Patients complain of pain and tenderness over the lateral epicondyle and in the proximal wrist extensor muscles (Cutts, Gangoo, Modi, et al., 2020). Medial epicondylitis (e.g., golfer's elbow) is consistent with repetitive wrist flexion and pronation of the forearm. Extreme tenderness occurs at the medial epicondyle and in the proximal wrist flexor muscles (Neeru, 2020). Lateral epicondylitis is seven times more common than its medial counterpart (Cutts et al., 2020).

Chart 37-1 ETHICAL DILEMMA

Does Informed Consent Always Uphold Autonomy?

Case Scenario

D.N. is a 27-year-old man brought by ambulance to the emergency department (ED) where you work as a staff nurse. You are his admitting nurse. Paramedics bring him to the trauma bay by stretcher; he is sitting upright, alert and fully oriented, breathing room air, and gripping his right elbow in flexion with his left hand, holding his right arm slightly away from his torso. The right arm has had a sling applied. As you approach him, you can hear him groaning and see that his forehead is diaphoretic. You see an obvious deformity at his right shoulder, which is slumped, and observe a bulge below his right clavicle, which is likely his dislocated right humeral head. The ED physician meets you and D.N. in the trauma bay and tells D.N. that he could send him to x-ray to confirm that his right shoulder is dislocated and to ensure he does not have any associated fractures; however, that will delay his treatment and fractures are very uncommon occurrences when shoulders dislocate in young men. The ED physician asks D.N. if he can attempt to correct his dislocation manually first, and that if that does not work, he will send him to x-ray. D.N. agrees that the ED physician may correct his dislocation; the physician begins to quickly note the risks associated with this manual procedure and procures an informed consent for D.N. to sign. D.N. blurts out “Oh for heaven’s sakes just fix my shoulder!” as he scribbles a jumbled signature on the form with his nondominant left hand. The ED physician quickly and efficiently reduces the dislocated shoulder, and D.N. immediately sighs with relief and says “Oh thank you, doctor! You are a miracle worker!” After you send D.N. to radiology for a follow-up x-ray, the physician turns to you and says “What a crock about these consents. Was that patient really going to not consent to have me try to fix his shoulder? It is just useless paperwork that takes additional time, and that poor guy had to needlessly suffer those extra minutes while we got that paperwork signed!”

Discussion

Obtaining informed consent from a patient prior to any procedure that incurs any risk is a legal requirement. The informed consent must clearly identify what is going to be done and what adverse consequences may ensue from the procedure. The informed consent must meet a *professional standard* so that it includes information that most other health care professionals would disclose during the informed consent process. Furthermore, the informed consent must also meet the *reasonable patient standard,* meaning that information is shared that the patient needs to know in order to make a decision whether or not to have the procedure performed. The informed consent process is considered central to ensuring patient autonomy.

However, some bioethicists have asserted that patients who have had a traumatic injury many times do not remember information shared during the informed consent process. They counter that because of pain, fear, and anxiety, patients with trauma are not focused on the actual risks associated with treatments. Therefore, these bioethicists note that the informed consent process with patients with trauma is actually a sham process and fundamentally does little to preserve patient self-determination.

Analysis

- Describe the ethical principles that are in conflict in this case (see Chapter 1, Chart 1-7). In most instances, the principle of autonomy is considered preeminent. In this case, are the principles of beneficence or nonmaleficence of more importance?
- Think about what the ED physician said about the informed consent process for D.N. Were there any benefits to D.N. by upholding the informed consent process? What risks could D.N. have incurred if there had not been an informed consent process?
- What if D.N. does indeed have a fracture associated with his dislocated shoulder? What risks are there to the ED physician or to you had you not ensured an informed consent occurs?
- What resources might be mobilized to be of assistance to you, the ED physician, and to D.N. so that D.N.'s autonomy is upheld and he can be assured the best treatment options?

References

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Resources

See Chapter 1, Chart 1-10, for Steps of an Ethical Analysis and Ethics Resources.

To date, there is no universally accepted regimen of treatment (Cutts et al., 2020); however, some general principles can be considered. Rest and cessation of aggravating actions is the first-line treatment. Intermittent application of ice and administration of NSAIDs usually relieve the pain and inflammation. In some instances, the arm is immobilized in a molded splint for support and pain relief. Local injection of corticosteroids may be used for symptom management, but because of its degenerative effects on tendons, this treatment is traditionally reserved for patients with severe pain who do not respond to first-line treatment methods (Lenoir, Mares, & Carlier, 2019). Physical therapy and rehabilitation exercises are also considered first-line, nonsurgical treatments (Lai, Erickson, Mlynarek, et al., 2018). Multiple electrophysical modalities, such as transcutaneous electrical nerve stimulation (TENS), ultrasound, extracorporeal shock wave therapy (ESWT), and laser therapy, may provide limited benefit; however, more research is needed to validate their efficacy (Cutts et al., 2020). Surgical interventions are typically a last resort and can be considered in patients who have no response to nonoperative management, want faster symptom management, or have severe pain (Lenoir et al., 2019).

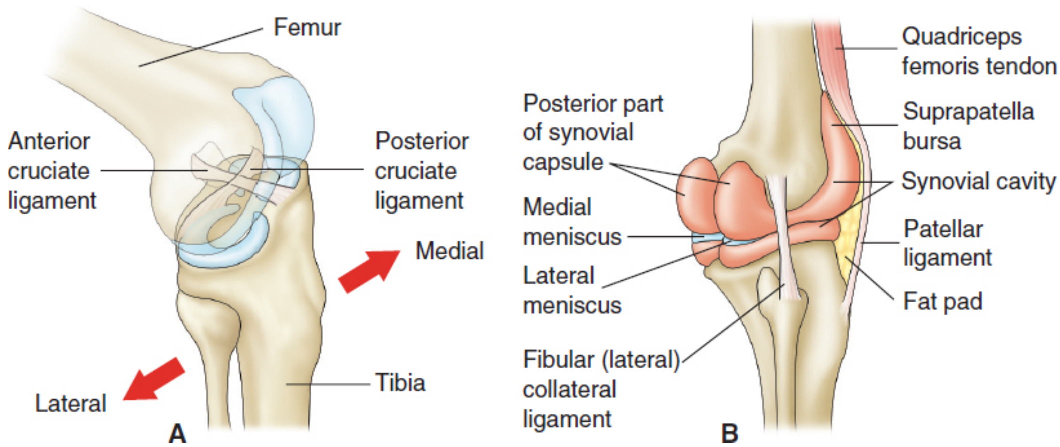

Figure 37-1 • Knee ligaments, tendons, and menisci. **A.** Anterolateral view. **B.** Posterolateral view.

Lateral and Medial Collateral Ligament Injury

Lateral and medial collateral ligaments (MCLs) of the knee (see Fig. 37-1) provide stability to the knee. Injury to these ligaments occurs when the foot is firmly planted and the knee is struck—either medially, causing stretching and tearing injury to the lateral collateral ligament (LCL), or laterally, causing stretching and tearing injury to the MCL. The patient experiences an acute onset of pain, joint tenderness, joint instability, and inability to walk without assistance.

Medical Management

Early management includes the RICE method, use of analgesics, and protection of the joint from further injury (Dexter, 2019). The joint is evaluated for fracture. Hemarthrosis (bleeding into the joint) may develop, contributing to the pain; should this occur, the joint fluid may be aspirated to relieve pressure.

Treatment depends on the severity of the injury. Conservative management includes weight bearing as tolerated and the use of a hinged-brace for support. Crutches may be indicated to assist ambulation until weight bearing can be tolerated. Exercises to strengthen the supportive muscles to the knee without straining the ligaments are beneficial. Severe MCL injuries are initially treated with non–weight-bearing status with progression to weight bearing as tolerated in a hinged-brace for a lengthy timeframe; the healing process may take 8 to 12 weeks. Severe LCL injuries with knee instability usually require surgical intervention, followed by bracing and physical therapy (Agranoff, 2019). A progressive rehabilitation program helps restore the function and strength of the knee. Rehabilitation occurs over many months, and the patient may need to wear a derotational brace while engaging in sports to prevent recurrence of injury.

Nursing Management

The nurse educates the patient about proper use of ambulatory devices, the healing process, and activity limitation to promote healing. Education addresses pain management, the use of analgesic agents, the use of a brace, wound care, cold therapy, signs and symptoms of possible complications (e.g., altered neurovascular status, infection, skin breakdown, venous thromboembolism [VTE]), and self-care (Dexter, 2019).

Cruciate Ligament Injury

The anterior cruciate ligament (ACL) and the posterior cruciate ligament (PCL) of the knee stabilize anterior and posterior motion of the tibia articulating with the femur (see Fig. 37-1A). These ligaments cross each other in the center of the knee. Injury occurs when the foot is firmly planted and the leg sustains direct force, either forward or backward. If the force is forward, the ACL suffers the impact from the force, whereas backward force places force on the PCL. The injured person may report feeling and hearing a “pop” in the knee with this injury. If the patient exhibits significant swelling of the joint within 2 hours after the injury, the ACL or PCL may be torn. A torn cruciate ligament produces pain, joint instability, and pain with weight bearing. Immediate postinjury management includes the RICE protocol, use of NSAIDs, and stabilization of the joint until it is evaluated for a fracture (Graham, 2019). Severe joint effusion and hemarthrosis may require joint aspiration and wrapping with an elastic compression dressing. Crutches may be needed to avoid weight bearing, especially if the knee is unstable (Friedberg, 2019).

Treatment depends on the severity of the injury, patient characteristics, and the effect of the injury on daily activities. Ligament injuries can be managed operatively or nonoperatively; most active, younger patients and high performing athletes opt for surgery due to the risk for reinjury and osteoarthritis (Friedberg, 2019). Older and less active patients, whose physical activity is community ambulation, tend to benefit from nonsurgical therapy (Graham, 2019). Surgical ACL or PCL reconstruction may be scheduled after near-normal joint ROM is achieved and includes tendon repair using a graft (e.g., autograft, allograft, or synthetic ligament; see later discussions). This is typically performed as ambulatory arthroscopic surgery, a procedure in which the surgeon uses an **arthroscope** to visualize and repair the damage. After surgery, the patient is instructed to control pain with oral analgesic medications and cryotherapy (e.g., a cooling pad incorporated in a dressing). The patient and family are educated about monitoring the neurovascular status of the leg, wound care, and signs of complications (e.g., infection, VTE) that need to be reported promptly to the surgeon (Cox, 2017). Exercises (ankle pumps, quadriceps sets, and hamstring sets) are encouraged during the early postoperative period. The patient must protect the graft by adhering to exercise restrictions. The physical therapist supervises progressive ROM and weight bearing (as permitted).

Meniscal Injuries

Within the knee are two semilunar (crescent-shaped) pads of fibrocartilages, called *menisci,* located on the right and left side of the proximal tibia, between the tibia and the femur (see Fig. 37-1B). These structures act as shock absorbers in the knee. Normally, little twisting movement is permitted in the knee joint. Forceful twisting of the knee or repetitive squatting and impact may result in either tearing or detachment of the cartilage from its attachment to the head of the tibia. The peripheral third of the menisci have a small amount of blood flow, which allows that portion to heal if torn.

These injuries leave loose cartilage in the knee joint that may slip between the femur and the tibia, preventing full extension of the leg. If this happens during walking or running, the patient often describes the leg as “giving way.” The patient may hear or feel a click in the knee when walking, especially when extending the leg that is bearing weight. When the cartilage is attached to the front and back of the knee but torn loose laterally (bucket-handle tear), it may slide between the bones to lie between the condyles and prevent full flexion or extension. As a result, the knee “locks.”

When a meniscus is torn, the synovial membrane secretes additional synovial fluid due to the irritation, and the knee becomes very edematous. Initial conservative management includes rest and immobilization of the knee, ice to the knee for 15 minutes every 4 to 6 hours, the use of crutches for support, anti-inflammatory agents, analgesic agents, and modification of activities to avoid those that cause the symptoms. Home exercises and physical therapy may be prescribed to increase strength in supporting muscles (e.g., quadriceps, hamstrings). Diagnosis is confirmed through MRI or arthroscopy; the approach to treatment depends on the patient’s age, type of tear, associated mechanical symptoms (e.g., knee is locked, or motion is severely impaired) and the presence of persistent knee effusions (Cardone & Jacobs, 2019).

Surgical options include a partial or total meniscectomy to repair the meniscal tissue. Open or arthroscopic surgery can be performed (Baker, Wolf, & Lubowitz, 2018). The most common complication is an effusion into the knee joint, which produces pain. To ensure independent home performance, the patient is instructed to continue quadriceps strengthening and progressive ROM exercises; neuromuscular electrical stimulation/biofeedback is also recommended (Logerstedt, Snyder-Mackler, Ritter, et al., 2018). There is a lack of consensus regarding the optimal postoperative time to return to activity; therefore, prescribed weight-bearing status can range from non–weight bearing for 4 to 6 weeks to full weight bearing in a “locked” (extension) knee brace (Spang, Nasr, Mohamadi, et al., 2018).

Rupture of the Achilles Tendon

The Achilles tendon is a tough band of fibrous tissue that attaches the soleus and gastrocnemius (e.g., calf) muscles to the calcaneus (e.g., heel bone). Injury to the Achilles tendon is often multifactorial; despite being the strongest and thickest tendon in the body, it is vulnerable to injury due to its limited blood supply and the high tensions placed upon it (Egger & Berkowitz, 2017). Rupture of the Achilles tendon most commonly occurs in active young to middle-aged adults with a predilection among males. The traumatic rupture of the Achilles tendon occurs with the “pushing off” or unexpected dorsiflexion of the foot and ankle (Karlsson Westin, Carmont, et al., 2019). Patients usually describe a “popping” sound or a “giving way” sensation in their posterior heel. Immediate pain is usually experienced but gradually subsides, leaving a patient with difficulty performing plantar flexion, and the inability to fully bear weight on the affected leg (Egger & Berkowitz, 2017).

Clinical examination is paramount in diagnosis; the ability to plantar flex is decreased and to dorsiflex is improved. MRI or ultrasound is indicated to determine the extent of the injury. The decision of surgical or nonsurgical treatment for Achilles tendon rupture is much debated and depends on the patient’s comorbidities, goals, and preferences (Karlsson et al., 2019). Nonoperative modalities include cast immobilization for 2 to 8 weeks; there is some controversy regarding optimal time. After immobilization with the cast, a boot and functional brace with a heel lift is worn with increasing weight-bearing status. Progressive physical therapy to promote ankle ROM and strength is implemented as well. Operative treatment has typically been reserved for young, healthy athletes, because surgery was associated with fewer cases of re-rupture. After surgery, a cast may be initially used to immobilize the ankle joint; however, early functional rehabilitation has been shown to be superior to cast immobilization in terms of patient satisfaction and the time to return to prior employment and sporting activity (Zhao, Meng, Liu, et al., 2017). The total rehabilitation is approximately 6 weeks (Karlsson et al., 2019).

Fractures

A **fracture** is a complete or incomplete disruption in the continuity of bone structure and is defined according to its type and extent. Fractures occur when the bone is subjected to stress greater than it can absorb (Buckley & Page, 2018). Fractures may be caused by direct blows, crushing forces, sudden twisting motions, and extreme muscle contractions. When the bone is broken, adjacent structures are also affected, which may result in soft tissue edema, hemorrhage into the muscles and joints, joint dislocations, ruptured tendons, severed nerves, and damaged blood vessels. Body organs may be injured by the force that caused the fracture or by fracture fragments.

Types of Fractures

Fractures types are identified by the name of the injured bone and location (e.g., proximal, midshaft, distal) (Beutler & Titus, 2019). Fractures are also described according to the degree of break (e.g., a *greenstick fracture* refers to a partial break) or the character of any fractured bone fragments (e.g., a *comminuted fracture* has more than two fragments). Select specific types of fractures are displayed in Figure 37-2.

A *closed fracture* (simple fracture) is one that does not cause a break in the skin. An *open fracture* (compound, or complex, fracture) is one in which the skin or mucous membrane wound extends to the fractured bone. Open fractures are often classified using a modified system by Gustilo-Anderson which classifies the severity into three categories based on the extent of soft-tissue injury and the size of the corresponding skin wounds (Elniel & Giannoudis, 2018):

- Type I is a clean wound less than 1 cm long and simple fracture pattern.
- Type II is a larger wound with minimal soft tissue damage and no flaps or avulsions.
- Type III (A, B, and C subtypes) is considered the most severe, highly contaminated, and has extensive soft tissue damage; it involves vascular injury or traumatic amputation.

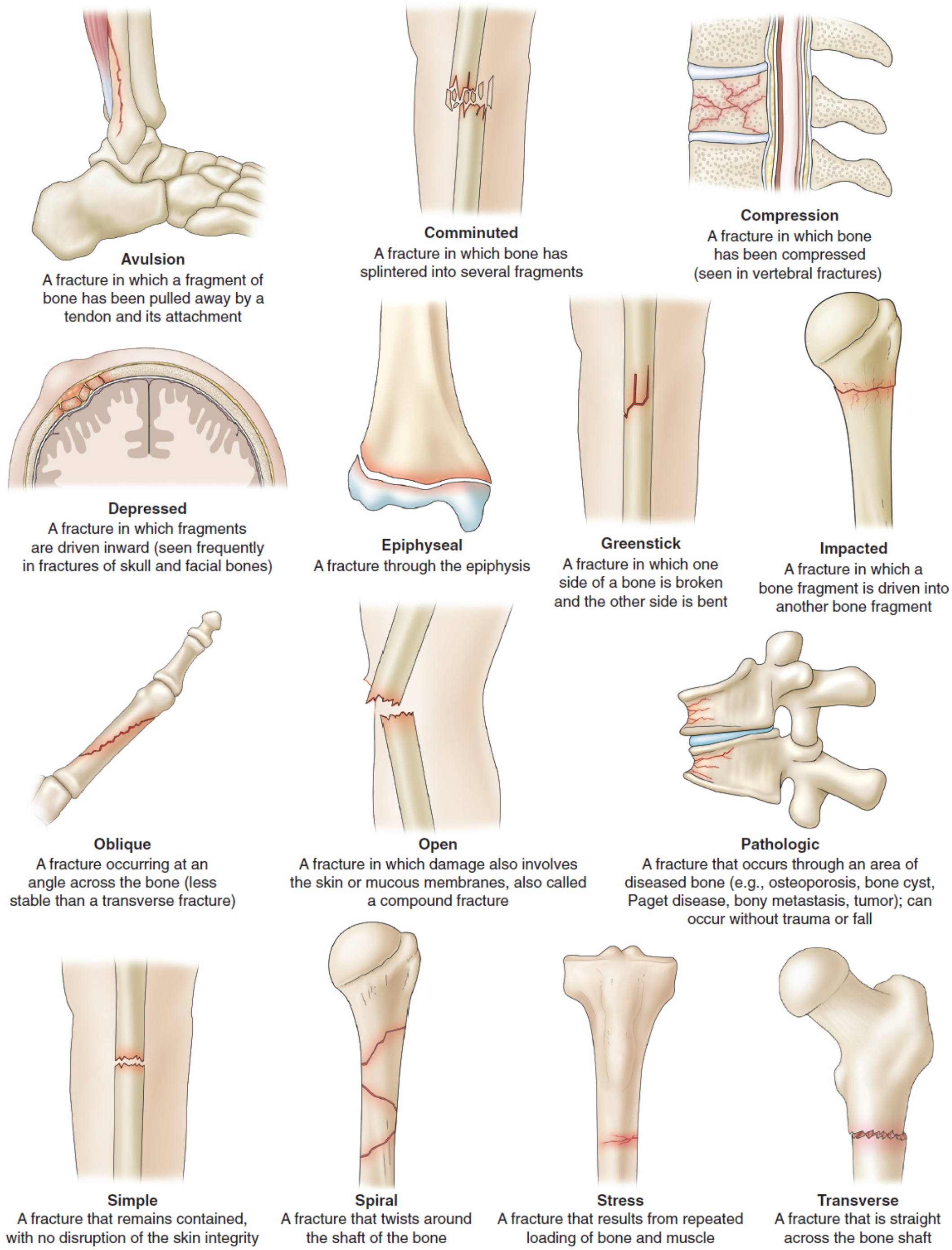

Figure 37-2 • Specific types of fractures.

An *intra-articular fracture* extends into the joint surface of a bone. Because each end of a long bone is cartilaginous, if the fracture is nondisplaced, x-rays will not always reveal the fracture because cartilage is nonradiopaque. MRI or arthroscopy will identify the fracture and confirm the diagnosis. The joint is stabilized and immobilized with a splint or cast, and no weight bearing is allowed until the fracture has healed. Because of the damage to articular cartilage, intra-articular fractures often lead to early posttraumatic osteoarthritis (Mittal & Mittal, 2019).

Clinical Manifestations

The clinical signs and symptoms of a fracture vary according to which bone is affected, the patient's health and age, and the severity of the injury (Whittle, 2017a). However, they often include acute pain, loss of function, deformity, shortening of the extremity, crepitus, localized edema and ecchymosis, muscle spasm, and tenderness (Iyer, 2019).

Pain

The pain is continuous and increases in severity until the bone fragments are immobilized. Immediately after a fracture, the injured area becomes numb and the surrounding muscles flaccid. The muscle spasms that accompany a fracture begin shortly thereafter, within a few to 30 minutes, and result in more intense pain than the patient reports at the time of injury. The muscle spasms can minimize further movement of the fracture fragments or can result in further bony fragmentation or malalignment (Norris, 2020).

Loss of Function

After a fracture, the extremity cannot function properly because normal function of the muscles depends on the integrity of the bones to which they are attached. Pain contributes to the loss of function. In addition, abnormal movement (false motion) may be present.

Deformity

Displacement, angulation, or rotation of the fragments in a fracture of the arm or leg causes a deformity that is detectable when the limb is compared with the uninjured extremity.

Shortening

In fractures of long bones, there is actual shortening of the extremity because of the compression of the fractured bone. Sometimes, muscle spasms can cause the distal and proximal site of the fracture to overlap, causing the extremity to shorten (Norris, 2020).

Crepitus

When the extremity is gently palpated, a crumbling sensation, called **crepitus,** can be felt or may be heard. It is caused by the rubbing of the bone fragments against each other.

Localized Edema and Ecchymosis

After a fracture, localized edema and ecchymosis occur as a result of trauma and bleeding into the tissues. These signs may not develop for several hours after the injury or may develop within an hour, depending on the severity of the fracture.

Emergency Management

Immediately after injury, if a fracture is suspected, the body part must be immobilized before the patient is moved. Adequate splinting is essential. Joints proximal and distal to the fracture also must be immobilized to prevent movement of fracture fragments. Immobilization of the long bones of the lower extremities may be accomplished by bandaging the legs together, with the unaffected extremity serving as a splint for the injured one. In an upper extremity injury, the arm may be bandaged to the chest, or an injured forearm may be placed in a sling. The neurovascular status distal to the injury should be assessed both before and after splinting to determine the adequacy of peripheral tissue perfusion and nerve function (Derby & Beutler, 2018).

With an open fracture, the wound is covered with a sterile dressing to achieve homeostasis as rapidly as possible at the injury site and to prevent contamination of deeper tissues (Buckley & Page, 2018). No attempt is made to reduce the fracture, even if one of the bone fragments is protruding through the wound. Splints are applied for immobilization.

In the ED, the patient is evaluated completely. The clothes are gently removed, first from the uninjured side of the body and then from the injured side. The patient's clothing may be cut away. The fractured extremity is moved as little as possible to avoid more damage.

Medical Management

Reduction

Fracture reduction refers to restoration of bone fragments to anatomic realignment and positioning with immobilization (Iyer, 2019). Either closed reduction or open reduction may be used to reduce a fracture. The specific method selected depends on the nature of the fracture; however, the underlying principles are the same. Usually, the primary provider reduces a fracture as soon as possible to prevent loss of elasticity from the tissues through infiltration by edema or hemorrhage. In most cases, fracture reduction becomes more difficult as the injury begins to heal (Buckley & Page, 2018).

Before fracture reduction and immobilization, the patient is prepared for the procedure; consent for the procedure is obtained, and an analgesic agent is given as prescribed. Regional anesthesia can also be very useful for pain control with fractures and dislocation reduction (Eiff, Hatch, & Higgins, 2020a). The injured extremity must be handled gently to avoid additional damage.

Closed Reduction

In most instances, closed reduction is accomplished by bringing the bone fragments into anatomic alignment through manipulation and manual traction. The extremity is held in the aligned position while a cast, splint, or other device is applied (see later discussion). Reduction under anesthesia with percutaneous pinning may also be used. The immobilizing device maintains the reduction and stabilizes the extremity for bone healing. X-rays are obtained after reduction to verify that the bone fragments are correctly aligned (Buckley & Page, 2018).

Traction (skin or skeletal) may be used until the patient is physiologically stable to undergo surgical fixation (see later discussion).

Open Reduction

Some fractures require open reduction. Through a surgical approach, the bone fragments are anatomically aligned. Internal fixation devices (e.g., metallic pins, wires, screws, plates, nails, or rods) may be used to hold the bone fragments in position until solid bone healing occurs (Iyer, 2019). These devices may be attached to the sides of bone, or they may be inserted through the bony fragments or directly into the medullary cavity of the bone (see Fig. 37-3). Internal fixation devices ensure firm approximation and fixation of the bony fragments (Buckley & Page, 2018). Open reduction internal fixation (ORIF) is a common orthopedic surgical procedure used to treat severe fractures.

Immobilization

After the fracture has been reduced, the bone fragments must be immobilized and maintained in proper position and alignment until union occurs. Immobilization may be accomplished by external or internal fixation. Methods of external fixation include bandages, casts, splints, continuous traction, and external fixators.

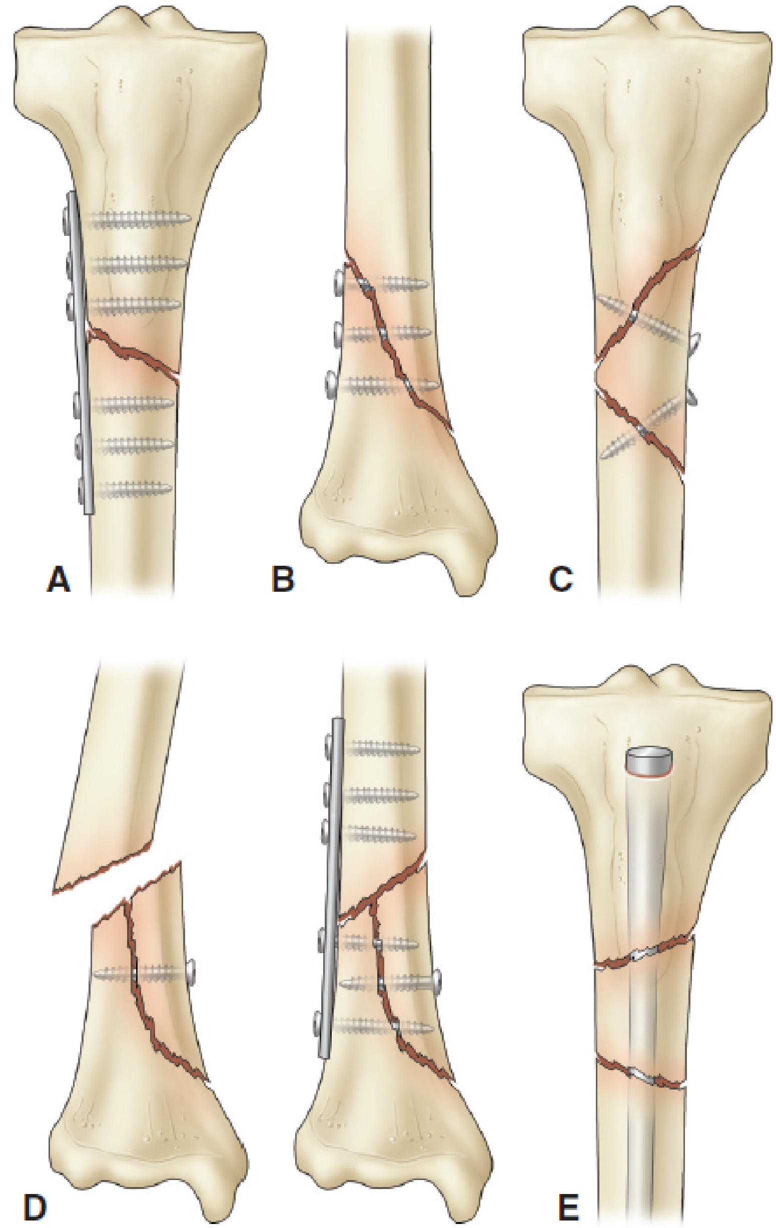

Figure 37-3 • Techniques of internal fixation. **A.** Plate and six screws for a transverse or short oblique fracture. **B.** Screws for a long oblique or spiral fracture. **C.** Screws for a long butterfly fragment. **D.** Plate and six screws for a short butterfly fragment. **E.** Medullary nail for a segmental fracture.

Maintaining and Restoring Function

Reduction and immobilization are maintained as prescribed to promote bone and soft tissue healing. Edema is controlled by elevating the injured extremity and applying ice as prescribed. Neurovascular status is monitored routinely, and the primary provider is notified immediately if signs of neurovascular compromise develop. Restlessness, anxiety, and discomfort are controlled with a variety of approaches, such as reassurance, position changes, and pain-relief strategies, including the use of analgesic medications. Isometric and muscle setting exercises are encouraged to minimize atrophy and to promote circulation. Participation in activities of daily living (ADLs) is encouraged to promote independent functioning and self-esteem. Gradual resumption of activities is promoted as prescribed. With internal fixation, the surgeon determines the amount of movement and weight-bearing stress the extremity can sustain and prescribes the level of activity (Buckley & Page, 2018). See later discussion for more information about caring for patients who have casts, are in traction, or are undergoing surgery for fractures.

Nursing Management

Patients with Closed Fractures

The patient with a closed fracture has no opening in the skin at the fracture site. The fractured bones may be nondisplaced or slightly displaced, but the skin is intact. The nurse educates the patient regarding the proper methods to control edema and pain (see Chart 37-2). It is important to educate about exercises to maintain the health of unaffected muscles and to increase the strength of muscles needed for transferring and for using assistive devices such as crutches, walkers, and special utensils. The patient is also educated to use assistive devices safely. Plans are made to help patients modify the home environment as needed and to ensure safety, such as removing floor rugs or anything that obstructs walking paths throughout the house. Patient education includes self-care, medication information, monitoring for potential complications, and the need for continuing health care supervision. Fracture healing and restoration of strength and mobility may take an average of 6 to 8 weeks, depending on the quality of the patient's bone tissue (Iyer, 2019).

Patients with Open Fractures

In an open fracture, there is a risk for **osteomyelitis** (i.e., infection of the bone), tetanus, and gas gangrene (see Chapter 36 for discussion of osteomyelitis). The objectives of management are to prevent infection of the wound, soft tissue, and bone, and to promote healing of bone and soft tissue. Intravenous (IV) antibiotics are given upon the patient's arrival in the hospital along with intramuscular (IM) tetanus toxoid as indicated (Howe, 2018).

Wound irrigation using a sterile isotonic saline solution and **débridement** (removal of tissues and foreign material) are initiated in the operating room as soon as possible. The wound is cultured, and bone grafting may be performed to fill in areas of bone defects. The fracture is carefully reduced and stabilized by external fixation (see later discussion), and the wound is usually left open.

If there is any damage to blood vessels, soft tissue, muscles, nerves, or tendons, appropriate treatment is implemented.

Chart 37-2 HOME CARE CHECKLIST

The Patient with a Closed Fracture

At the completion of education, the patient and/or caregiver will be able to:

- Name the procedure that was performed and identify any changes in anatomic structure or function as well as changes in ADLs, IADLs, roles, relationships, and spirituality.
- Identify modification of home environment, interventions, and strategies (e.g., durable medical equipment, adaptive equipment) used in safely promoting effective recovery and rehabilitation.
- Describe ongoing therapeutic regimen, including diet and activities to perform (e.g., exercises) and to limit or avoid (e.g., lifting weights, driving a car, contact sports).
    - Describe approaches to control swelling (e.g., elevate extremity to heart level).
    - Consume a healthy diet to promote bone healing.
    - Observe prescribed weight-bearing and activity limits.
    - Participate in prescribed exercise regimen to maintain the health of unaffected muscles and those muscles now needed for safe transfer, mobility, etc.
    - If indicated, demonstrate safe use of mobility aid, assistive device, immobilizing device and transfer technique.
- State the name, dose, side effects, frequency, and schedule for all prescribed therapeutic and prophylactic medications (e.g., antibiotics, analgesic agents).
- Control pain with pharmacologic and nonpharmacologic interventions.
- Report pain uncontrolled by elevation and analgesics (may be an indicator of impaired tissue perfusion or compartment syndrome).
- State indicators of complications to report promptly to primary provider (e.g., uncontrolled swelling and pain; cool, pale fingers or toes; paresthesia; paralysis; signs of local and systemic infection; signs of venous thromboembolism; problems with immobilization device).
- State possible complications of fractures (e.g., delayed union; nonunion; avascular necrosis; complex regional pain syndrome, formerly called *reflex sympathetic dystrophy syndrome;* heterotopic ossification).
- Describe gradual resumption of normal activities when medically cleared and discuss how to protect fracture site from undue stresses.
- Relate how to reach primary provider with questions or complications.
- State time and date of follow-up appointments, therapy, and testing.
- Identify the need for health promotion, disease prevention, and screening activities.

Resources

See Chapter 2, Chart 2-6, for additional information related to durable medical equipment, adaptive equipment, and mobility skills.

ADLs, activities of daily living; IADLs, instrumental activities of daily living.

With open fractures, primary wound closure is usually delayed, particularly with higher-grade fractures. Heavily contaminated wounds are left unsutured and treated with vacuum-assisted closures (VACs) to facilitate wound drainage. Wound irrigation and débridement may be repeated, removing infected and devitalized tissue and increasing vascularity in the region (Dunbar & Cannada, 2017).

The extremity is elevated to minimize edema. Neurovascular status must be assessed frequently. Temperature is monitored at regular intervals, and the patient is monitored for signs of infection. Bone grafting may be necessary to bridge bone defects and to stimulate bone healing (Dunbar & Cannada, 2017).

Unfolding Patient Stories: Marilyn Hughes • Part 1

Marilyn Hughes, a 45-year-old female, was brought to the emergency department by her husband after a fall down icy stairs. She is complaining of severe left lower leg pain. She is wearing long pants and boots. What are priority assessments and interventions that the nurse should implement for a suspected lower leg fracture? (Marilyn Hughes' story continues in Chapter 60.)

Care for Marilyn and other patients in a realistic virtual environment: ***vSim** for Nursing* (**thepoint.lww.com/vSimMedicalSurgical**). Practice documenting these patients' care in DocuCare (**thepoint.lww.com/DocuCareEHR**).

Fracture Healing and Complications

Weeks to months are required for most fractures to heal. Many factors influence the timeframe of the healing process (see Chart 37-3). With a comminuted fracture, bone fragments must be properly aligned to attain the best healing possible. It is essential for the fractured bone to have blood supply to the area to facilitate the healing process. In general, fractures of flat bones (pelvis, sternum, and scapula) heal rapidly. A complex, comminuted fracture may heal slowly. Fractures at the ends of long bones, where the bone is more vascular and cancellous, heal more quickly than do fractures in areas where the bone is dense and less vascular (midshaft). Fractures typically heal more quickly in younger patients (Howe, 2018).

If fracture healing is disrupted, bone union may be delayed or stopped completely. Factors that can impair fracture healing include inadequate fracture immobilization, inadequate blood supply to the fracture site or adjacent tissue, multiple trauma, extensive bone loss, infection, poor adherence to prescribed restrictions (e.g., cigarette smoking and excessive alcohol use), malignancy, certain medications (e.g., corticosteroids), older age, and some disease processes (e.g., rheumatoid arthritis) (Howe, 2018).

Complications of fractures may be either acute or delayed. Early complications include shock, fat embolism, acute compartment syndrome, VTE (deep vein thrombosis [DVT], pulmonary embolism [PE]), disseminated intravascular coagulation (DIC) and infection (Iyer, 2019). Late complications include delayed union, malunion, nonunion, AVN of bone, complex regional pain syndrome (CRPS), and heterotopic ossification.

Chart 37-3

Factors That Inhibit Fracture Healing

- Age >40 years
- Avascular necrosis
- Bone loss
- Cigarette smoking
- Comorbidities (e.g., diabetes, rheumatoid arthritis)
- Corticosteroids, nonsteroidal anti-inflammatory drugs
- Extensive local trauma
- Inadequate immobilization
- Infection
- Local malignancy
- Malalignment of the fracture fragments
- Space or tissue between bone fragments
- Weight bearing prior to approval

Adapted from Buckley, R., & Page, J. L. (2018). General principles of fracture care. *Medscape*. Retrieved on 1/7/2020 at: emedicine.medscape.com/article/1270717-overview#a6; Norris, T. L. (2020). *Porth's essentials of pathophysiology* (5th ed.). Philadelphia, PA: Wolters Kluwer.

Early Complications

Shock

Hypovolemic or traumatic shock resulting from hemorrhage is more frequently noted in trauma patients with pelvic fractures and in patients with a displaced or open femoral fracture in which the femoral artery is torn by bone fragments. Treatment for shock consists of stabilizing the fracture to prevent further hemorrhage, restoring blood volume and circulation, relieving the patient's pain, providing proper immobilization, and protecting the patient from further injury and other complications (Iyer, 2019). See Chapter 11 for a discussion of shock.

Fat Embolism Syndrome

Fat embolism syndrome (FES) describes the clinical manifestations that occur when fat emboli enter circulation following orthopedic trauma, especially long bone (e.g., femur) and pelvic fractures. FES is more frequent in closed fractures than in open fractures (Weinhouse, 2019). At the time of fracture, fat globules may diffuse from the marrow into the vascular compartment. The fat globules (e.g., emboli) may occlude the small blood vessels that supply the lungs, brain, kidneys, and other organs. The onset of symptoms is rapid, typically within 24 to 72 hours of injury, but may occur up to a week after injury (Iyer, 2019). FES occurs more frequently in males than in females, with its highest incidence in those between the ages of 10 and 40 years.

Clinical Manifestations

The classic triad of clinical manifestations of FES includes hypoxemia, neurologic compromise, and a petechial rash (Weinhouse, 2019). The typical first manifestations are pulmonary and include hypoxia, tachypnea, and dyspnea accompanied by tachycardia, substernal chest pain, low-grade fever, crackles, and additional manifestations of respiratory failure. Chest x-ray may show evidence of acute respiratory distress syndrome (ARDS) or it may be normal. Petechial rash may develop 2 to 3 days after the onset of symptoms. This rash is secondary to dysfunction in the microcirculation and/or thrombocytopenia and is typically located in nondependent regions (e.g., chest, mucous membranes) of the body. There may be varying degrees of neurologic deficits that can include restlessness, agitation, seizures, focal deficits, and encephalopathy (Fukumoto & Fukumoto, 2018). There are no universal criteria for diagnosis of FES; diagnosis relies on clinical suspicion based upon the classic triad of symptoms and imaging findings (Uranslip, Muengtaweepongsa, Chanalithichai, et al., 2018).

Quality and Safety Nursing Alert

Subtle personality changes, restlessness, irritability, or confusion in a patient who has sustained a fracture are indications for immediate arterial blood gas studies.

Prevention and Management

Prevention is the most important aspect of treatment; immediate immobilization of fractures, including early surgical fixation, minimal fracture manipulation, and adequate support for fractured bones during turning and positioning, and maintenance of fluid and electrolyte balance are measures that may reduce the incidence of fat emboli. There is no specific treatment for FES; the treatment is supportive. Fluid resuscitation, oxygenation, vasopressors, mechanical ventilation, and sometimes corticosteroids are used as supportive therapy (Weinhouse, 2019).

Acute Compartment Syndrome

An anatomic compartment is an area of the body encased by bone or fascia (e.g., the fibrous membrane that covers and separates muscles) that contains muscles, nerves, and blood vessels. The human body has 46 anatomic compartments, and 36 of these are located in the extremities (see Fig. 37-4). Acute compartment syndrome, a time-sensitive surgical emergency, is characterized by the elevation of pressure within an anatomic compartment that is above normal perfusion pressure. Acute compartment syndrome arises from an increase in compartment volume (e.g., from edema or bleeding), a decrease in compartment size (e.g., from a restrictive cast), or aspects of both. When the pressure within an affected compartment rises above normal, perfusion to the tissues is impaired, causing cell death, which may lead to tissue necrosis and permanent dysfunction (Papachristos & Giannoudis, 2018). The most common cause is fractures, with tibial fractures having the highest risk (Long, Koyfman, & Gottlieb, 2019). Acute compartment syndrome is most common among young adults, and although it may take up to 48 hours for symptoms to present, it typically has a rapid progression of symptoms and signs over a few hours after the initial injury or fracture repair (Stracciolini & Hammerberg, 2019).

Assessment and Diagnostic Findings

Frequent assessment of neurovascular function after a fracture is essential and focuses on the "five Ps": ***p***ain, ***p***allor, ***p***ulselessness, ***p***aresthesia, and ***p***aralysis (Papachristos & Giannoudis, 2018). The patient with acute compartment syndrome typically presents with severe pain that is out of proportion to the injury, which is considered the cardinal symptom (Stracciolini & Hammerberg, 2019). Additionally, patients often describe this pain as deep and burning, and that it is unrelieved by medications. Exacerbation of pain on passive stretching of the muscles within the involved compartment is highly predictive (McMillan, Gardner, Schmidt, et al., 2019). With continued nerve ischemia and edema, the patient experiences diminished sensation followed by complete numbness. Motor weakness may occur as a late sign of nerve ischemia. Motion is evaluated by asking the patient to flex and extend the wrist or plantar flex and dorsiflex the foot. Paralysis (no movement) is a late finding after prolonged ischemia and is associated with neurovascular injury (McMillan et al., 2019).

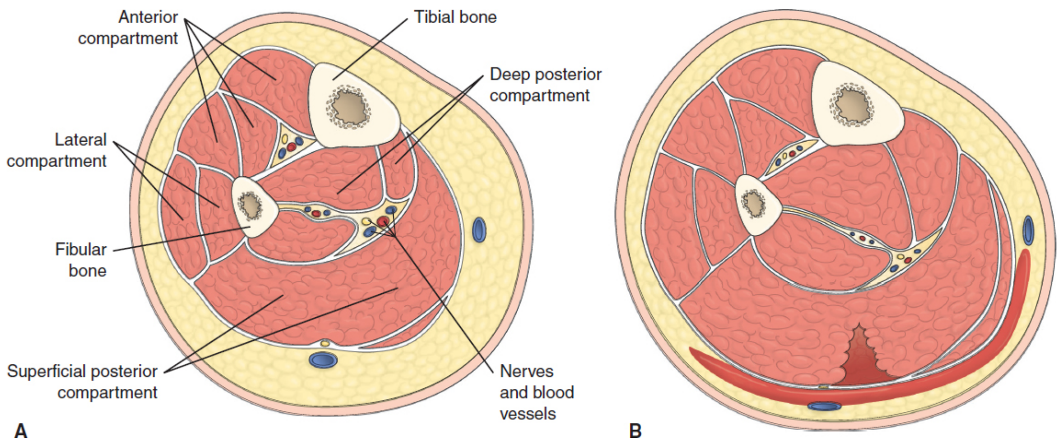

Figure 37-4 • **A.** Cross-section of normal lower leg with muscle compartments. **B.** Cross-section of lower leg with compartment syndrome.

Peripheral circulation is evaluated by assessing color, temperature, capillary refill time, edema, and pulses. Cyanotic nail beds suggest venous congestion. Pallor or dusky and cold digits, prolonged capillary refill time, and diminished pulses suggest impaired arterial perfusion. Edema may obscure the function of arterial pulsation, and Doppler ultrasonography may be used to verify a pulse. Pulselessness is a late sign (McMillan et al., 2019).

A prompt diagnosis of acute compartment syndrome is based on clinical suspicion and repeated clinical examinations of the "five Ps"; however, it is important to keep in mind that pain is a subjective measure and may only be detected in patients who are conscious (AAOS, 2018). As well, some of the clinical signs and symptoms may only present in the late stages of acute compartment syndrome (Stracciolini & Hammerberg, 2019). Palpation of the muscle, if possible, reveals it to be swollen and hard with the skin taut and shiny. The orthopedic surgeon may measure tissue pressure by inserting a tissue pressure-monitoring device, such as a handheld direct injection device (e.g., Stryker Intra-Compartmental Pressure Monitor), into the muscle compartment (normal pressure is 8 mm Hg or less) (see Fig. 37-5). Nerve and muscle tissues deteriorate as compartment pressure increases. Prolonged pressure of more than 30 mm Hg can result in irreversible changes (Long et al., 2019).

Medical Management

Prompt management of acute compartment syndrome is essential and includes relieving all external pressure on the compartment. The orthopedic surgeon needs to be notified immediately if neurovascular compromise is suspected. Delay in treatment may result in permanent nerve and muscle damage, necrosis, infection, rhabdomyolysis with acute kidney injury, and amputation (Stracciolini & Hammerberg, 2019).

If conservative measures do not restore tissue perfusion and relieve pain, a fasciotomy (surgical decompression with excision of the fascia) is considered the definitive treatment to relieve the constrictive muscle fascia (AAOS, 2018). After fasciotomy, the wound is not sutured but is left open to allow the muscle tissues to expand; it is covered with moist, sterile saline dressings or with artificial skin. Negative-pressure wound therapy using a vacuum dressing has been shown to be effective to remove fluids and decrease times to primary closure (Modrall, 2019). The affected arm or leg is splinted in a functional position and elevated to heart level and prescribed intermittent passive ROM exercises are usually performed. In 2 to 3 days, when the swelling has resolved and tissue perfusion has been restored, the wound is débrided and closed (possibly with skin grafts).

Figure 37-5 • The Stryker Intra-Compartmental Pressure Monitor. Reprinted with permission from Stryker Inc.

Nursing Management

The nurse should frequently assess pain and neurovascular status of the affected limb and report any negative changes that may suggest compartment syndrome immediately to the primary provider. The limb should be maintained in a functional position at the level of the heart to promote optimal blood flow.

Quality and Safety Nursing Alert

Acute compartment syndrome is managed by maintaining the extremity at heart level (not above heart level) and removing constrictive dressings by opening and bivalving the cast or opening the splint, if one or the other is present.

Pain management is essential and is accomplished with opioid analgesia, as prescribed. Careful assessment of intake and output and urinalysis could alert the nurse to the development of rhabdomyolysis (see Chapter 48).

Education is necessary for those patients discharged to home-based or community settings with fractures and casts and should include recognition of the unique characteristics of acute compartment syndrome (increasing, refractory pain and neurovascular manifestations) and instructions when to contact the primary provider for emergent follow-up.

Other Early Complications

VTE, including DVT and PE, are associated with reduced skeletal muscle contractions and bed rest. Patients with fractures of the lower extremities and pelvis are at high risk for VTE (Buckley & Page, 2018). PE may cause death several days to weeks after injury. See Chapter 26 for a discussion of VTE, PE, and DVT.

Disseminated intravascular coagulation (DIC) is a systemic disorder that results in widespread hemorrhage and microthrombosis with ischemia. Its causes are diverse and can include massive tissue trauma. Early manifestations of DIC include ecchymoses, unexpected bleeding after surgery and bleeding from the mucous membranes, venipuncture sites, and gastrointestinal and urinary tracts (Iyer, 2019). See Chapter 29 for discussion of treatment for DIC.

All open fractures are considered contaminated and are treated as soon as possible with copious irrigation, débridement, tetanus immunization/prophylaxis, and IV antibiotics (Schaller, 2018). Surgical internal fixation of fractures carries a risk of infection. The nurse must monitor and educate the patient regarding signs and symptoms of infection, including tenderness, pain, redness, swelling, local warmth, elevated temperature, and purulent drainage.

Figure 37-6 • Eight-month-old ring finger malunion in a 19-year-old female patient. Reprinted with permission from Strickland, J. W., & Graham, T. J. (2005). *Master techniques in orthopaedic surgery: The hand* (2nd ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

Delayed Complications

Delayed Union, Nonunion, and Malunion

Delayed union occurs when healing does not occur within the expected timeframe for the location and type of fracture. Delayed union may be associated with distraction (pulling apart) of bone fragments, systemic or local infection, poor nutrition, or comorbidity (e.g., diabetes, autoimmune disease). The healing time is prolonged, but the fracture eventually heals (Nyary & Scammell, 2018). **Nonunion** is an incomplete healing of a fracture and results from failure of the ends of a fractured bone to unite, whereas **malunion** is the healing of a fractured bone in a malaligned (deformed) position (see Fig. 37-6). In both of these instances, the patient complains of persistent discomfort and abnormal movement at the fracture site. Nonunion occurs most commonly in tibial fractures, whereas malunion occurs most commonly in fractures of the hand (or fingers) (Howe, 2018). Factors contributing to delayed union, nonunion, and malunion are those associated with impaired bone healing (see Chart 37-3).

Medical Management

Impaired bone healing can be treated with nonsurgical and surgical interventions. Nonsurgical treatment modalities include low-intensity pulsed ultrasound and externally applied electrical bone growth stimulators (Osman, Gabr, & Haddad, 2019). Electrical stimulation techniques enhance the process of bone healing by exposure of osteoblasts to electromagnetic fields, which stimulate the secretion of growth factors (Bhavsar, Leppik, Oliveira, et al., 2019). In some cases, electrical bone stimulators can also be invasive: completely implanted or partially implanted in the form of pins to the site of impaired healing (see Fig. 37-7). Surgical interventions include bone grafts and internal and external fixation (Weinlein, 2017; Whittle, 2017b).

Grafted bone undergoes a reconstructive process that results in a gradual replacement of the graft with new bone. During surgery, the bone fragments are débrided and aligned, infection (if present) is removed, and a bone graft is placed in the bony defect. The bone graft may be an **autograft** (tissue, frequently from the iliac crest, harvested from the patient for their own use; also called autogenous), an **allograft** (tissue harvested from a donor), or a bone graft substitute (Baldwin, Li, Auston, et al., 2019). The bone graft fills the bone gap and provides a lattice structure for invasion by bone cells and actively promotes bone growth. The type of bone selected for grafting depends on function—cortical bone is used for structural strength, cancellous bone for osteogenesis, and corticocancellous bone for strength and rapid incorporation (Baldwin et al., 2019). Free vascularized bone autografts are grafted with their own blood supply, allowing for primary fracture healing.

Figure 37-7 • Bone healing stimulator applied to the arm. Reprinted with permission from EBI Medical Systems, Parsippany, NJ.

After grafting, immobilization and non–weight-bearing restrictions are required while the bone graft becomes incorporated and the fracture or defect heals, which may be confirmed on an x-ray (Whittle, 2017b). Depending on the type of bone grafted and the age of the patient, healing may take from 6 to 12 months or longer. Bone grafting complications include wound or graft infection, fracture of the graft, and nonunion. Specific problems associated with autografts include a limited quantity of bone available for harvest and harvest site pain that may persist for up to 2 years after harvest. Infrequent specific allograft complications include partial acceptance (lack of host and donor histocompatibility, which retards graft incorporation), graft rejection (rapid and complete resorption of the graft), and transmission of disease (rare) (Whittle, 2017b).

Nursing Management

The patient with a nonunion has experienced an extended time in fracture treatment and may become frustrated with prolonged therapy. The nurse provides emotional support and encouragement to the patient and encourages adherence to the treatment regimen. The orthopedic surgeon evaluates the progression of bone healing with periodic x-rays.

Nursing care for the patient with a bone graft includes providing pain management and monitoring the patient for possible complications. The nurse needs to reinforce educational information concerning the objectives of the bone graft, immobilization, non–weight-bearing regimen and exercises, wound care, monitoring for signs of infection, and the importance of follow-up care with the orthopedic surgeon (Whittle, 2017b).

Nursing care for the patient using a bone growth stimulator focuses on patient education that addresses immobilization, weight-bearing restrictions, and correct use of the stimulator as prescribed (Mains, 2017).

Avascular Necrosis of Bone (AVN; Osteonecrosis)

AVN occurs when the bone loses its blood supply and dies; the process eventually leads to bony collapse and destruction of the associated joint. It may occur after a fracture with disruption of the blood supply to the distal area. It is also seen with prolonged high-dose corticosteroid therapy, exposure to radiation, sickle cell disease, rheumatoid arthritis, and other diseases; chronic alcohol use and cigarette smoking are other atraumatic etiologies (Graham, 2020). The process is often progressive, and the patient develops pain with movement that progresses to pain at rest. Diagnostics include history and physical examination with x-rays, CT scans, and bone scans. AVN of the hip is the most commonly affected site; the knee is the second most common site. The goal of treatment is to preserve the native joint for as long as possible and includes both conservative and surgical interventions (Graham, 2020). Nonoperative management includes activity modification, administration of analgesics, and partial weight bearing of the affected region. Joint preserving procedures are aimed at revascularizing the affected area by drilling the avascular segment or using a bone marrow graft. In extreme cases, it is advisable to remove the fragment and reconstruct the joint (Jones & Mont, 2018).

Complex Regional Pain Syndrome (CRPS)

CRPS is a complex and rare disorder characterized by regional pain in a limb that is disproportionate; it typically begins following a fracture, soft tissue injury, or surgery. Dysfunctional peripheral and central nervous system responses that mount an excessive response to the precipitating event (e.g., fracture, surgery) are thought to be the cause of the pain. Women are affected more often than men, and the average age of diagnosis is 40 years (National Institute of Neurological Disorders and Stroke [NINDS], 2017). Two subtypes of CRPS have been recognized: Type I (formerly called *reflex sympathetic dystrophy*) applies to patients with CRPS without evidence of peripheral nerve injury, and Type II (formerly called *causalgia)* refers to patients with nerve injury (Abdi, 2020).

Clinical manifestations of CRPS include severe burning pain, local edema, hyperesthesia, stiffness, discoloration, vasomotor skin changes (e.g., fluctuating warm, red, dry and cold, sweaty, cyanotic), and trophic changes that may include glossy, shiny skin, and changes in hair and nail growth. This syndrome is frequently chronic, with extension of symptoms to adjacent areas of the body. Dysfunction of the affected limb may also be manifested in CRPS. The diagnosis is made through the history and physical examination and ruling out other organic causes (NINDS, 2017).

Nursing Management

The primary objective of treatment is physical functional maintenance or recovery of physical function (Stanton-Hicks, 2018). Early effective pain relief is the focus of management. Pain may be controlled with analgesic agents. NSAIDs, topical anesthetics (e.g., lidocaine patches), corticosteroids, and opioids. Anticonvulsant agents (e.g., gabapentin) and antidepressant agents (e.g., amitriptyline) can be effective in treating neuropathic pain. Additional treatments may include sympathetic nerve blocks, neural stimulation, and intrathecal delivery of prescribed medications. Novel treatments under investigation include infusions of immunoglobulin (IVIG) and ketamine and the use of hyperbaric oxygen (Abdi, 2020). The nurse evaluates the effectiveness of these interventions and therapies (see Chapter 9) and helps the patient cope with CRPS manifestations through therapeutic listening, initiation of relaxation techniques and behavior modification, and referral for rehabilitation therapy. Rehabilitation initiated early can improve circulation to the affected area and maximize function. Depression and anxiety are often associated with severe pain disorders; therefore, the nurse should recommend a mental health referral as necessary (NINDS, 2017).

Quality and Safety Nursing Alert

The nurse avoids using the affected extremity for blood pressure measurements and venipuncture in the patient with CRPS.

Heterotopic Ossification

Heterotopic ossification refers to benign bone growth in an atypical location, such as in the soft tissue (Speed, 2019). Heterotopic ossification that is categorized as traumatic myositis ossificans usually develops in response to soft tissue trauma (e.g., contusion, sprain). It is characterized by pain and joint stiffness that causes decreased ROM. It typically occurs in young males after musculoskeletal sports injuries (Meyers, Lisiecki, Miller, et al., 2019). If significant ROM dysfunction persists, surgery may be indicated to remove the bone growth and restore function (Speed, 2019).

The Patient with a Cast, Splint, or Brace

The patient with musculoskeletal trauma typically requires immobilization at some point as part of the management plan. Casts, splints, and braces are external immobilizers that are frequently indicated to treat these injuries.

Casts

A **cast** is a rigid external immobilizing device that is molded to the contours of the body. The cast must fit the shape of the injured limb correctly to provide the best support possible (AAOS, 2019c). A cast is used to immobilize a reduced fracture, to correct or prevent a deformity (e.g., clubfoot, hip displacement), apply uniform pressure to underlying soft tissue, or support and stabilize weakened joints. Generally, casts permit mobilization of the patient while restricting movement of the affected body part.

Because of their ability to provide more complete immobilization, casting is the mainstay of treatment for many fractures as it provides a protected environment for bone healing to occur (Beutler & Titus, 2019). The most common casting materials consist of fiberglass or plaster of Paris, as these are materials that can be molded. The choice of material depends on several factors, which include the condition being treated, availability, and costs. Maximal immobilization is achieved with casts that include the joints proximal and distal to the fracture site (Alexandre & Hodax, 2017). However, with some fractures, cast construction and molding may allow movement of a joint while immobilizing a fracture (e.g., three-point fixation in a patellar tendon weight-bearing cast).

Generally, casts can be divided into three main groups: arm casts, leg casts, and body or spica casts:

Short arm cast: Extends from below the elbow to the palmar crease, secured around the base of the thumb. If the thumb is included, it is known as a thumb spica or gauntlet cast.

Long arm cast: Extends from the axillary fold to the proximal palmar crease. The elbow usually is immobilized at a right angle.

Short leg cast: Extends from below the knee to the base of the toes. The foot is flexed at a right angle in a neutral position.

Long leg cast: Extends from the junction of the upper and middle third of the thigh to the base of the toes. The knee may be slightly flexed.

Walking boot: Also called an air or walking cast; protects and supports the foot, ankle or lower leg by controlling alignment and reducing movement; also supports the user's weight while walking.

Body cast: Encircles the trunk.

Shoulder spica cast: A body jacket that encloses the trunk, shoulder, and elbow.

Hip spica cast: Encloses the trunk and a lower extremity. A double hip spica cast includes both legs.

Figure 37-8 illustrates long arm and long leg casts and areas in which pressure problems commonly occur with these casts.

The application of a cast is a specialized skill, typically performed by orthopedic technologists. The skillset needed to apply and remove casts requires education, training, practice, and constant review of provider competence to ensure patients receive safe, high-quality care. Casts that are not properly applied or cared for may hinder healing and predispose patients to a number of complications (Adib-Hajbaghery & Mokhtari, 2018).

Fiberglass Casts

Fiberglass casts are composed of polyurethane resins that have the versatility of plaster but are lighter in weight, stronger, water resistant, and more durable than plaster. In addition, fiberglass casts facilitate radiographic imaging better than plaster (AAOS, 2019c) and have the benefit of reaching full rigidity within 30 minutes of application. Because they tend to be more difficult to contour and mold, fiberglass casts are more commonly used for simple fractures of the upper and lower extremities. They consist of an open-weave, nonabsorbent fabric that requires tepid water for activation. Heat is given off (an exothermic reaction) while the cast is applied. The heat given off during this reaction can be uncomfortable, and the nurse should prepare the patient for the sensation of increasing warmth so that the patient does not become alarmed. Fiberglass casts can cause thermal injury like plaster casts, but the risk is less (Beutler & Titus, 2019).

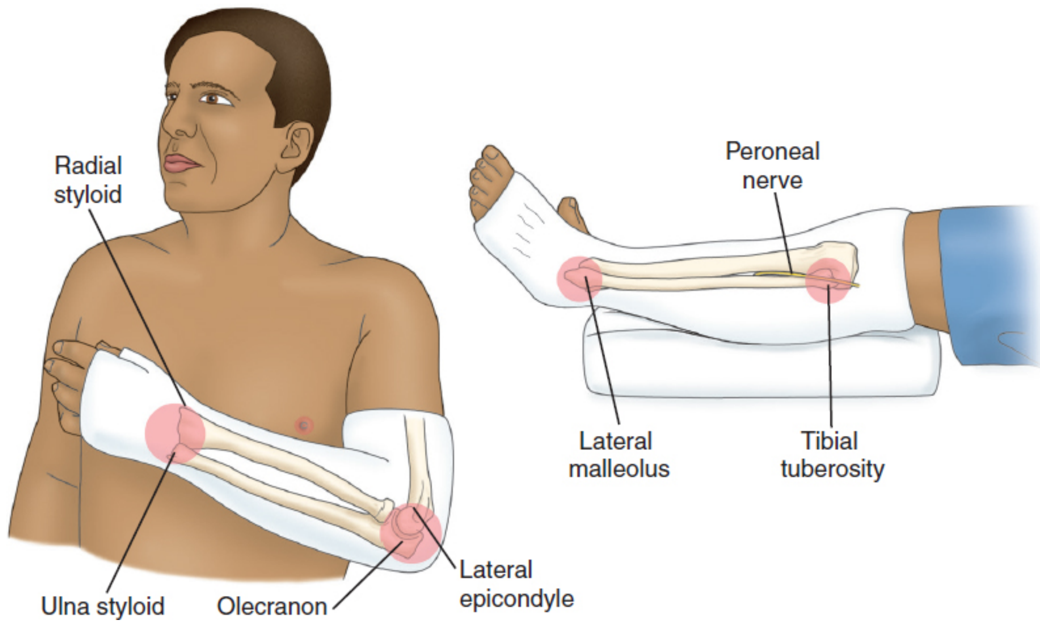

Figure 37-8 • Pressure areas in common types of casts. **Left.** Long arm cast. **Right.** Long leg cast.

Some fiberglass casts use a waterproof lining (Gore-Tex), which permits the patient to shower, swim, or engage in hydrotherapy (the use of water for treatment). When the cast is wet, the patient is instructed to remove excess water by blotting or patting the cast with a towel and making sure to drain the water out of it. The patient must understand that thorough drying is important to prevent skin breakdown, infection, or irritation; sweeping motions with a blow dryer on a cool or warm setting for approximately 1 hour can help to dry the cast inside and out (Mains, 2017). The best results are achieved with casts that can easily drain, such as short arm casts. Heels and elbows encased in wet casts may become macerated from the trapped water and therefore are associated with more skin breakdown.

Plaster Casts

Casts made of plaster of Paris are less costly and achieve a better mold than fiberglass casts; however, they are heavy, not water resistant, and can take up to 24 to 72 hours to dry postapplication. The exothermic reaction during cast application has the potential to cause serious burns (Szostakowski, Smitham, & Khan, 2017). Extra care should be taken when these types of casts are applied to older adults because their skin is more temperature sensitive than average adult skin. During the cast application process, clean, room temperature water should be used. Minimal layers of padding should be used. In addition, the cast should not be covered while it is drying because the heat generated by the chemical reaction cannot escape.

The time that it takes for a plaster cast to dry completely depends on its size, thickness, and location, as well as environmental drying conditions (Nemeth, Halanski, & Noonan, 2020). A freshly applied cast should be handled as little as possible to prevent denting and cracking (Mains, 2017). The wet plaster cast should be handled by only the palms so that indentations in the cast may be prevented; indentations can result in areas of pressure on the skin (Mains, 2017). The cast should be exposed to circulating air to dry and supported on a firm and smooth surface; it should not be placed on a metallic surface or one with sharp edges. If elevation is requested to reduce swelling, a cloth-covered pillow is preferred to one covered in plastic, which could retain heat and prevent drying. A wet plaster cast feels damp, appears dull and gray, sounds dull on percussion, and smells musty. The cast is dry when it feels hard and firm, has a white and shiny appearance, is resonant to percussion, and odorless.

On occasion, the plaster cast may have rough edges, which can crumble and cause skin irritation. Petaling, or smoothing the rough edges of the cast, resolves this problem if the underlying stockinette does not cover the edges of the cast. To prevent skin breakdown, moleskin can be used over any rough area of the cast that may rub against the patient's skin.

Splints and Braces

Many injuries that were treated previously with casts may now be treated with other immobilization devices such as splints and braces. Application of a **splint** (i.e., a process called splinting) is usually more practical and common and is the preferred method of fracture immobilization in the acute care setting and for the initial treatment of fractures that eventually require casting (Beutler & Titus, 2019). Splints are often used for simple and stable fractures, sprains, tendon injuries, and other soft tissue injuries. They offer many advantages over casts in that they are faster and easier to apply; however, increased joint mobility and decreased patient adherence may be a concern (Eubanks & Chien, 2019). Splints are also noncircumferential and allow for natural swelling during the inflammatory phase of injury. Pressure-related complications (e.g., skin breakdown, necrosis, acute compartment syndrome) are more prevalent when soft tissue swelling occurs within a contained space (e.g., a circumferential cast). Splints are easily removed, facilitating inspection of the injury site. In addition, splints can be indicated to provide initial stability for fractures that are unstable while awaiting definitive care (Schub & Balderrama, 2017).

Contoured splints of plaster or pliable thermoplastic materials may be used for conditions that do not require rigid immobilization, for those in which swelling may be anticipated, and for those that require special skin care. Splints made of thermoplastics are warmed and molded to custom-fit the affected body part (e.g., hand and thoracolumbosacral orthotics [TLSOs], clamshell-type back braces). The splint needs to immobilize and support the body part in a functional position, and it must be well padded to prevent pressure, skin abrasion, and skin breakdown (Eubanks & Chien, 2019). The splint is overwrapped with an elastic bandage applied in a spiral fashion and with pressure uniformly distributed so that circulation is not restricted.

Braces (e.g., orthoses) are used to provide support, control movement, and prevent additional injury. They are custom-fitted to various parts of the body; thus, they tend to be indicated for longer-term use than splints. The orthotist adjusts the brace for fit, positioning, and motion so that movement is enhanced, any deformities are corrected, and discomfort is minimized.

Many splints and braces are prefabricated and fastened with Velcro straps. They may be made of plastic and other materials such as cloth, leather, metal, and elastic. Knee immobilizers, ankle stirrups, and cock-up wrist splints are types of prefabricated splints and braces. Both splints and braces may be either custom-made or standard "off the shelf." Splints and braces are generally less compliant and permit more motion at the injury site than casts, which can be a serious disadvantage in that underlying injuries are not as well stabilized (Schub & Balderrama, 2017).

Nursing Management

Before the cast, splint, or brace is applied, the nurse completes an assessment of the patient's general health, presenting signs and symptoms, emotional status, understanding of the need for the device, and condition of the body part to be immobilized (Schub & Balderrama, 2017). Physical assessment of the part to be immobilized must include a thorough assessment of the skin and neurovascular status, including the degree and location of swelling, bruising, and skin abrasions (Mains, 2017).

To promote healing, any skin lacerations and abrasions that may have occurred as a result of the trauma that caused the fracture must be treated before the cast, brace, or splint is applied. The nurse thoroughly cleanses the skin and treats it as prescribed. The patient may require a tetanus booster if the wound is dirty and if the last known booster was given more than 5 years ago. Sterile dressings are used to cover the injured skin. If the skin wounds are extensive, an alternative method (e.g., external fixator) may be chosen to immobilize the body part (AAOS, 2019c).

The nurse gives the patient or family information about the underlying pathologic condition and the purpose and expectations of the prescribed treatment regimen. This knowledge promotes the patient's active participation in and adherence to the treatment program.

The nurse prepares the patient for the application of the cast, splint, or brace by describing the anticipated sights, sounds, and sensations (e.g., heat from the hardening reaction of the fiberglass or plaster) that they may experience (Chinai, Walker, Rebesco, et al., 2019). Asking the patient and family what they know about the application and care of the cast can help determine opportunities for education. The patient needs to know what to expect during application and the reason the body part must be immobilized.

The main concern following the application of an immobilization device is assessment and prevention of neurovascular dysfunction or compromise of the affected extremity. Assessments are performed at least every hour for the first 24 hours and every 1 to 4 hours thereafter to prevent neurovascular compromise related to edema and/or the device. Neurovascular assessment includes the assessment of peripheral circulation, motion, and sensation of the affected extremity, assessing the fingers or toes of the affected extremity, and comparing them with those of the opposite extremity. When assessing peripheral circulation, the nurse must check peripheral pulses as well as capillary refill response (within 3 seconds), edema, and the color and temperature of the skin. While assessing motion, the nurse should note any weakness or paralysis of the injured body part. While assessing sensation, the nurse monitors for **paresthesia** (i.e., numbness or tingling) or absence of feeling in the affected extremity, which could indicate nerve damage (Schub & Balderrama, 2017).

Nurses must be vigilant in assessing for subtle neurovascular changes in these patients (Schub & Balderrama, 2017). The "5 Ps" indicative of symptoms of neurovascular compromise, described previously, including ***p***ain, ***p***allor, ***p***ulselessness, ***p***aresthesia, and ***p***aralysis, are assessed (Papachristos & Giannoudis, 2018). Early recognition of diminished circulation and nerve function is essential to prevent loss of function. Swelling is a concern and can create excessive pressure under the cast (AAOS, 2019c). To augment the flow of fluid, the nurse elevates the extremity so that it is above the level of the heart during the first 24 to 48 hours postapplication to enhance arterial perfusion and control edema and notifies the primary provider at once if signs of compromised neurovascular status are present.

The nurse must carefully evaluate pain associated with the musculoskeletal condition, asking the patient to indicate the exact site and to describe the character and intensity of the pain using a pain rating scale (see Chapter 9). Pain associated with the underlying condition (e.g., fracture) is frequently controlled by immobilization. Pain due to edema that is associated with trauma, surgery, or bleeding into the tissues can frequently be controlled by elevation and, if prescribed, intermittent application of ice or cold packs (AAOS, 2019c). Ice bags (one third to one half full) or cold application devices are placed on each side of the cast, if prescribed, making sure not to indent or wet the cast. Unrelieved or pain out of proportion following cast application may indicate complications. Pain associated with acute compartment syndrome (see previous discussion) is relentless and is not controlled by modalities such as elevation, application of ice or cold, and usual dosages of analgesic agents. Severe burning pain over bony prominences, especially the heels, anterior ankles, and elbows, warns of an impending pressure injury (Chinai et al., 2019). This may also occur from too-tight elastic wraps used to hold splints in place.

Quality and Safety Nursing Alert

The nurse must never ignore complaints of pain from the patient in a cast because of the possibility of problems, such as impaired tissue perfusion, acute compartment syndrome or pressure injury formation. A patient's unrelieved pain and increasing analgesic requirements must be reported immediately to the primary provider to avoid necrosis, neuromuscular damage, and possible paralysis.

The nurse observes the patient for systemic signs of infection, which include an unpleasant odor from the cast, splint, or brace, and purulent drainage staining the cast. Infection is more common from an open wound, but the moist, warm environment of a splint or cast can be an ideal conduit for infection. Foul-smelling casts should be removed to prevent skin and wound infections (Nemeth et al., 2020). If the infection progresses, a fever may develop. The nurse must notify the primary provider if any of these signs occur.

Finally, some degree of joint stiffness is an inevitable complication of immobilization. Every joint that is not immobilized should be exercised and moved through its ROM to maintain function. The nurse encourages the patient to move all fingers or toes hourly when awake to stimulate circulation.

Monitoring and Managing Potential Complications

It is important to assess for potential complications resulting from casts, splints, and braces that can be serious and life-threatening, such as acute compartment syndrome, pressure injury formation, and disuse syndrome.

Acute Compartment Syndrome

Acute compartment syndrome—the most serious complication of casting and splinting—occurs when increased pressure within a confined space (e.g., cast, muscle compartment) compromises blood flow and tissue perfusion (Schub & Balderrama, 2017). Ischemia and potentially irreversible damage to the soft tissues within that space can occur within a few hours if action is not taken (see Fig. 37-4). A tight or rigid cast/splint that constricts a swollen limb is associated with this complication.

If the complication is due to a cast or tight splint, the splint may be loosened or removed and the cast univalved or bivalved (cut in half longitudinally, on one side or two parallel sides of the cast, respectively) to release constriction and allow for inspection of the skin (Nemeth et al., 2020). The nurse assists in maintaining limb alignment, and the extremity must then be elevated no higher than heart level to maintain arterial perfusion. If pressure is not relieved and circulation is not restored, an emergent surgical fasciotomy may be necessary to relieve the pressure within the muscle compartment. The nurse closely monitors the patient's response to conservative and surgical management of compartment syndrome. The nurse records frequent neurovascular responses and promptly reports changes to the primary provider.

Pressure Injuries

Casts or splints can put pressure on soft tissues, particularly if they are inappropriately applied, causing tissue anoxia and pressure injuries. Although the term pressure ulcer has been previously used, the European Pressure Ulcer Advisory Panel, National Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance (2019) currently considers pressure injury the best term to use, given that open ulceration does not always occur. Lower extremity sites most susceptible are the heel, malleoli, dorsum of the foot, head of the fibula, and anterior surface of the patella. The main pressure sites on the upper extremity are located at the medial epicondyle of the humerus and the ulnar styloid (see Fig. 37-8).

If pressure necrosis occurs, the patient typically reports a very painful "hot spot" and tightness under the cast. The cast may feel warmer in the affected area, suggesting underlying tissue erythema (Beutler & Titus, 2019). Drainage may stain the cast or splint and emit an unpleasant odor. Even if discomfort does not occur, there may still be extensive loss of tissue with skin breakdown and tissue necrosis. To assess for pressure injury development, the primary provider may univalve, bivalve, or cut an opening (window) in the cast to allow for inspection, access, and possible treatment (Szostakowski et al., 2017). A dressing may be applied over the exposed skin, and the cutout portion of the cast is replaced and held in place by an elastic compression dressing or tape. This prevents "window edema" from occurring, which is the swelling or bulging of the underlying soft tissue through the window opening.

Disuse Syndrome

Immobilization in a cast, splint, or brace can cause muscle atrophy and loss of strength, and can place patients at risk for disuse syndrome, which is the deterioration of body systems as a result of prescribed or unavoidable musculoskeletal inactivity. To prevent this, the nurse instructs the patient to tense or contract muscles (e.g., isometric muscle contraction) without moving the underlying bone (Arora, Erosa, & Danesh, 2019). Isometric exercises, such as instructing the patient with a leg or arm cast to splint or brace to "push down" the knee or to "make a fist," respectively, helps reduce muscle atrophy and maintain strength. Muscle setting exercises (e.g., quadriceps and gluteal setting exercises) are important in maintaining muscles essential for walking (see Chart 37-4). Isometric exercises should be performed hourly while the patient is awake.

Promoting Home, Community-Based, and Transitional Care

Educating the Patient About Self-Care

Self-care deficits occur when a portion of the body is immobilized. The nurse encourages the patient to participate actively in personal care and to use assistive devices safely. The nurse must assist the patient in identifying areas of self-care deficit and in developing strategies to achieve independence in ADLs (see Chart 37-5). Participating in self-care activities can have a positive effect on patient's knowledge and physical and psychological health (Khorais, Ebraheim, & Barakat, 2018). Patient and family education are also described in Chart 37-5.

Chart 37-4 PATIENT EDUCATION

Muscle Setting Exercises

The nurse instructs the patient to perform isometric contractions of the muscle to maintain muscle mass and strength and to prevent atrophy:

Quadriceps Setting Exercise

- Position patient supine with leg extended.
- Instruct patient to push knee back onto the mattress by contracting the anterior thigh muscles.
- Encourage patient to hold the position for 5 to 10 seconds.
- Let patient relax.
- Have patient repeat the exercise 10 times each hour when awake.

Gluteal Setting Exercise

- Position patient supine with legs extended, if possible.
- Instruct patient to contract the muscles of the buttocks.
- Encourage patient to hold the contraction for 5 to 10 seconds.
- Let the patient relax.
- Have patient repeat the exercise 10 times each hour when awake.

Chart 37-5 HOME CARE CHECKLIST

The Patient with a Cast, Splint, or Brace

At the completion of education, the patient and/or caregiver will be able to:

- State the impact of the musculoskeletal injury/disorder on physiologic functioning, ADLs, IADLs, roles, relationships, and spirituality.
- State rationale for use of cast, splint or brace and resulting changes in lifestyle (e.g., activity, exercise, rest) necessary to maintain health and safety.
    - Avoid excessive use of injured extremity.
    - Observe prescribed weight-bearing limits.
    - Demonstrate ability to transfer (e.g., from a bed to a chair) and/or safe use of mobility aid.
    - Demonstrate exercises to promote circulation and minimize disuse syndrome.
- State the name, dose, side effects, frequency, and schedule for all medications.
- Describe techniques to promote cast drying (e.g., do not cover cast; expose cast to circulating air; handle damp plaster cast with palms of hands; do not rest the cast on hard surfaces or sharp edges that can dent soft cast).
- Describe approaches to controlling swelling and pain (e.g., elevate immobilized extremity to heart level, apply ice bag intermittently if prescribed, take analgesic agents as prescribed).
- Report pain uncontrolled by elevating the immobilized limb and by analgesic agents (may be an indicator of impaired tissue perfusion—acute compartment syndrome or pressure injury).
- Verbalize care for minor skin irritations (e.g., for skin irritation from edge of cast, splint, or brace, pad rough edges with tape or moleskin; to relieve itching, blow cool air from hair dryer; do not insert foreign objects inside the cast, splint, or brace).
- Demonstrate ability to perform ADLs independently or with assistive devices/adaptive equipment.
- State indicators of complications to report promptly to primary provider (e.g., uncontrolled swelling and pain; cool, pale fingers or toes; paresthesia; paralysis; purulent drainage staining cast; signs of systemic infection; cast, splint, or brace breaks).
- State how to reach primary provider with questions or complications
    - State time and date of follow-up appointments and testing
- Identify the need for health promotion, disease prevention, and screening activities
- Describe care of extremity following cast, splint, or brace removal (e.g., skin care, gradual resumption of normal activities to protect limb

from undue stresses, management of swelling).

Resources

See Chapter 2, Chart 2-6, for additional information related to durable medical equipment, adaptive equipment, and mobility skills.

ADLs, activities of daily living; IADLs, instrumental activities of daily living.

Continuing and Transitional Care

For the patient with a cast that is ready for removal, the nurse should provide an explanation about what to expect, as the patient may be apprehensive about the procedure due to noise and vibration from the electric saw and fear of being cut (Mains, 2017). The cast saw uses an oscillating blade that vibrates but does not spin; thus, it cuts through the outer cast layer but does not penetrate deeply enough to injure the patient's skin. The cast will be cut in several places, usually along both sides of the cast. The cast is then spread and opened, and a special tool is used to lift it off. Scissors are used to cut through the protective padding and stockinette layers to ensure that the patient's skin will not be cut.

The formerly immobilized body part will be weak from disuse, stiff, and may appear atrophied. As the cast or splint is removed, the affected body part should be supported to prevent injury. The skin, which is usually dry and scaly from accumulated dead skin, is vulnerable to injury from scratching. The extremity is soaked in warm water to soften the skin; a warm washcloth may be used to loosen dead skin and an emollient lotion may be used as lubrication (Mains, 2017). The patient should be instructed to avoid rubbing and scratching the skin, because doing so can cause damage to newly exposed skin.

The nurse and physical therapist educate the patient to resume activities gradually within the prescribed therapeutic regimen. Exercises prescribed to help the patient restore muscle strength, joint motion, and flexibility are explained and demonstrated. Because the muscles are weak from disuse, the body part that has been immobilized cannot withstand normal stresses immediately. In addition, the patient should be instructed to control swelling by elevating the formerly immobilized body part, no higher than the heart, until normal muscle tone and use are reestablished (AAOS, 2019c).

Nursing Management of the Patient with an Immobilized Upper Extremity

The patient whose arm is immobilized must readjust to many routine tasks. The unaffected arm will assume all upper extremity activities. The nurse, in consultation with an occupational therapist, suggests devices designed to aid one-handed activities. The patient may experience fatigue due to modified activities and the weight of the cast, splint, or brace. Frequent rest periods are necessary.

To control swelling, the immobilized arm is elevated above heart level with a pillow. When the patient is lying down, the arm is elevated so that each joint is positioned higher than the preceding proximal joint (e.g., elbow higher than the shoulder, hand higher than the elbow).

A sling may be used when the patient ambulates. To prevent pressure on the cervical spinal nerves, the sling should distribute the supported weight over a large area of the shoulders and trunk, not just the back of the neck. The nurse encourages the patient to remove the arm from the sling and elevate it frequently.

Circulatory disturbances in the hand may become apparent with signs of cyanosis, swelling, and an inability to move the fingers. A missed acute compartment syndrome in the arm can result in a Volkmann ischemic contracture, which may lead to devastating impairment of motor function and sensibility (Rubinstein, Ahmed, & Vosbikian, 2018). Contracture of the fingers and wrist occurs as the result of obstructed arterial blood flow to the forearm and hand. The patient is unable to extend the fingers, describes abnormal sensation (e.g., unrelenting pain, pain on passive stretch), and exhibits signs of diminished circulation to the hand. Irreversible damage develops within a few hours if action is not taken. This serious complication can be prevented with nursing surveillance and proper care (Ferla, Ciravegna, Mariani, et al., 2019).

Nursing Management of the Patient with an Immobilized Lower Extremity

The application of a leg cast, splint, or brace imposes a degree of immobility on the patient. Casts may include short leg casts, extending to the knees, or long leg casts, extending to the groin. Hinged knee braces and immobilizers typically extend from ankle to groin.

The patient's leg must be supported on pillows to the level of the heart to control swelling. Cold therapy or ice packs should be applied as prescribed over the fracture site for 1 to 2 days. The patient is taught to elevate the immobilized leg when seated. The patient should also assume a recumbent position several times a day with the immobilized leg elevated to promote venous return and control swelling (Rasmussen, 2019). Gentle toe and ankle exercises that allow for isometric contraction of muscles beneath the cast have also been shown to increase venous return and diminish edema (AAOS, 2019c).

The nurse assesses circulation by observing the color, temperature, and capillary refill of the exposed toes. Nerve function is assessed by observing the patient's ability to move the toes and by asking about the sensations in the foot. Numbness, tingling, and burning may indicate peroneal nerve injury resulting from pressure at the head of the fibula.

Quality and Safety Nursing Alert

Injury to the peroneal nerve as a result of pressure is a cause of footdrop (the inability to maintain the foot in a normally flexed position). Consequently, the patient drags the foot when ambulating.

The nurse and physical therapist instruct the patient how to transfer and ambulate safely with assistive devices (e.g., crutches, walker) (see Chapter 2). The gait to be used depends on whether the patient is permitted to bear weight. If weight bearing is allowed, the cast, splint, or brace is reinforced to withstand the body weight. A cast boot or shoe, which is worn over the casted foot, provides a broad, nonskid walking surface.

Nursing Management of the Patient with a Body or Spica Cast

Casts that encase the trunk of the body (body cast) and portions of one or two extremities (spica cast) require special nursing strategies. Body casts are used to immobilize the spine. Hip spica casts are utilized to treat various fractures of the hip or femur or to correct or maintain the correction of hip deformities after reduction or surgery. These casts typically remain in place for 4 to 6 weeks (Nemeth et al., 2020). Shoulder spica casts are used for some humeral neck fractures.

Nursing responsibilities include preparing and positioning the patient, assisting with skin care and hygiene, and monitoring for complications. Explaining the casting procedure helps reduce the patient's apprehension about being encased in a large cast. The nurse reassures the patient that several people will provide care during the application, support for the injured area will be adequate, and care providers will be as gentle as possible. Patients immobilized in large casts may develop superior mesenteric artery syndrome, also known as cast syndrome, a rare condition characterized by compression of the third portion of the duodenum between the aorta and superior mesenteric artery (Karrer & Jones, 2018). A partial or complete obstruction of the duodenum can occur within days or weeks after the cast has been applied and includes psychological or physiologic manifestations. The psychological component is similar to a claustrophobic reaction. The patient exhibits an acute anxiety reaction characterized by behavioral changes and autonomic responses (e.g., increased respiratory rate, diaphoresis, dilated pupils, increased heart rate, elevated blood pressure). The nurse needs to recognize the anxiety reaction and provide an environment in which the patient feels secure. The administration of pain and antianxiety medications prior to the casting procedure may help to reduce this reaction.

With decreased physical activity, gastrointestinal motility decreases, and intestinal gases accumulate. Physiologic manifestations include abdominal distention and discomfort, nausea, and bilious vomiting, which can lead to food aversion, poor intake, malnourishment, and weight loss (Rai, Shah, Palliyil, et al., 2019). Eventually, increased abdominal pressure and ileus may occur. As with other instances of adynamic ileus, the patient is treated conservatively with decompression (nasogastric intubation connected to suction) and IV fluid therapy until gastrointestinal motility is restored. If conservative measures are ineffective, surgical intervention is warranted. Rarely, the abdominal distention can place added pressure on the superior mesenteric artery, reducing the blood supply to the bowel, which can result in gangrenous bowel. The descending aorta may also sustain pressure, as it may be compressed between the spine and pressure of abdominal distention, which results in ischemia. These complications can be severe, and the pressure needs to be relieved as soon as possible by cutting a window in the abdominal portion of the cast or bivalving the cast; these measures may be sufficient to prevent or relieve pressure on the duodenum.

Quality and Safety Nursing Alert

The nurse monitors the patient in a large body cast for potential superior mesenteric artery syndrome, noting bowel sounds every 4 to 8 hours, and reports abdominal discomfort and distention, nausea, and vomiting to the primary provider.

Caring for a patient with a body or spica cast at home can be very stressful for the caregiver(s); therefore, it is essential that nurses provide appropriate support and discharge education. To minimize complications after the cast is applied, the nurse should give the patient a comprehensive discharge package that supplements home care instructions with visual training instructions, as well as provide telephone counseling after discharge (Schweich, 2019). Specifically, the nurse educates the family about how to care for the patient, including providing hygienic, cast and skin care, proper positioning, preventing complications, and recognizing symptoms that should be reported to the primary provider.

The Patient with an External Fixator

External fixator devices are used to manage fractures with large amounts of soft tissue damage. Complicated fractures of the humerus, forearm, femur, tibia, and pelvis are also managed with external skeletal fixators. They are also used to correct defects, treat nonunion, and lengthen limbs. Their use has increased in recent years with advances in orthopedic trauma care. The fixator provides skeletal stability for severe comminuted (crushed or splintered) fractures while permitting active treatment of extensive soft tissue damage (see Fig. 37-9).

Figure 37-9 • External fixation device. Pins are inserted into bone. The fracture is reduced and aligned and then stabilized by attaching the pins to a rigid portable frame. The device facilitates treatment of soft tissue damaged in complex fractures.

External fixation is a technique that involves the surgical insertion of pins through the skin and soft tissues into and through the bone. A metal external frame is attached to these pins and is designed to hold the fracture in proper alignment to enable healing to occur (Kani, Porrino, & Chew, 2020). Advantages of external fixation, compared to other modes of treatment, include immediate fracture stabilization, minimization of blood loss (in comparison to internal fixation), increased patient comfort, improved wound care, promotion of early mobilization and weight bearing on the affected limb, and active exercise of adjacent uninvolved joints (AAOS, 2019d). The disadvantages are an increased risk for pin site loosening and infection, which can lead to osteomyelitis, septic arthritis, and progressive pain (Sayed, Mohammed, Mostafa, et al., 2019).

Management

Patients should be prepared psychologically for application of the external fixator, as they may be at risk for an altered body image related to the size and bulk of the apparatus. To promote acceptance of the device, patients should be given comprehensive information about the frame and reassurance that the discomfort associated with the device is minimal and that early mobility is anticipated (Walker, 2018); however, among patients who have had significant trauma, there may not be time to engage them in this type of preparation. Nurses should initiate open discussions to help patients describe their concerns about the apparatus and expectations about care.

After the external fixator is applied, the extremity is elevated to the level of the heart to reduce swelling, if appropriate. Any sharp points on the fixator or pins are covered with caps to prevent device-induced injuries. The nurse must be alert for potential problems caused by pressure from the device on the skin, nerves, or blood vessels and for the development of acute compartment syndrome. The nurse monitors the neurovascular status of the extremity every 2 to 4 hours and promptly reports changes to the primary provider (Hadeed, Werntz, & Varacallo, 2019). Because the pins are inserted externally, particular attention is focused on the pin sites for signs of inflammation and infection. The goal is to avoid osteomyelitis. The nurse assesses each pin site at least every 8 to 12 hours for redness, swelling, pain around the pin sites, warmth, and purulent drainage, because these are the most common indicators of pin site infections. In the first 48 to 72 hours postinsertion, some serous drainage, skin warmth, and mild redness at the pin sites are expected (Walker, 2018); these are expected to subside after 72 hours.

Currently, there is no consensus or research-based evidence to direct the best method for cleansing and dressing percutaneous pin sites to minimize infection rates and complications (Lobst, 2017). Additionally, there continues to be a lack of evidence regarding best management of crusting on pin sites (Georgiades, 2018). In the absence of such research, aseptic technique during pin insertion is advised (Gasiorowski, 2017), along with general strategies such as cleansing each pin site separately to avoid cross contamination with nonshedding material (e.g., gauze, cotton-tip swab) and using chlorhexidine 2 mg/mL solution once weekly. Chlorhexidine can be an allergen, however. Therefore, the patient should be monitored for manifestations of an allergic reaction, which may include pruritus and/or contact dermatitis at the pin site, or, rarely in severe cases, angioedema and even anaphylactic shock (Campbell & Watt, 2020). Pin sites should be cleaned and dressed as prescribed unless there is copious drainage, the dressing becomes wet, or infection is suspected, in which case cleaning and dressing may be more frequent. If signs of an allergic reaction or infection are present or if the pins or clamps seem loose, the nurse notifies the primary provider.

Chart 37-6 HOME CARE CHECKLIST

The Patient with an External Fixator

At the completion of education, the patient and/or caregiver will be able to:

- State the impact of the musculoskeletal injury/disorder on physiologic functioning, ADLs, IADLs, roles, relationships, and spirituality.
- State rationale for use of external fixation and resulting changes in lifestyle (e.g., activity, exercise, rest) necessary to maintain health and safety.
  - Avoid excessive use of injured extremity.
  - Observe prescribed weight-bearing limits.
  - Demonstrate ability to transfer (e.g., from a bed to a chair) and/or safe use of mobility aid.
  - Demonstrate exercises to promote circulation and minimize disuse syndrome.
- State signs of pin site infection (e.g., redness, tenderness, increased or purulent pin site drainage) to be reported promptly.
- Describe approaches to controlling swelling and pain (e.g., elevate extremity to heart level, take analgesic agents as prescribed).
- Verbalize plan to report pain uncontrolled by elevation and analgesic agents (may be an indicator of impaired tissue perfusion, acute compartment syndrome, or pin tract infection).
- State indicators of complications to report promptly to primary provider (e.g., uncontrolled swelling and pain; cool, pale fingers or toes; paresthesia; paralysis; purulent drainage; signs of systemic infection; loose fixator pins or clamps).
- State how to reach primary provider with questions or complications
  - State time and date of follow-up appointments and testing
- State the name, dose, side effects, frequency, and schedule for all medications.
- Identify the need for health promotion, disease prevention, and screening activities
- Describe care of extremity after fixator removal (e.g., gradual resumption of normal activities to protect limb from undue stresses).

Resources

See Chapter 2, Chart 2-6, for additional information related to durable medical equipment, adaptive equipment, and mobility skills.

ADLs, activities of daily living; IADLs, instrumental activities of daily living.

Quality and Safety Nursing Alert

The nurse never adjusts the clamps on the external fixator frame. It is the primary provider's responsibility to do so.

If activity is restricted, the nurse encourages isometric exercises as tolerated to prevent complications of mobility (e.g., thrombus formation). When the swelling subsides, the nurse helps the patient become mobile within the prescribed weight-bearing limits (non–weight bearing to full weight bearing). Adherence to weight-bearing instructions minimizes the chance of loosening of the pins when stress is applied to the bone–pin interface. The external fixator may be removed once the soft tissue heals and there are no signs of infection. The fracture may require additional stabilization by a cast, molded orthosis, or internal fixation while healing.

Ilizarov fixation is a specialized type of external fixator consisting of numerous wires that penetrate the limb and are attached to a circular metal frame (Kani et al., 2020). This device is used to correct angulation and rotational defects, to treat nonunion (failure of bone fragments to heal), and to lengthen limbs. The device gently pulls apart the cortex of the bone and stimulates new growth through daily adjustment of the telescoping rods. The nurse must educate the patient about adjusting the telescoping rods and caring for the pin sites and apparatus, because this fixator can be in place for many months. When discharge is anticipated, the nurse educates the patient or caregiver about how to perform pin site care according to the prescribed protocol (clean technique can be used at home) and to promptly report any signs of pin site inflammation, irritation, infection, or pin loosening (Sayed et al., 2019; Walker, 2018). The nurse also instructs the patient or family to monitor neurovascular status and report any changes promptly. The patient or family members are instructed to check the integrity of the fixator frame daily and to report loose pins or clamps. A physical therapy referral is helpful in educating the patient how to transfer, use ambulatory aids safely, and adjust to weight-bearing limits and altered gait patterns (see Chart 37-6).

The Patient in Traction

Traction uses a pulling force to promote and maintain alignment to an injured part of the body (Flynn, 2018). The goals of traction include decreasing muscle spasms and pain, realignment of bone fractures, and correcting or preventing deformities. The type of traction, amount of weight, and whether traction can be removed for nursing care must be determined to obtain its therapeutic effects.

At times, traction needs to be applied in more than one direction to achieve the desired line of pull. When this is done, one of the lines of pull counteracts the other. These lines of pull are known as the vectors of force. The actual resultant pulling force is somewhere between the two lines of pull (see Fig. 37-10). The effects of traction are evaluated with x-ray studies, and adjustments are made if necessary.

Traction is used primarily as a short-term intervention until other modalities, such as external or internal fixation, are possible (AAOS, 2019d). These operative techniques reduce the risk of disuse syndrome and minimize hospital lengths of stay, often allowing the patient to be cared for in the home setting.

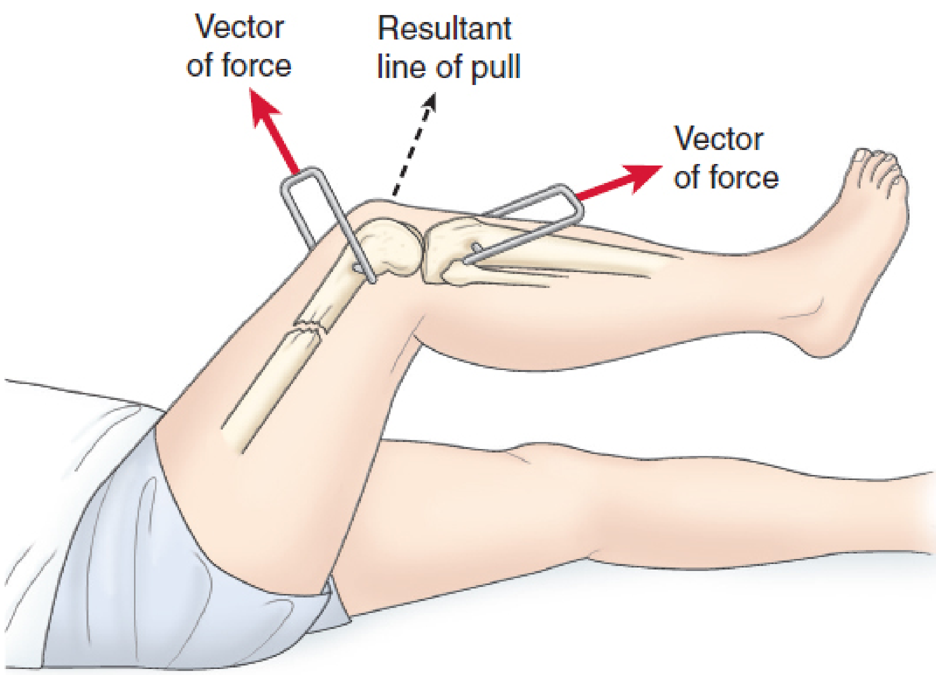

Figure 37-10 • Traction may be applied in different directions to achieve the desired therapeutic line of pull. Adjustments in applied forces may be prescribed over the course of treatment.

Principles of Effective Traction

Whenever traction is applied, countertraction must be used to achieve effective results. Countertraction is the force acting in the opposite direction. Usually, the patient's body weight and bed position adjustments supply the needed countertraction.

When caring for the patient in traction, the nurse should follow these additional principles:

- Traction must be continuous to be effective in reducing and immobilizing fractures.
- Skeletal traction is *never* interrupted.
- Weights are not removed unless intermittent traction is prescribed.

- Any factor that might reduce the effective pull or alter its resultant line of pull must be eliminated.
- The patient must be in good body alignment in the center of the bed when traction is applied.
- Ropes must be unobstructed.
- Weights must hang freely and not rest on the bed or floor.
- Knots in the rope or the footplate must not touch the pulley or the foot of the bed.

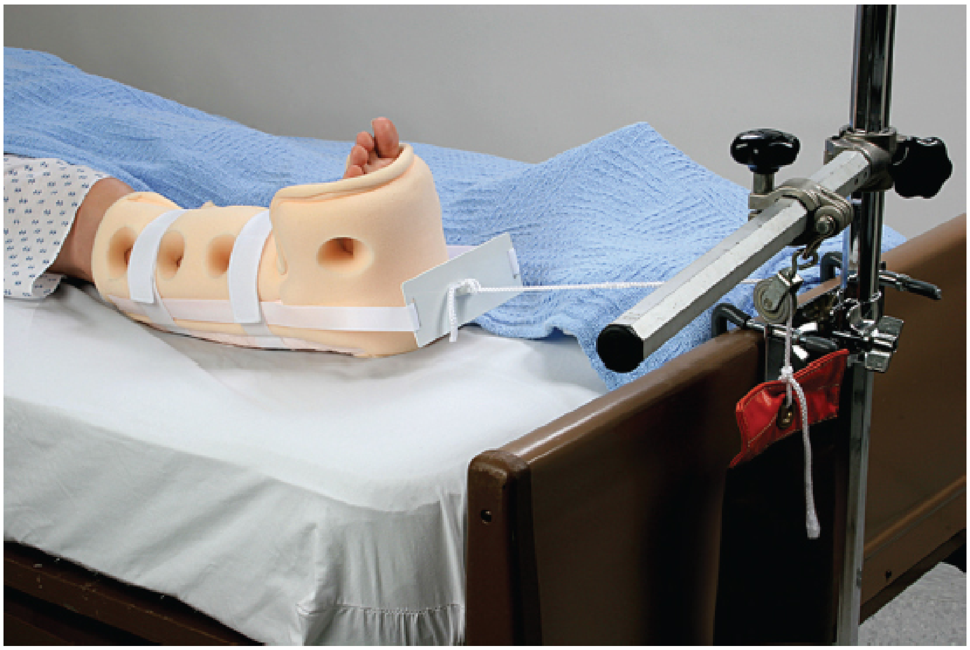

Figure 37-11 • Buck's extension traction. Lower extremity in unilateral Buck's extension traction is aligned in a foam boot and traction applied by the free-hanging weight. The Heelift® Traction Boot is shown here. Photo courtesy of DM Systems, Inc.

Types of Traction

The use of traction has decreased significantly due to advances in the surgical reduction of fractures, shortened lengths of hospital stay, and research that queries the effectiveness of its use (Biz, Fantoni, Crepaldi, et al., 2019). However, a basic working knowledge of the use of traction is necessary, because some orthopedic surgeons still prescribe traction for their patients (Santy-Tomlinson, 2017).

There are several types of traction. *Straight* or *running traction* applies the pulling force in a straight line with the body part resting on the bed. The countertraction is provided by the patient's body and movement can alter the traction provided. Buck's extension traction (discussed later; see Fig. 37-11) is an example of straight traction. *Balanced suspension traction* (see Fig. 37-12) supports the affected extremity off the bed and allows for some patient movement without disruption of the line of pull. With this traction, the countertraction is produced by devices such as slings or splints.

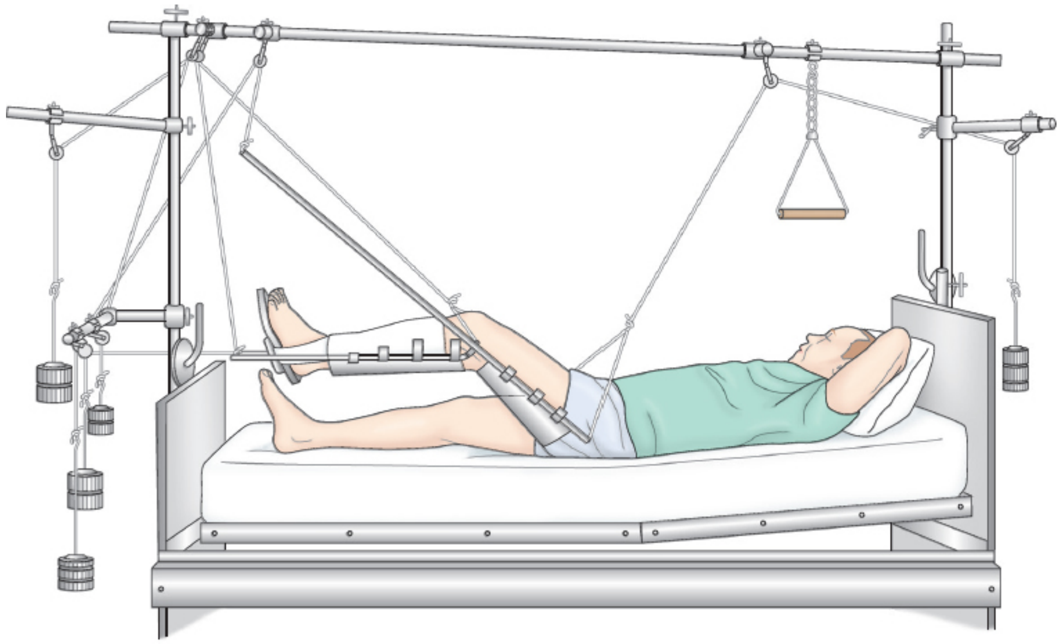

Figure 37-12 • Balanced suspension skeletal traction with Thomas leg splint. The patient can move vertically as long as the resultant line of pull is maintained. Note the use of overhead trapeze.

Traction may be applied to the skin (*skin traction*) or directly to the bony skeleton (*skeletal traction*). The mode of application is determined by the purpose of the traction. Traction can be applied with the hands (*manual traction*). This is temporary traction that may be used when applying a cast, giving skin care under a Buck's extension foam boot, or adjusting the traction apparatus.

Skin Traction

Skin traction is not frequently used but it may be prescribed as a temporary measure to stabilize a fractured leg, control muscle spasms, and immobilize an area before surgery. The pulling force is applied by weights that are attached to the patient with Velcro, tape, straps, boots, or cuffs (Duperouzel, Gray, & Santy-Tomlinson, 2018). The amount of weight applied must not exceed the tolerance of the skin. No more than 2 to 3.5 kg (4.5 to 8 lb) of traction can be used on an extremity. Pelvic traction is usually limited to 4.5 to 9 kg (10 to 20 lb), depending on the weight of the patient. Buck's extension traction (applied to the lower leg) is the most common type of skin traction indicated for select adults with musculoskeletal injury.

Buck's Extension Traction

Buck's extension traction (unilateral or bilateral) is skin traction to the lower leg. The pull is exerted in one plane when partial or temporary immobilization is desired (see Fig. 37-11). It is used as a temporary measure to overcome muscle spasms and promote immobilization of hip fractures in adult patients waiting for more definitive treatment such as surgery. However, current data show no direct benefit; that is, there is no improvement in pain and better fracture reduction when Buck's traction is applied preoperatively in patients with hip fractures (Etxebarria-Foronda & Caeiro-Rey, 2018).

Before the traction is applied, the nurse inspects the skin for abrasions and circulatory disturbances. The skin and circulation must be in healthy condition to tolerate the traction. The extremity should be clean and dry before the foam boot or traction tape is applied.

To apply Buck's traction, the extremity is elevated and supported under the patient's heel and knee while the foam boot is placed under the leg, with the patient's heel in the heel of the boot. Next, the Velcro straps are secured around the leg. Traction tape that is overwrapped with an elastic bandage in a spiral fashion may be used instead of the boot. Excessive pressure is avoided over the malleolus and proximal fibula during application to prevent pressure injuries and nerve damage. The rope is then affixed to the spreader or footplate over a pulley fastened to the end of the bed and attaches the prescribed weight —usually approximately 2.25 to 3.5 kg (or more precisely 5 to 8 lb)—to the rope. The weight should hang freely, not touching parts of the bed or floor as this compromises the efficiency of the traction system (Duperouzel et al., 2018).

Nursing Interventions

To ensure effective skin traction, it is important to avoid wrinkling and slipping of the traction bandage and to maintain countertraction. Proper positioning must be maintained to keep the leg in a neutral position. To prevent bony fragments from moving against one another, the patient should not turn from side to side; however, the patient may shift position slightly with assistance.

Monitoring and Managing Potential Complications

The nurse monitors for complications of skin traction, which can include skin breakdown, nerve damage, and circulatory impairment.

Skin Breakdown

During the initial assessment, the nurse identifies sensitive, fragile skin (common in older adults). The nurse also inspects the skin area that is in contact with tape, foam, or shearing forces, at least every 8 hours, for signs of irritation or inflammation (Duperouzel et al., 2018). The nurse performs the following procedures to monitor and prevent skin breakdown:

- Removes the foam boots to inspect the skin, the ankle, and the Achilles tendon at least twice daily. A second person is needed to support the extremity during the inspection and skin care.
- Palpates the area of the traction tapes daily to detect underlying tenderness.
- Provides frequent repositioning to alleviate pressure and discomfort, because the patient who must remain in a supine position is at increased risk for development of a pressure injury.
- Uses advanced static mattresses or overlays rather than standard hospital foam or alternating-air/low-air-loss mattresses to reduce the risk of pressure injury formation (Kirman, 2018).

Nerve Damage

Skin traction can place pressure on peripheral nerves. Care must be taken to avoid pressure on the peroneal nerve at the point at which it passes around the neck of the fibula just below the knee when traction is applied to the lower extremity. Pressure at this point can cause footdrop. The nurse regularly questions the patient about sensation and asks the patient to move the toes and foot. The nurse should immediately investigate any complaint of a burning sensation under the traction bandage or boot. Dorsiflexion of the foot demonstrates function of the peroneal nerve. Weakness of dorsiflexion or foot movement and inversion of the foot might indicate pressure on the common peroneal nerve. Plantar flexion demonstrates function of the tibial nerve. In addition, the nurse should promptly report altered sensation or impaired motor function.

Circulatory Impairment

After skin traction is applied, the nurse assesses circulation of the foot within 15 to 30 minutes and then every 1 to 2 hours. Circulatory assessment consists of:

- Peripheral pulses, color, capillary refill, and temperature of the fingers or toes.
- Manifestations of DVT, which include unilateral calf tenderness, warmth, redness, and swelling.

The nurse also encourages the patient to perform active foot exercises every hour when awake.

Skeletal Traction

Skeletal traction is often used when continuous traction is desired to immobilize, position, and align a fracture of the femur, tibia, and cervical spine. It is used when traction is to be maintained for a significant amount of time, when skin traction is not possible, and when greater weight (11 to 18 kg [25 to 40 lb]) is needed to achieve the therapeutic effect. Skeletal traction involves passing a metal pin or wire (e.g., Steinmann pin, Kirschner wire) through the bone (e.g., proximal tibia or distal femur) under local anesthesia, avoiding nerves, blood vessels, muscles, tendons, and joints (Buckley & Page, 2018). Traction is then applied using ropes and weights attached to the end of the pin. Alternatively, skeletal traction may involve the application of tongs to the head that are fixed to the skull to immobilize cervical fractures (see Chapter 63).

The surgeon applies skeletal traction using surgical asepsis. The insertion site is prepared with a surgical scrub agent such as chlorhexidine solution. A local anesthetic agent is given at the insertion site and periosteum. The surgeon makes a small skin incision and drills the sterile pin or wire through the bone. The patient feels pressure during this procedure and possibly some pain when the periosteum is penetrated.

After insertion, the pin or wire is attached to the traction bow or caliper. The ends of the pin or wire are covered with caps to prevent injury to the patient or caregivers. The weights are attached to the pin or wire bow by a rope and pulley system that exerts the appropriate amount and direction of pull for effective traction (Biz et al., 2019). The weights applied initially must overcome the shortening spasms of the affected muscles. As the muscles relax, the traction weight is reduced to prevent fracture dislocation and to promote healing.

Often, skeletal traction is balanced traction, which supports the affected extremity, allows for some patient movement, and facilitates patient independence and nursing care while maintaining effective traction. The Thomas splint with a Pearson attachment is frequently used with skeletal traction for fractures of the femur (see Fig. 37-12). Because upward traction is required, an overbed frame is used (Gray & Santy-Tomlinson, 2018).

When skeletal traction is discontinued, the extremity is gently supported while the weights are removed. The pin is cut close to the skin and removed by the surgeon. Internal fixation, casts, or splints are then used to immobilize and support the healing bone.

Nursing Interventions

When skeletal traction is used, the nurse checks the traction apparatus to see that the ropes are in the wheel grooves of the pulleys, the ropes are not frayed, the weights hang freely, and the knots in the rope are tied securely. The nurse also evaluates the patient's position, making sure that the traction force is always in correct alignment with the leg, with the patient in the mid-line position (Gray & Santy-Tomlinson, 2018).

Quality and Safety Nursing Alert

The nurse must never remove weights from skeletal traction unless a life-threatening situation occurs. Removal of the weights defeats their purpose and may result in injury to the patient.

The nurse must maintain alignment of the patient's body in traction as prescribed to promote an effective line of pull (Gray & Santy-Tomlinson, 2018). The nurse positions the patient's foot to avoid footdrop (plantar flexion), inward rotation (inversion), and outward rotation (eversion). The patient's foot may be supported in a neutral position by orthopedic devices (e.g., foot supports).

If the patient reports severe pain from muscle spasm, the weights may be too heavy, or the patient may need realignment. Pain must be reported to the primary provider if body alignment fails to reduce discomfort. Opioid and nonopioid analgesics may be used to control pain. Muscle relaxants may be prescribed to relieve muscles spasms as needed.

Preventing Skin Breakdown

The patient's elbows frequently become sore, and nerve injury may occur if the patient repositions by pushing on the elbows. In addition, patients frequently push on the heel of the unaffected leg when they raise themselves. This digging of the heel into the mattress may injure the tissues. It is important to instruct patients not to use their heels or elbows to push themselves up in bed (El-saidy & Aboshehata, 2019). To encourage movement without using the elbows or heel, an assistive device called a **trapeze** can be suspended overhead within easy reach of the patient (see Fig. 37-12). The trapeze helps the patient move about in bed and move on and off the bedpan. Transparent film, hydrocolloid dressings, or skin sealants may also be applied to bony prominences (such as elbows) or critical areas to decrease the force of shearing and friction (Gaspar, Peralta, Marques, et al., 2019).

Specific pressure points are assessed for irritation and inflammation at least every 8 hours. Patients at high risk for skin breakdown (e.g., older adults, patients who are malnourished or who have impaired mobility or sensation) may need to be assessed more frequently (Mervis & Phillips, 2019). Areas that are particularly vulnerable to pressure caused by a traction apparatus applied to the lower extremity include the ischial tuberosity, popliteal space, Achilles tendon, and heel. If the patient is not permitted to turn on one side or the other, the nurse must make a special effort to provide back care and to keep the bed dry and free of crumbs and wrinkles. The patient can assist by holding the overhead trapeze and raising the hips off the bed. If the patient cannot do this, the nurse can push down on the mattress with one hand to relieve pressure on the back and bony prominences and to provide for some shifting of weight. Given the supine position that most patients with skeletal traction assume, the use of advanced static mattresses or overlays should be considered rather than foam or alternating-air/low-air-loss mattresses to reduce the risk of pressure injury (Serraes, Van Leen, Schols, et al., 2018). The patient's heel should be "off-loaded" and carefully placed on a pillow or heel suspension device to keep the heel from the bed's surface (Gray & Santy-Tomlinson, 2018).

For change of bed linens, the patient raises the torso while caregivers on both sides of the bed roll down and replace the upper mattress sheet. Then, as the patient raises the buttocks off the mattress, the sheets are slid under the buttocks. Finally, the lower section of the bed linens is replaced while the patient rests on the back. Sheets and blankets are placed over the patient in such a way that the traction is not disrupted.

Monitoring Neurovascular Status

The nurse evaluates the body part to be placed in traction and compares its neurovascular status (e.g., color, temperature, capillary refill, edema, pulses, ability to move, and sensations) to the unaffected extremity every hour for the first 24 hours after traction is applied and every 4 hours thereafter. The nurse instructs the patient to report any changes in sensation or movement immediately so that they can be promptly evaluated. VTE formation is a significant risk for the patient who is immobilized. The nurse encourages the patient to do active flexion–extension ankle exercises and isometric contraction of the calf muscles (calf-pumping exercises) 10 times an hour while awake to decrease venous stasis. In addition, anti-embolism stockings, compression devices, and anticoagulant therapy may be prescribed to help prevent thrombus formation.

Quality and Safety Nursing Alert

The nurse must immediately investigate every report of discomfort expressed by the patient in traction. Prompt recognition of a developing neurovascular problem is essential so that corrective measures can be instituted quickly.

Providing Pin Site Care

The wound at the pin insertion site requires attention, and it is important to follow the facility's specific policy pertaining to skeletal pin care. The goal is to avoid infection and development of osteomyelitis (see Chapter 36). For the first 48 hours after insertion, the site is covered with a sterile absorbent nonstick dressing and a rolled gauze or Ace-type bandage. After this time, a loose cover dressing or no dressing is recommended (a bandage is necessary if the patient is exposed to airborne dust). Expert consensus-based recommendations for pin site care include the following (Walker, 2018):

- Pins located in areas with soft tissue are at greatest risk for infection.
- After the first 48 to 72 hours following skeletal pin placement, pin site care should be performed daily or weekly.
- Chlorhexidine 2 mg/mL solution is the most effective cleansing solution. If chlorhexidine is contraindicated (due to known hypersensitivity or skin reaction), saline solution should be used for cleansing.
- Strict hand hygiene before and after skeletal pin site care should always take place.

The nurse must inspect the pin sites at least every 12 hours for signs of hypersensitivity/allergic reaction (e.g., contact dermatitis, pruritus, urticaria, angioedema), irritation (e.g., normal changes that occur at the pin site after insertion) and infection. Signs of irritation may include redness, warmth, and serosanguineous drainage at the site, which tend to subside after 72 hours. Signs of infection may mirror those of reaction but also include the presence of purulent drainage, pain, pin loosening, tenting of skin at pin site, odor, and fever. Patient descriptions of their pin sites might be helpful as they are often the first to notice subtle changes in their symptoms and may be able to differentiate between different pin site states (Santy-Tomlinson, Jomeen, & Ersser, 2019). Prophylactic broad-spectrum IV antibiotics may be given for 24 to 48 hours postinsertion to prevent infection; however, the evidence is confounding and there is no general consensus on the advisability of this practice (Walker, 2018). Minor infections may be readily treated with antibiotics, and infections that result in systemic manifestations may additionally warrant pin removal until the infection resolves.

Due to a lack of evidence-based research findings, controversy exists about skeletal pin care, showering, and the overall management of pin site crusts, which are the hardened plugs of exudate that adhere to and block the pin sites. Current evidence suggests that crusting at the pin site should be retained as long as the pin site remains uninfected as the retained crusts provides a natural barrier from the external environment, which can prevent bacterial contamination (Georgiades, 2018). The patient and family should be educated on the performance of any prescribed pin site care prior to discharge from the hospital and should be provided with written follow-up instructions that include the signs and symptoms of infection.

Promoting Exercise

Patient exercises, within the therapeutic limits of the traction, assist in maintaining muscle strength and tone, and in promoting circulation. Active exercises include pulling up on the trapeze, flexing and extending the feet, and range-of-motion and weight-resistance exercises for noninvolved joints. Isometric exercises of the immobilized extremity (quadriceps and gluteal setting exercises) are important for maintaining strength in major ambulatory muscles (see Chart 37-4). Without exercise, the patient will lose muscle mass and strength, and rehabilitation will be greatly prolonged.

Nursing Management of the Patient in Traction

Nursing management of the patient in traction includes assessing for and addressing anxiety, assisting with self-care, and monitoring for complications.

Assessing Anxiety

The nurse must consider the psychological and physiologic impact of the musculoskeletal problem, traction device, and immobility. Traction restricts mobility and independence. The equipment can look threatening, and its application can be frightening. Confusion, disorientation, and behavioral problems may develop in patients who are confined in a limited space for an extended time. Therefore, the nurse must assess and monitor the patient's anxiety level and psychological responses to traction.

Assisting with Self-Care

Initially, the patient may require assistance with self-care activities. The nurse helps the patient eat, bathe, dress, and toilet. Convenient arrangement of items such as the telephone, tissues, water, and assistive devices (e.g., reachers, overbed trapeze) may facilitate self-care. With resumption of self-care activities, the patient feels less dependent and less frustrated and experiences improved self-esteem. Because some assistance is required throughout the period of immobility, the nurse and the patient can creatively develop routines that maximize the patient's independence.

Monitoring and Managing Potential Complications

Immobility-related complications may include pressure injuries (see Chapter 56), atelectasis, pneumonia, constipation, loss of appetite, urinary stasis, urinary tract infections, and VTE formation. Early identification of preexisting or developing conditions facilitates prompt interventions to resolve them.

Atelectasis and Pneumonia

The nurse auscultates the patient's lungs every 4 to 8 hours to assess respiratory status and educates the patient about performing deep breathing and coughing exercises to aid in fully expanding the lungs and clearing pulmonary secretions. If the patient history and baseline assessment indicate that the patient is at risk for development of respiratory complications, specific therapies (e.g., the use of an incentive spirometer) may be indicated (see Chapter 19, Chart 19-1). If a respiratory complication develops, prompt institution of prescribed therapy is needed.

Constipation and Anorexia

Reduced gastrointestinal motility results in constipation and anorexia. A diet high in fiber and fluids may help stimulate gastric motility. If constipation develops, therapeutic measures may include stool softeners, laxatives, suppositories, and enemas. To improve the patient's appetite, the patient's food preferences are included, as appropriate, within the prescribed therapeutic diet.

Urinary Stasis and Infection

Incomplete emptying of the bladder related to positioning in bed can result in urinary stasis and infection. In addition, the patient may find the use of a bedpan uncomfortable and may limit fluids to minimize the frequency of urination. The nurse monitors the fluid intake and the character of the urine. Adequate hydration is important; therefore, the nurse instructs the patient to consume adequate amounts of fluid and to void every 3 to 4 hours. If the patient exhibits signs or symptoms of urinary tract infection (e.g., burning or pain on urination, hematuria), the nurse notifies the primary provider.

Venous Thromboembolism

Venous stasis that predisposes the patient to VTE occurs with immobility. The nurse educates the patient about how to perform ankle and foot exercises within the limits of the traction therapy every 1 to 2 hours when awake to prevent DVT. To increase adherence and promote the family's involvement with the patient's care, it is important to include the family members in any education and care decisions about VTE prevention (Health Services Advisory Group, 2019). The patient is encouraged to drink fluids to prevent dehydration and associated hemoconcentration, which contribute to stasis. The nurse monitors the patient for signs of DVT, including unilateral calf tenderness, warmth, redness, and swelling (increased calf circumference). The nurse promptly reports findings to the primary provider for evaluation and therapy.

During traction therapy, the nurse encourages the patient to exercise muscles and joints that are not in traction to prevent deterioration, deconditioning, and venous stasis. The physical therapist can design bed exercises that minimize loss of muscle strength. During the patient's exercise, the nurse ensures that traction forces are maintained and that the patient is properly positioned to prevent complications resulting from poor alignment.

Fractures of Specific Sites

Common sites of fractures include the clavicle, humeral neck, humeral shaft, elbow, proximal radius, radial and ulnar shafts, wrist, hand, pelvis, acetabulum, hips, femoral shaft, tibia and fibula, ribs, and thoracolumbar spine.

Clavicle

Fracture of the clavicle (collar bone) is a common injury that can result from a fall or a direct blow to the shoulder. The clavicle helps maintain the shoulder in the upward, outward, and backward position from the thorax. Therefore, when the clavicle is fractured, the patient assumes a protective position, slumping the shoulders and immobilizing the arm to prevent shoulder movements. The treatment goal is to align the shoulder in its normal position by means of closed reduction and immobilization. Surgical intervention is not typical but may be indicated if the fracture is located in the distal third of the clavicle or is severely displaced, which may result in neurovascular compromise or pneumothorax (Kleinhenz, 2019).

The majority of clavicle fractures occur in the middle third of the clavicle; clinical union (healing) takes 6 to 12 weeks in adults (Eiff, Hatch, & Higgins, 2020b). A clavicular strap, also called a *figure-eight bandage* (see Fig. 37-13), may be used to pull the shoulders back, reducing and immobilizing the fracture. The nurse monitors the circulation and nerve function of the affected arm and compares it with the unaffected arm to determine variations, which may indicate disturbances in neurovascular status. A sling may be used to support the arm and relieve pain. The patient may be permitted to use the arm for light activities as pain allows (Hatch, Clugston, & Taffee, 2019).

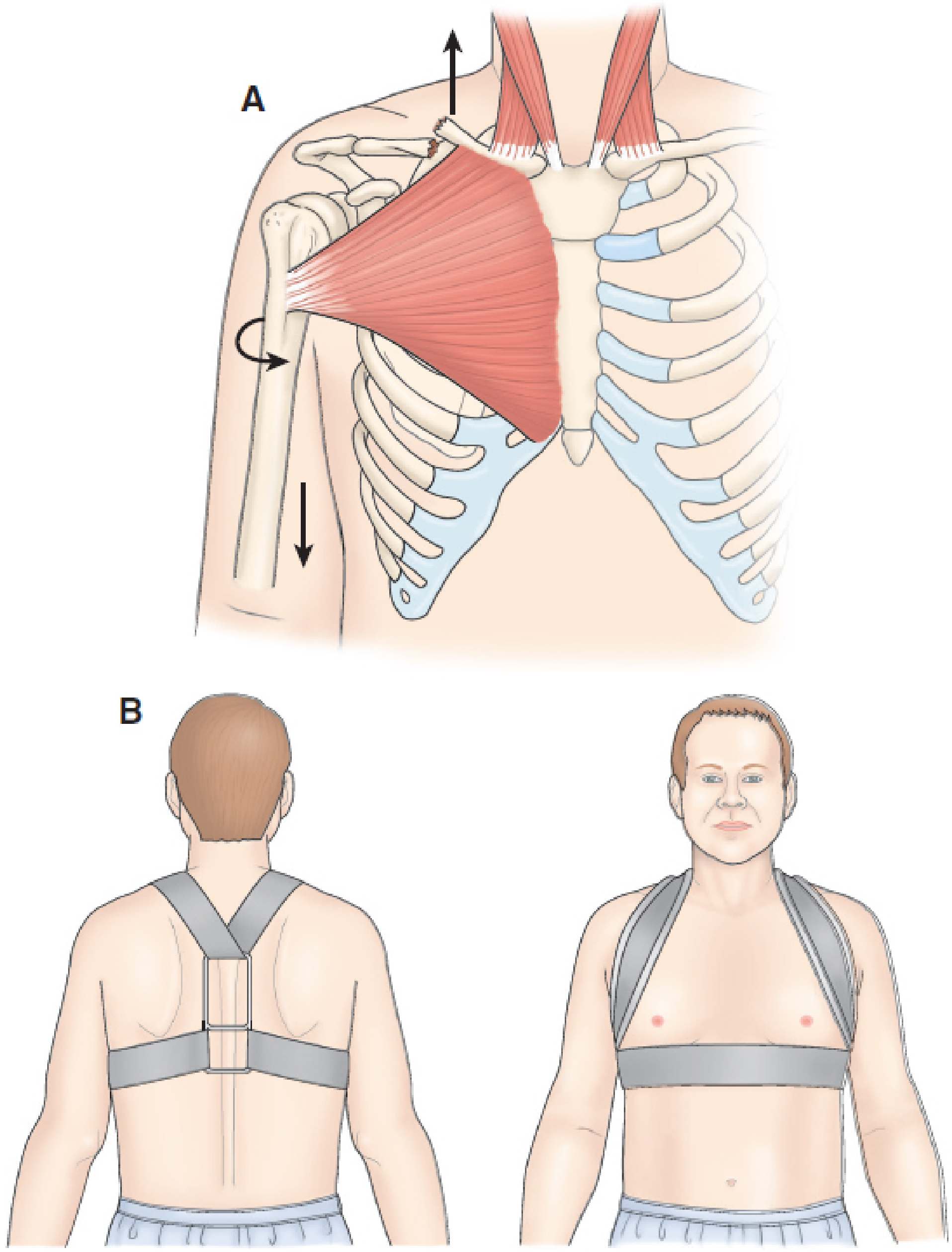

Figure 37-13 • Fracture of the clavicle. **A.** Anteroposterior view shows typical displacement in midclavicular fracture. **B.** Immobilization is accomplished with a clavicular strap.

Fracture of the distal third of the clavicle, without displacement and ligament disruption, is treated with a sling and restricted motion of the arm. When a fracture in the distal third is accompanied by a disruption of the coracoclavicular ligament that connects the coracoid process of the scapula and the inferior surface of the clavicle, the bony fragments are frequently displaced. This type of injury may be treated surgically by ORIF.

Immobilization of the shoulder in the figure-eight bandage or arm sling should be continued until clinical union occurs (e.g., the fracture site is nontender and the patient can move the arm with little or no discomfort) (Hatch et al., 2019). The nurse cautions the patient not to elevate the arm above shoulder level until the fracture has healed but encourages the patient to exercise the elbow, wrist, and fingers as soon as possible. When prescribed, shoulder exercises are performed to obtain full shoulder motion (see Fig. 37-14). Contact sports or activities with potential for falling should be avoided for 1 to 2 months after healing is complete, and has been confirmed by clinical assessment and x-ray findings (Eiff et al., 2020b).

Complications of clavicular fractures are uncommon but can include neurovascular injuries (brachial plexus injury, subclavian vein or artery injury from a bony fragment, and thoracic outlet syndrome), pneumothorax, malunion, and nonunion (Hatch et al., 2019).

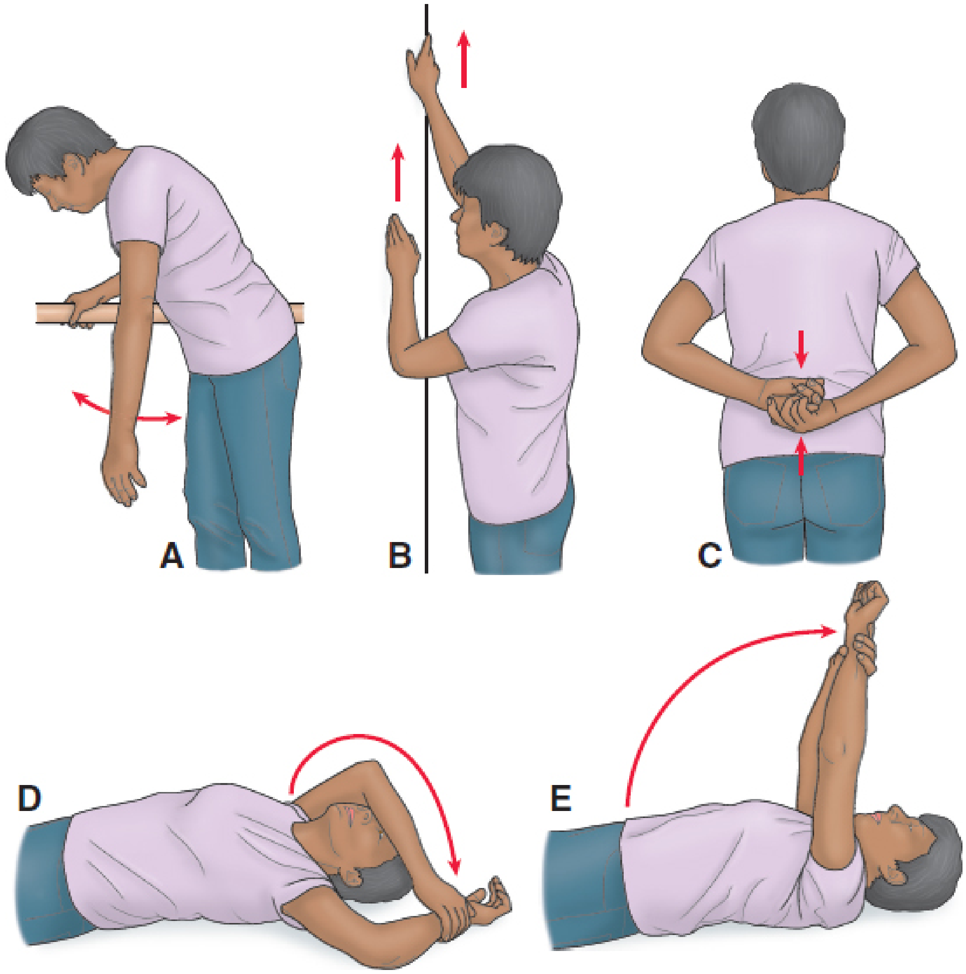

Figure 37-14 • Exercises that promote shoulder range of motion include pendulum exercise (**A**) and wall climbing (**B**). The unaffected arm is used to assist with internal rotation (**C**), external rotation(**D**), and elevation (**E**). In **C, D,** and **E,** the unaffected arm is used for power.

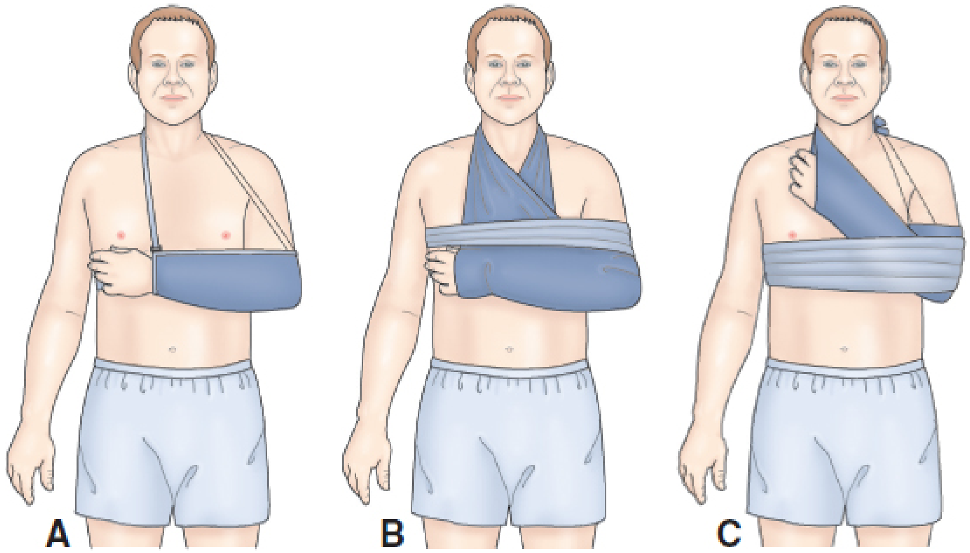

Figure 37-15 • Immobilizers for proximal humeral fractures. **A.** Commercial sling with immobilizing strap permits easy removal for hygiene and is comfortable on the neck. **B.** Conventional sling and swathe. **C.** Stockinette Velpeau and swathe are used when there is an unstable surgical neck component. This position relaxes the pectoralis major.

Humeral Neck

Fractures of the proximal humerus may occur through the neck of the humerus and are most often the result from a fall onto an outstretched hand. Most proximal humerus fractures occur in those older than 60 years of age and are more common in older women because of their greater risk of low bone density (Dorsey, 2020).

The patient presents with moderate to severe shoulder pain with the affected arm hanging limp at the side or supported by the uninjured hand. Neurovascular assessment of the extremity is essential to evaluate the full extent of injury and the possible involvement of the nerves and blood vessels of the arm.

The majority of proximal humerus fractures are impacted with little to no displacement and do not require surgical reduction. The arm is supported and immobilized by a sling and swathe splint that secures the supported arm to the trunk (see Fig. 37-15). Limitation of motion and stiffness of the shoulder occur with disuse. Therefore, pendulum exercises begin as soon as tolerated by the patient. In pendulum or circumduction exercises, the physical therapist instructs the patient to lean forward and allow the affected arm to hang in abduction and rotate. These fractures heal rapidly in about 6 to 10 weeks due to the large areas of cancellous bone (Dorsey, 2020). The goal of treatment is to restore as much function as possible; therefore, shoulder rehabilitation should begin as pain allows. Residual stiffness, aching, and some loss of shoulder motion (“frozen shoulder”) and function may persist and is more likely to develop in patients who do not perform ROM exercises regularly during recovery (Bassett, 2019).

When a humeral neck fracture is significantly displaced, treatment consists of closed reduction with splinting, ORIF, hemiarthroplasty, and reverse shoulder arthroplasty. Exercises begin after an adequate period of immobilization (Bassett, 2019).

Humeral Shaft

Fractures of the midshaft of the humerus are most frequently caused by either a direct blow or trauma that results in a transverse, oblique, or comminuted fracture, or an indirect twisting force that results in a spiral fracture. Patients usually present with considerable swelling and severe arm pain in the area of the mid-arm but may have referred pain to the shoulder or the elbow; shortening of the upper arm may indicate significant displacement (Dorsey, 2020). A thorough neurovascular assessment is important as injury to the radial nerve is often present and may require immediate attention.

There are absolute indications for emergent surgical exploration such as open fractures and fractures associated with neurovascular injuries (Dorsey, 2020). External fixators are used to treat open fractures of the humeral shaft. ORIF is necessary with nerve injury, blood vessel damage, or comminuted or displaced fractures (Bassett, 2018).

However, most humeral midshaft fractures can be treated nonsurgically. Initial splinting is commonly done with a coaptation (*sugar tong*) splint. (A sugar tong splint is a U-shaped splint that looks like tongs used for sugar cubes.) The splint is placed around the medial and lateral arm to the elbow and up to the top of the shoulder. The splint supports the arm in 90 degrees of flexion at the elbow; a sling or collar and cuff support the forearm. The weight of the hanging arm and splints put traction on the fracture site.

The preferred definitive treatment for a humerus shaft fracture is functional bracing. A contoured thermoplastic sleeve is secured in place with interlocking fabric (Velcro) closures around the upper arm, immobilizing the reduced fracture. As swelling decreases, the sleeve is tightened, and uniform pressure and stability are applied to the fracture. The forearm is supported with a collar and cuff sling (see Fig. 37-16). Functional bracing allows active use of muscles, shoulder and elbow motion, and good approximation of fracture fragments. Pendulum shoulder exercises are performed as prescribed to provide active movement of the shoulder, thereby preventing a “frozen shoulder.” Isometric exercises may be prescribed to prevent muscle atrophy. The callus that develops is substantial, and the sleeve can be discontinued in about 8 weeks. Complications that are seen with humeral shaft fractures include neurovascular compromise and nonunion because of decreased blood supply in that area.

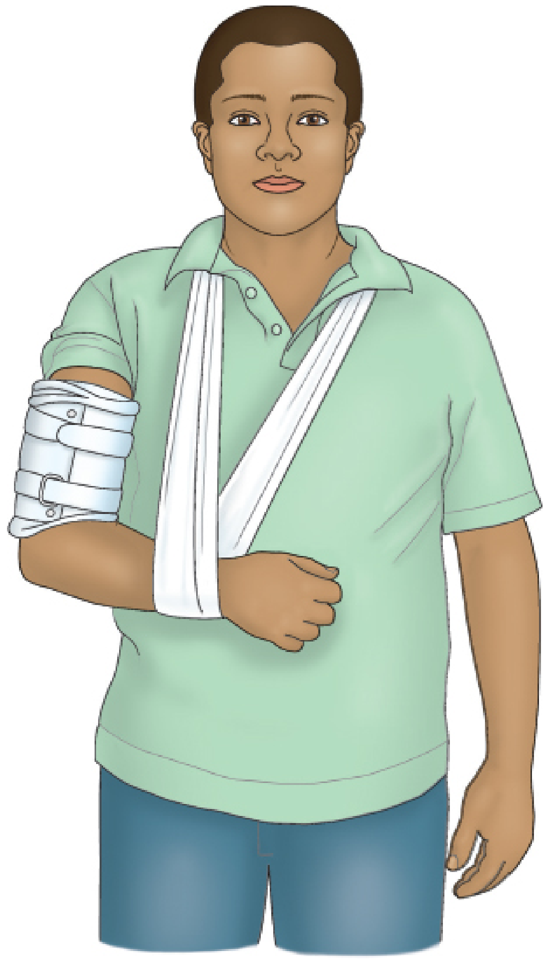

Figure 37-16 • Functional humeral brace with collar and cuff sling.

Elbow

About 30% of adult elbow fractures involve the distal part of the humerus (Eiff, Hatch, & Higgins, 2020c) and are classified as supracondylar, single column (condyle), bicolumn and coronal shear fractures. Most fractures result from high-energy mechanisms such as motor vehicle crashes, falls directly on the elbow (in the extended or flexed position), or a direct blow. These fractures can be very painful and may result in injury to the brachial artery and median nerves (Yian, 2019).

A comprehensive examination of the neurovascular status of the affected extremity should be conducted. The patient is evaluated for paresthesia and signs of compromised circulation in the forearm and hand. The most serious complication of a supracondylar fracture of the humerus is Volkmann ischemia contracture (an acute compartment syndrome), which results from antecubital swelling or damage to the brachial artery and leads to contracture (shortening) of the forearm muscles. This more commonly occurs in children than in adults and will result in a “clawlike” appearance to the hand and wrist. The nurse needs to monitor the patient regularly for compromised neurovascular status with the “5 Ps”; marked swelling and induration of the forearm are other signs (Kare, 2019). Emergency fasciotomy with débridement of the muscle may be necessary to prevent progression to Volkmann contracture (Eiff et al., 2020c). Other potential complications are damage to the joint articular surfaces and hemarthrosis (e.g., blood in the joint), which may be treated by needle aspiration by the primary provider to relieve the pressure and pain.

The goal of therapy is prompt reduction and stabilization of the distal humeral fracture, followed by controlled active motion after swelling has subsided and healing has begun. If the fracture is not displaced, the arm is immobilized in a posterior splint for 2 to 3 weeks. At that point, ROM exercises can begin with the use of a hinged functional brace (Yian, 2019).

Usually, a displaced fracture is treated with ORIF. Excision of bone fragments may be necessary. Additional external support with a splint is then applied. Active finger exercises are encouraged. Gentle ROM exercise of the injured joint is begun early. Motion promotes healing of injured joints by producing movement of synovial fluid into the articular cartilage. Active exercise to prevent residual limitation of motion is performed as prescribed. Total elbow arthroplasty may be indicated in the presence of significant comminution (e.g., fragmentation of bone). Pain management is achieved through the use of NSAIDs or opioid medications (Yian, 2019).

Proximal Radius

Radial head and neck fractures are fractures of the proximal radius. They are common and are usually the result of a fall on an outstretched hand with the elbow extended. The patient presents with localized swelling over the lateral elbow, tenderness, and decreased motion; pain increases with passive rotation. If blood has collected in the elbow joint, it is aspirated to relieve pain and to allow early active elbow and forearm ROM exercises (Eiff et al., 2020c). Nondisplaced fractures are typically managed nonsurgically with a sling for comfort; elbow flexion and extension as tolerated out of the sling should begin as soon as tolerated, usually within the first few days after injury (Eiff et al., 2020c). If the fracture is displaced, surgery is typically indicated, with excision of or replacement of the radial head when necessary (Rabin, 2018).

Radial and Ulnar Shafts

Fractures of the distal radius are among the most common fractures and occur more frequently in children and adolescents but can occur in adults. The radius or the ulna may be fractured at any level. Frequently, displacement occurs when both bones are broken. The forearm serves an integral role in upper extremity function; therefore, the unique functions of pronation and supination must be preserved with proper anatomic alignment (Kakarala & Simons, 2019).

In adults, if the fragments are not displaced, the fracture is treated by closed reduction with immobilization in a bivalved long arm cast with the wrist in slight extension, the forearm in neutral rotation, and the elbow at 90 degrees (Michaudet, 2020). Circulation, motion, and sensation of the hand are assessed before and after the cast is applied. The arm is elevated to control edema. Frequent finger flexion and extension are encouraged to reduce edema. Active motion of the involved shoulder is essential. The reduction and alignment are monitored closely by x-rays at weekly intervals for the first 4 weeks to ensure proper alignment and then every 2 weeks until healing has occurred (usually 12 to 16 weeks). During the last 6 weeks, the arm may be in a functional forearm brace that allows exercise of the wrist and elbow. Lifting and twisting are avoided.

Displaced fractures of the radius and ulna require an ORIF, using a compression plate with screws, intramedullary nails, or rods. The arm is usually immobilized in a plaster splint or cast. Open and displaced fractures may be managed with external fixation devices. The arm is elevated to control swelling. Neurovascular status is assessed and documented. Elbow, wrist, and hand exercises are begun when prescribed by the primary provider.

Wrist

Fractures of the distal radius (Colles fracture) are common and are usually the result of a fall on an open, outstretched hand, with the wrist in extension. This fracture is frequently seen in older adults with osteoporotic bones that do not dissipate the energy of the fall; it can also occur in youth who are involved in sports who sustain a high-energy fall. The patient presents with a deformed wrist, pain, swelling, weakness, and limited finger ROM, and possibly reports of "tingling" in the affected hand. Tingling sensation may indicate injury to the median nerve (Nelson, 2018).

Treatment usually consists of closed reduction and immobilization with a sugar-tong splint until swelling resides. The splint is placed so that it extends from the palm around the elbow to the back of the hand just below the fingers. This splint should remain in place until the edema lessens and usually the splint is changed to a short arm cast in 2 to 3 weeks. For fractures with extensive comminution, ORIF, plating, percutaneous pinning, or external fixation is used to achieve and maintain reduction. Pain medication is given as prescribed to aid in pain control (Petron, 2018).

Chart 37-7 PATIENT EDUCATION

Encouraging Exercise After Treatment for Wrist Fracture

The nurse encourages active motion of the fingers and shoulder. The patient is instructed to perform the following exercises to reduce swelling and prevent stiffness:

- Hold the hand at the level of the heart.
- Move the fingers from full extension to flexion. Hold and release. Repeat at least 10 times every hour when awake.
- Use the hand in functional activities.
- Actively exercise the shoulder and elbow, including complete range-of-motion exercises of both joints.

Active motion of the fingers and shoulder should begin promptly to reduce swelling and prevent stiffness (see Chart 37-7).

The fingers may swell due to diminished venous and lymphatic return. The nurse assesses the sensory function of the median nerve by pricking the distal aspect of the index finger. The motor function is assessed by the patient's ability to touch the thumb to the little finger. Diminished circulation and nerve function must be treated promptly (see previous discussion of acute compartment syndrome).

Hand

Fractures of the bones of the hand, phalanges and metacarpals, are a common injury of the skeletal system and a frequent reason that patients seek care in EDs (Muttath, Chung, & Ono, 2019). The most common type of metacarpal fracture in adults is referred to as boxer's fracture, which occurs when a closed fist bangs against a hard surface, fracturing the neck of the fifth finger. Falls and occupational injuries (e.g., machinery injuries, crushes) are the most common cause of phalangeal injury in adults (Lakshmanan, Damodaran, & Sher, 2018). When any of the bones of the hand are fractured, the objectives of treatment are to regain maximum function of the hand and minimize cosmetic deformities. X-rays are the diagnostic studies of choice (Muttath et al., 2019).

For a nondisplaced fracture of the phalanx (finger bone), the finger is splinted for 3 to 4 weeks to relieve pain and to protect the finger from further trauma. Splinting sometimes consists of "buddy taping" a fractured finger to an adjoining nonfractured finger. Serial x-rays may be done to monitor healing. Displaced fractures and open fractures may require ORIF, using wires or pins. If the fracture is open, or if a fingernail is avulsed, antibiotics may be prescribed (Basset, 2019).

The neurovascular status of the injured hand is evaluated and documented. Swelling is controlled by elevation of the hand. Functional use of the uninvolved portion of the hand is encouraged. Assistive devices might be recommended to aid the patient in performing ADLs until the hand has healed and functional status returns.

Pelvis

The sacrum, ilium, pubis, and ischium bones form the bony pelvis, which unites to form an anatomic ring in adults (see Fig. 37-17). Falls from a great height, motor vehicle and motorcycle crashes, vehicle versus pedestrian, and crush injuries can cause pelvic fractures. There is a high mortality rate associated with unstable pelvic fractures, second only to head injuries among trauma-related deaths; this is primarily related to hemorrhage, although pulmonary complications, fat emboli, thromboembolic complications, and infection are also implicated (Fiechtl, 2018). Management of severe, life-threatening pelvic fractures is coordinated with the trauma team.

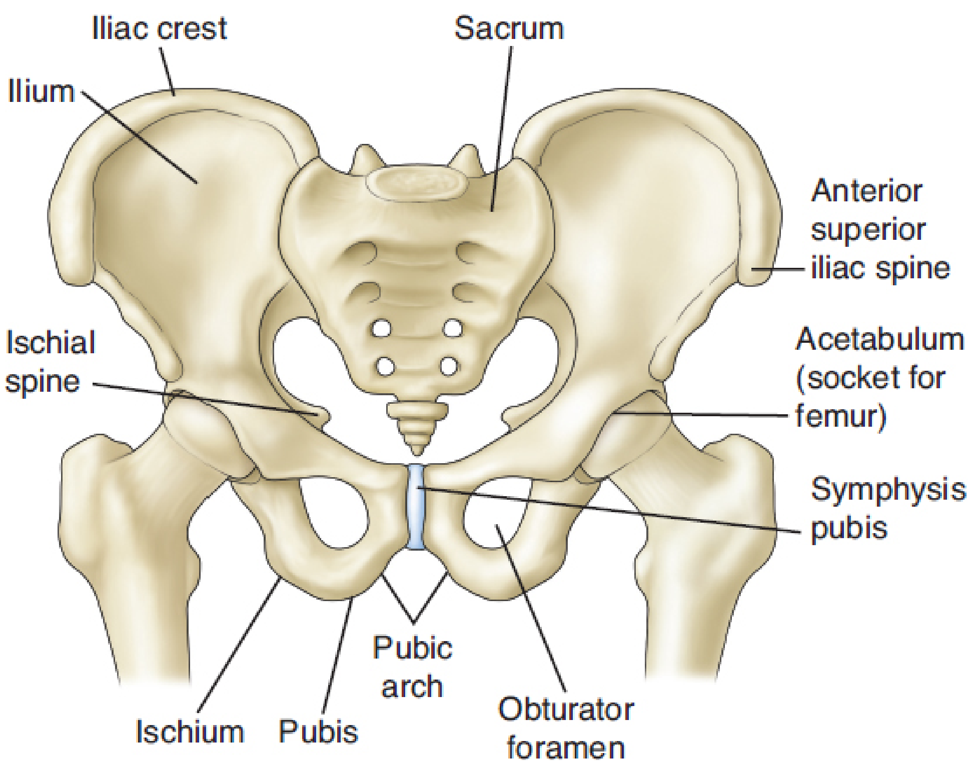

Figure 37-17 • Pelvic bones.

Signs and symptoms of pelvic fracture may include ecchymosis; tenderness over the symphysis pubis, anterior iliac spines, iliac crest, sacrum, or coccyx; local edema; numbness or tingling of the pubis, genitals, and proximal thighs; inability to bear weight without discomfort; severe back pain (retroperitoneal bleed); alterations in neurovascular status of lower extremities (see later discussion of pedal pulse assessment); and clinical manifestations of shock (see Chapter 11). CT scanning of the pelvis helps determine the extent of injury by demonstrating sacroiliac joint disruption, soft tissue trauma, pelvic hematoma, and fractures. Neurovascular assessment of the lower extremities is completed to detect any injury to pelvic blood vessels and nerves. Assessment of underlying organs for injury is indicated especially in high-impact trauma (Eiff, Hatch, & Higgins, 2020d). Trauma to the ureters, urethra, rectum, vagina; abdominal vascular trauma to veins (more common) and arteries; and neurologic trauma, particularly spinal column and cord injury, should be assessed as potential concomitant injuries (Eiff et al., 2020d). See Chapter 67 for discussion of multi trauma and abdominal trauma.

Hemorrhage and shock are two of the most serious consequences that can occur. Bleeding arises mainly from the laceration of veins and arteries by bone fragments and possibly from a torn iliac artery. The peripheral pulses, especially the dorsalis pedis pulses of both lower extremities, are palpated; absence of a pulse may indicate a tear in the iliac artery or one of its branches. Abdominal CT may be performed to detect intra-abdominal hemorrhage. Excessive movement of the pelvis should be avoided, and the patient is handled gently so that bony fragments are not displaced, which may exacerbate bleeding and shock. Fluid replacement and analgesics are administered as needed. Exploratory laparotomy may be performed to further visualize the peritoneum (Moore & Doty, 2017).

Assessment of adjacent structures must be completed when pelvic injury is suspected.

Numerous classification systems have been used to describe pelvic fractures in relation to anatomy, stability, and mechanism of injury. Some fractures of the pelvis do not disrupt the pelvic ring; others disrupt the ring, which may be rotationally or vertically unstable. The severity of pelvic fractures varies. Long-term complications of pelvic fractures include malunion, nonunion, DVTs, residual gait disturbances, back pain from ligament injury, and dyspareunia and erectile dysfunction (Eiff et al., 2020d).

Stable Pelvic Fractures

Stable fractures of the pelvis (see Fig. 37-18) include fracture of a single pubic or ischial ramus, fracture of ipsilateral pubic and ischial rami, fracture of the pelvic wing of the ilium (Duverney fracture), and fracture of the sacrum or coccyx. If injury results in only a slight widening of the pubic symphysis or the anterior sacroiliac joint and the pelvic ligaments are intact, the disrupted pubic symphysis is likely to heal spontaneously with conservative management. Most fractures of the pelvis heal rapidly because the pelvic bones are mostly cancellous bone, which has a rich blood supply.

Stable pelvic fractures can be treated with a few days of bed rest, analgesics, and progressive mobilization, depending on the level of patient discomfort, which can seriously hamper patient mobility. Fluids, dietary fiber, ankle and leg exercises, anti-embolism stockings to aid venous return, logrolling, deep breathing, early immobilization, and skin care reduce the risk of complications and increase the patient's comfort. The patient with a fractured sacrum is at risk for paralytic ileus; therefore, bowel sounds should be monitored.

The patient with a fracture of the coccyx experiences pain when sitting and when defecating. A donut ring cushion, sitz baths, and stool softeners to ease defecation are beneficial adjuncts to ease pain. As pain resolves, activity is gradually resumed with the use of assistive mobility devices. Early mobilization reduces problems related to immobility (Eiff et al., 2020d). Most patients should be managed with these conservative measures for at least 2 months until symptoms improve (Foye, 2020).

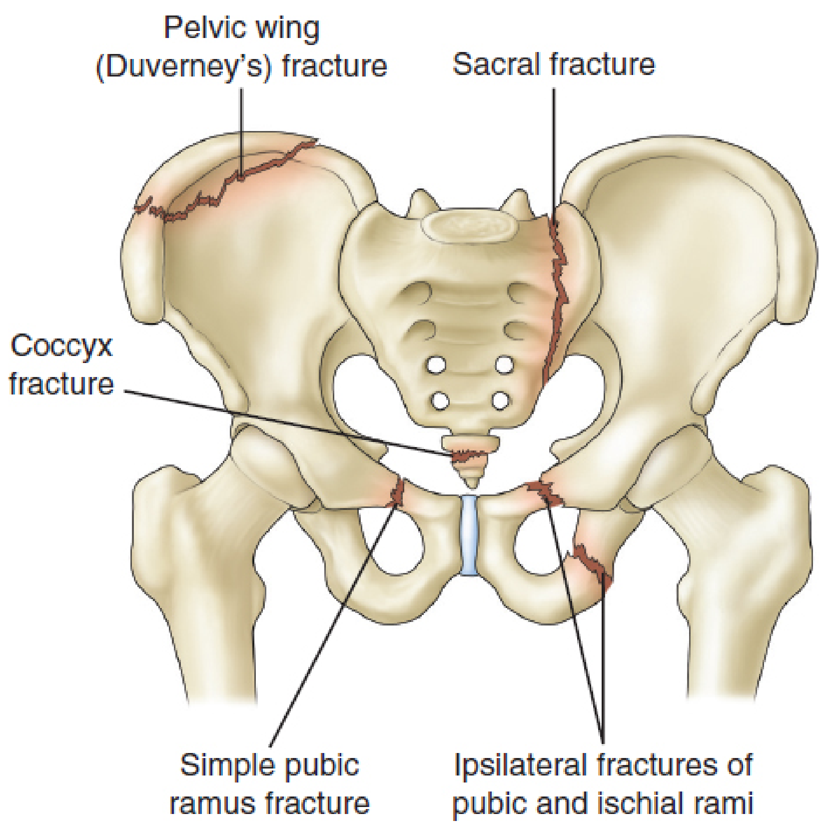

Figure 37-18 • Stable pelvic fractures.

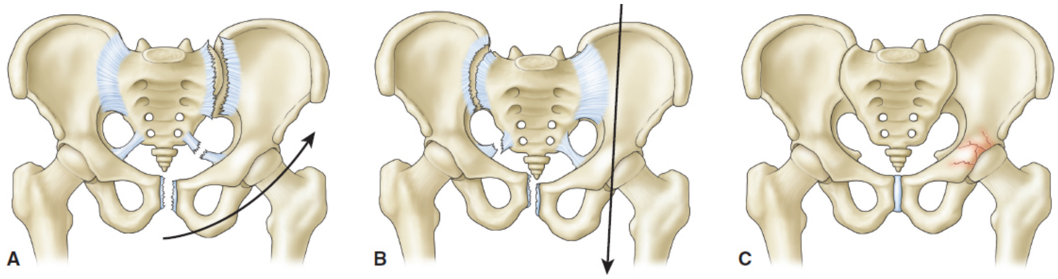

Figure 37-19 • Unstable pelvic fracture. **A.** Rotationally unstable fracture. The symphysis pubis is separated and the anterior sacroiliac, sacrotuberous, and sacrospinous ligaments are disrupted. **B.** Vertically unstable fracture. The hemipelvis is displaced anteriorly and posteriorly through the symphysis pubis, and the sacroiliac joint ligaments are disrupted. **C.** Undisplaced fracture of the acetabulum.

Unstable Pelvic Fractures

Unstable fractures of the pelvis (see Fig. 37-19) may result in rotational instability (e.g., the "open book" type, in which a separation occurs at the symphysis pubis with sacroiliac ligament disruption), vertical instability, or a combination of both. Lateral or anteroposterior compression of the pelvis produces rotationally unstable pelvic fractures. Vertically unstable pelvic fractures occur when force is exerted on the pelvis vertically, as may occur when the patient falls onto extended legs or is struck from above by a falling object. Vertical shear pelvic fractures involve the anterior and posterior pelvic ring with vertical displacement, usually through the sacroiliac joint. There is generally complete disruption of the posterior sacroiliac, sacrospinous, and sacrotuberous ligaments.

Trauma to soft-tissue, urethral, skeletal, neurovascular, and/or neurologic structures that are contiguous with the pelvis may also occur in unstable pelvic fractures as a result of high-energy mechanisms of injury (e.g., motor vehicle or motorcycle crashes, motor vehicles striking pedestrians, falls from great heights) (Russell & Jarrett, 2020). Immediate treatment in the ED for a patient with an unstable pelvic fracture includes stabilizing the pelvic bones and compressing bleeding vessels with a pelvic girdle, which is an external binding and stabilizing device. If major vessels are lacerated, the bleeding may be stopped through embolization using interventional radiology techniques prior to surgery. Because of the tremendous force necessary to cause an unstable pelvic fracture, hemorrhage and associated head injury are the most common causes of death within 24 hours post arrival to the hospital, and multiple organ dysfunction syndrome and sepsis resulting from infection are the main causes of death after that timeframe (Moore & Doty, 2017). See Chapter 11 for nursing management of the patient in shock. When the patient is hemodynamically stable, treatment generally involves external fixation or

ORIF. These measures promote hemostasis, hemodynamic stability, comfort, and early mobilization.

Acetabulum

Acetabular fractures are a type of intra-articular fracture that require a very precise and delicate surgical reduction. The typical mechanism of injury is that an external force drives the femoral shaft into the hip joint, fracturing the acetabulum. This may be caused by high-speed motor vehicle crashes (e.g., knees driven into dashboard, pedals forcibly driven upward into legs) or from falls from heights (Thacker, Tejwani, & Thakkar, 2018). Treatment depends on the pattern of fracture. Stable, nondisplaced fractures may be managed with traction and protective weight bearing so that the affected foot is placed on the floor only for balance. Displaced and unstable acetabular fractures are treated either with closed reduction and skeletal traction or ORIF (Eiff et al., 2020d). Internal fixation permits early non–weight-bearing ambulation and ROM exercise. Complications seen with acetabular fractures include nerve damage, AVN, malunion, heterotopic ossification, and posttraumatic arthritis (Thacker et al., 2018).

Hip

Annually, more than 300,000 adults older than 65 years of age sustain a hip fracture requiring hospitalization; 95% of these result from falls (United Health Foundation, 2019). Hip fracture is a debilitating condition in older adults, particularly women (Veronese & Maggi, 2018). As the U.S. population ages, the annual number of hip fractures is expected to increase. The costs of treatment are high, due to long periods of hospitalization and subsequent rehabilitation. Contributing factors for falls and resultant hip fracture include weak quadriceps muscles, slowed reflexes, osteoporosis, poor vision, diminished balance, general frailty due to age, and conditions that produce decreased cerebral arterial perfusion and cognitive impairment (e.g., transient ischemic attacks, anemia, thromboemboli, cardiovascular disease). In addition to these factors, many medications may cause orthostasis and instability in the older adult. In recognition of this, the American Geriatrics Society periodically publicizes an updated list of *Potentially Inappropriate Medications* (PIM) for Older Adults, and a tool to evaluate medication use for problems in older adults, called the *Beers Criteria.* Medications that can cause orthostasis and instability in older adults, particularly if they take multiple medications (i.e., polypharmacy) include antihypertensive agents, diuretics, beta-blockers, sedatives and hypnotics, neuroleptics and antipsychotics, antidepressants, benzodiazepines, opioid analgesics, and NSAIDs (Fick, Semla, Steinman, et al., 2019; Ming & Zecevic, 2018).

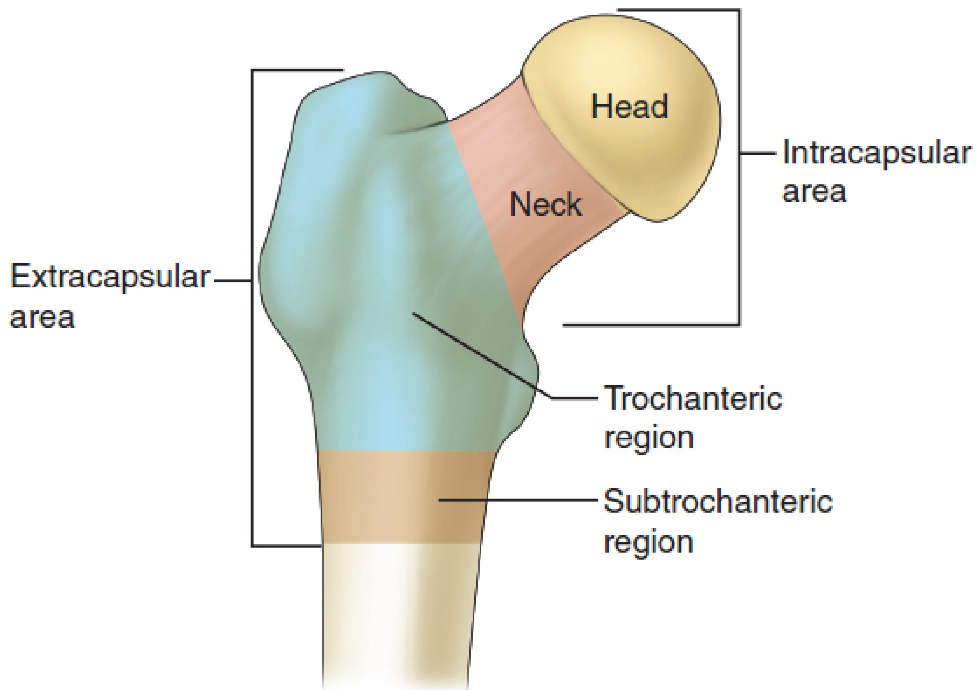

Figure 37-20 • Regions of the proximal femur.

Hip fractures are classified by anatomic location and fracture type. *Extracapsular fractures* (extending from the base of the femoral neck to the area just distal to the lesser trochanter) are fractures of the trochanteric, intertrochanteric, and subtrochanteric region. *Intracapsular fractures* are fractures of the femoral head and neck. Intrascapular fractures have a higher rate of nonunion or malunion and femoral neck fractures may damage the vascular system that supplies blood to the head and the neck of the femur, and the bone may become ischemic (Foster, 2020). For this reason, AVN is common in patients with femoral neck fractures (see Fig. 37-20). *Periprosthetic fractures* are fractures to the regions surrounding prosthetics joints which are increasing due to the growing number patients having previously had total joint replacements (Capone, Congia, Civinini, et al., 2017).

Clinical Manifestations

The patient with a hip fracture will have pain over the outer thigh or in the groin and limited ROM. There will be significant discomfort with any attempt to flex or rotate the hip (Bhatti & Ertl, 2019). With fractures of the femoral neck, the leg may be shortened, adducted, and externally rotated. With most fractures of the femoral neck, the patient cannot move the leg without a significant increase in pain. The patient is most comfortable with the leg slightly flexed in external rotation. Impacted intracapsular femoral neck fractures cause moderate discomfort (even with movement), may allow the patient to bear weight, and may not demonstrate obvious shortening or rotational changes. With extracapsular femoral fractures of the trochanteric or subtrochanteric region, the extremity is significantly shortened, externally rotated to a greater degree than intracapsular fractures, exhibits muscle spasm that resists positioning of the extremity in a neutral position, and has an associated area of ecchymosis. The diagnosis is confirmed by x-ray (Morrison & Siu, 2019).

Gerontologic Considerations

Populations at higher risk of hip fracture include older adults (particularly women) who have decreased bone density and muscle mass and those with chronic conditions (e.g., endocrine and intestinal disorders) that lead to weakened bones or who have cognitive impairment which increases the risk of falling (United Health Foundation, 2019). Stress and immobility related to the trauma predispose the older adult to atelectasis, pneumonia, sepsis, VTE, pressure injuries, and reduced ability to cope with other health problems. Many older adults hospitalized with hip fractures are vulnerable for delirium as a result of stress of the trauma, pain, unfamiliar surroundings, sleep deprivation, and medications. In addition, delirium that develops in some older adult patients may be caused by mild cerebral ischemia or mild hypoxemia. Other factors associated with delirium include frailty, malnutrition, dehydration, infectious processes, mood disturbances, and blood loss. In older patients with hip fractures who have dementia, the same factors that may cause delirium may exacerbate their dementia, further complicating recovery and increasing the risk for adverse outcomes (Mosk, Mus, Vroemen, et al., 2017).

To prevent complications, the nurse must assess the older patient for chronic conditions that require close monitoring. Examination of the legs may reveal edema due to heart failure or absence of peripheral pulses from peripheral vascular disease. Similarly, chronic respiratory problems may be present and may contribute to the possible development of atelectasis or pneumonia. Coughing and deep-breathing exercises are encouraged. Frequently, older adults take cardiac, antihypertensive, or respiratory medications that need to be continued. The patient’s responses to these medications should be monitored.

Dehydration and poor nutrition may be present. At times, older adults who live alone cannot call for help at the time of injury. A day or two may pass before assistance is provided, and as a result, dehydration and debilitation occur. Nutritional status may have been poor prior to admission, so the nurse should monitor for complications of dehydration and malnutrition (e.g., pressure injuries, etc.). Screening for malnutrition and high-protein nutritional supplementation may be effective in improving outcomes in older adults with hip fractures and should be incorporated into the plan of care (Kramer, Blokhuis, Verdijk, et al., 2019).

Muscle weakness may have initially contributed to the fall and fracture. Bed rest and immobility cause an additional loss of muscle strength unless the nurse encourages the patient to move all joints except the involved hip and knee. Patients are encouraged to use their arms and the overhead trapeze to reposition themselves. This strengthens the arms and shoulders, which facilitates walking with assistive devices.

Medical Management

Surgery is indicated for most patients with hip fracture. Nonoperative management may be considered in some older patients with advanced comorbidities or cognitive impairment; certain types of fractures may be sufficiently stable to benefit from nonoperative treatment (Morrison & Sui, 2019). Buck's extension traction, a type of temporary skin traction, was traditionally applied because it was believed to reduce muscle spasm, to immobilize the extremity, and to relieve pain. However, skin traction is rarely used as a definitive therapy. It may be prescribed as a temporary measure until definitive therapy is achieved (Buckley & Page, 2018; Morrison & Siu, 2019). The goal of surgical treatment for hip fractures is to obtain a satisfactory fixation so that the patient can be mobilized quickly and avoid secondary medical complications. Surgical treatment consists of open or closed reduction of the fracture and internal fixation, hemiarthroplasty (replacement of the femoral head with a prosthesis), or closed reduction with percutaneous stabilization for an intracapsular fracture. Surgical intervention is carried out as soon as possible after injury. The preoperative objective is to ensure that the patient is in as favorable a condition as possible for the surgery. Displaced femoral neck fractures are treated as emergencies, with reduction and internal fixation performed within 24 hours after fracture. The femoral head is often replaced with an orthopedic implant if there is complete disruption of blood flow to the femoral head, which may cause AVN (Lu & Uppal, 2019).

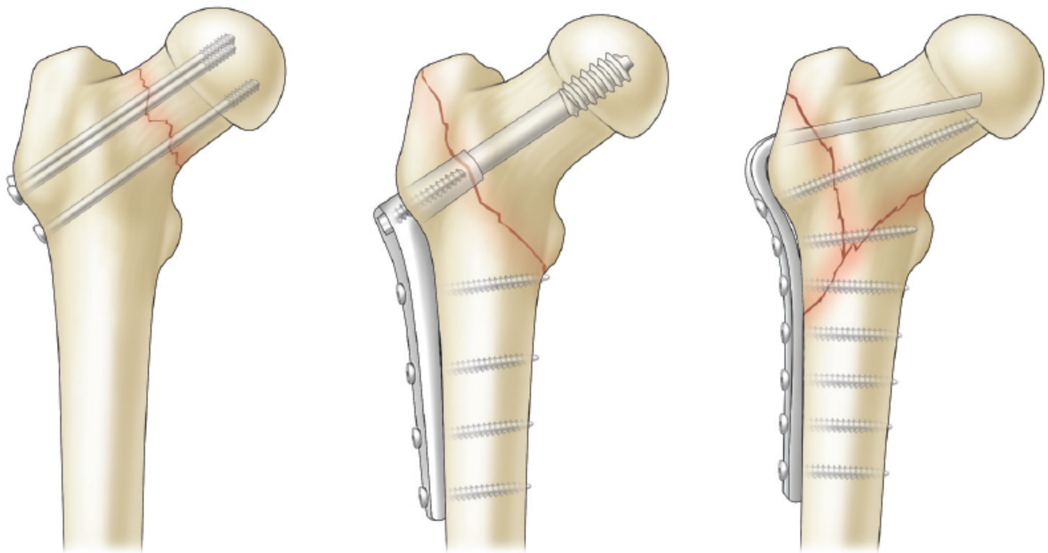

Figure 37-21 • Examples of internal fixation for hip fractures. Internal fixation is achieved through the use of screws and plates specifically designed for stability and fixation.

After general or spinal anesthesia, the hip fracture is reduced under fluoroscopic visualization. A stable fracture is usually fixed with nails, a nail and plate combination, multiple pins, or compression screw devices (see Fig. 37-21). The orthopedic surgeon determines the specific fixation device based on the fracture site or sites. Adequate reduction is important for fracture healing—the better the reduction, the better the healing.

Total hip arthroplasty (i.e., replacement of both the femoral head and acetabulum) or hemiarthroplasty (i.e., replacement of only the femoral head) (see Chapter 36) may be used in select patients with intracapsular fractures (Lu & Uppal, 2019).

Nursing Management

The immediate postoperative care for a patient with a hip fracture is similar to that for other patients undergoing major surgery (see Chapter 16). Attention is given to pain management, prevention of secondary medical problems, and early mobilization of the patient so that independent functioning can be restored.

During the first 24 to 48 hours, relief of pain and prevention of complications are important, and continuous neurovascular assessment is essential. The nurse encourages deep breathing and dorsiflexion and plantar flexion exercises every 1 to 2 hours. Thigh-high anti-embolism stockings or pneumatic compression devices are used, and anticoagulants are given as prescribed to prevent the formation of VTE. The nurse administers prescribed analgesic medications and monitors the patient's hydration, nutritional status, and urine output.

Repositioning the Patient

The most comfortable and safest way to turn the patient is to turn to the uninjured side. The standard method involves placing a pillow between the patient's legs to keep the affected leg in an abducted position. Proper alignment and supported abduction are maintained while turning (Hohler, 2018).

Promoting Exercise

The patient is encouraged to exercise as much as possible by means of the overbed trapeze. This device helps strengthen the arms and shoulders in preparation for protected ambulation (e.g., toe touch, partial weight bearing). On the first postoperative day, the patient transfers to a chair with assistance and begins assisted ambulation. The amount of weight bearing that can be permitted depends on the stability of the fracture reduction. The primary provider prescribes the degree of weight bearing. In general, hip flexion and internal rotation restrictions apply only if the patient has had a hemiarthroplasty or total arthroplasty (Kellam, 2020) (see Chapter 36). Physical therapists work with the patient on transfers, ambulation, and the safe use of assistive devices.

The patient can anticipate discharge to home or to an extended-care facility with the use of assistive devices (see Chapter 2). Some modifications in the home may be needed, such as installation of elevated toilet seats and grab bars.

Monitoring and Managing Potential Complications

Neurovascular complications may occur from direct injury or edema in the area that causes compression of nerves and blood vessels. With hip fracture, bleeding into the tissues and edema are expected. Monitoring and documenting the neurovascular status of the affected leg are vital.

To prevent VTE, the nurse encourages intake of fluids and ankle and foot exercises. Anti-embolism stockings, pneumatic compression devices, and prophylactic anticoagulant therapy are indicated and should be prescribed (Forsh, 2019). During hospitalization, the patient or the patient's caregiver should be educated regarding the signs, symptoms, and risks of VTE, and how to administer anticoagulant prophylaxis as prescribed. Intermittent assessment of the patient's legs for signs of DVT, which may include unilateral calf tenderness, warmth, redness, and swelling, is indicated.

Pulmonary complications (e.g., atelectasis, pneumonia) are a threat to older patients undergoing hip surgery. Coughing and deep-breathing exercises, intermittent changes of position, and the use of an incentive spirometer may help prevent respiratory complications. Pain must be treated with analgesic agents, typically opioids; otherwise, the patient may not be able to cough, deep breathe, or engage in prescribed activities. The nurse assesses breath sounds to detect adventitious or diminished sounds.

Skin breakdown is often seen in older patients with hip fracture. Blisters caused by tape are related to the tension of soft tissue edema under a nonelastic tape. An elastic hip wrap dressing or elastic tape applied in a vertical fashion may reduce the incidence of tape blisters. In addition, patients with hip fractures tend to remain in one position and may develop pressure injuries. Proper skin care, especially on the bony prominences, helps to relieve pressure. High-density foam mattress overlays may provide protection by distributing pressure evenly.

Loss of bladder control (incontinence or retention) may occur. If an indwelling catheter is inserted at the time of surgery, it usually is removed within 24 hours of surgery to avoid a hospital-acquired urinary tract infection (Morrison & Siu, 2020). If the patient does not void within 6 hours of catheter removal and/or is expressing symptoms of urinary retention (e.g., abdominal fullness, discomfort), a bladder scan should be performed to determine the volume of urine; intermittent catheterization may be indicated.

Delayed complications of hip fractures include infection, nonunion, and AVN of the femoral head (particularly with femoral neck fractures) (Bhatti & Ertl, 2019). Infection is suspected if the patient complains of constant pain in the hip and has an elevated erythrocyte sedimentation rate.

The nursing management of the older adult patient with a hip fracture is summarized in the Plan of Nursing Care (see Chart 37-8).

Promoting Home, Community-Based, and Transitional Care

Educating the Patient About Self-Care

Most patients are discharged from the hospital to an inpatient rehabilitation facility. The patient and family members or caregivers are assessed for their readiness to commence activities that promote healing and mobility. The nurse collaborates with other members of the multidisciplinary physiotherapy team (e.g., physical therapist, occupational therapist) to gather baseline data on the patient's anticipated long-term care environment post discharge, whether that is home or a long-term care facility, such as a skilled nursing facility. The patient begins a rehabilitation routine geared to meet the needs of this environment. For instance, if the patient is to be discharged home, and there are stairs in the home, then a goal of rehabilitation is that the patient will be able to get up and down stairs before discharge.

The patient engages in regular exercises to improve muscle tone and balance. The safe use of ambulatory aids, any specific activity restrictions (e.g., hip precautions if total hip arthroplasty was performed), and fall prevention measures (e.g., appropriate footwear, proper lighting, removal of throw rugs, getting rid of clutter) are also vitally important education topics that must be adequately addressed prior to discharge (Walker & Revell, 2019). The patient and caregiver are educated on the indications for any newly prescribed medications, wound care, and the importance of proper nutrition. Identification of any potential complications (e.g., reddened wound, fever) and when and how to contact the patient's primary provider are also important to understand.

Continuing and Transitional Care

Referral for home, community-based, or transitional care is important to enable assessment of the patient's home environment and the adequacy of resources and support of caregivers. Home-based intensive physical therapy improves strength and gait for older adults with hip fractures; accommodations to the home may need to be made to ensure the patient's continuing care, safety, and mobility (Hohler, 2018). During follow-up home health or outpatient clinic visits, the nurse reevaluates the patient's healing process and the continued adequacy of resources and support of caregivers. Based upon these findings, modifications may need to be made. For instance, an older adult spouse may require assistance or respite care. Home health agencies, local area agencies on aging (for older adult patients), and faith community nursing organizations, may be tapped into to provide assistance within the home or with transporting the patient to follow-up outpatient appointments.

Osteoporosis screening of patients who have experienced hip fracture is important for prevention of future fractures. With dual-energy x-ray absorptiometry (DEXA) scan testing, the risk of additional fracture can be predicted. Specific patient education regarding dietary requirements, lifestyle changes, and weight-bearing exercise to promote bone health is needed. Adequate dietary or supplemental vitamin D and calcium supplements are also recommended (Conley, Adib, Adler, et al., 2020). Specific therapeutic interventions need to be initiated to slow bone loss and to build bone mineral density (see Chapter 36).

Femoral Shaft

The femur is the longest and strongest tubular bone in the body; it requires considerable force to break the shaft of a femur in adults. Most femoral fractures occur in young adults who have been involved in motor vehicle crashes or who have fallen from heights. Due to high-energy force, these patients frequently have associated multiple traumatic injuries (Asplund & Mezzanotte, 2019).

The patient presents with an edematous, deformed, painful thigh and cannot move the hip or the knee. The fracture may be transverse, oblique, spiral, or comminuted. Frequently, the patient develops shock, because the loss of 1 to 2.5 L of blood into the tissues is common with these fractures (Makhni, Makhni, Swartz, et al., 2017). Types of femoral fractures are illustrated in Figure 37-22.

Chart 37-8 PLAN OF NURSING CARE

Care of the Older Adult Patient with a Fractured Hip

NURSING DIAGNOSIS: Acute pain associated with fracture, soft tissue damage, muscle spasm, and surgery
GOAL: Relief of pain

Nursing Interventions	Rationale	Expected Outcomes
1. Assess type and location of patient's pain whenever vital signs are obtained and as needed.	1. Pain is expected after fracture; soft tissue damage and muscle spasm contribute to discomfort; pain is subjective and is best evaluated on a pain scale of 0–10 and through description of characteristics and location, which are important for identifying cause of discomfort and for proposing interventions. Continuing pain may indicate development of neurovascular problems. Pain must be assessed periodically to gauge effectiveness of continuing analgesic therapy.	• Patient describes and rates pain on scale of 0–10. • Expresses confidence in efforts to control pain. • Expresses comfort with position changes. • Expresses comfort when leg is positioned and immobilized. • Minimizes movement of extremity before reduction and fixation. • Uses physical, psychological, and pharmacologic measures to reduce discomfort. • Describes acceptable pain level that does not interfere with ability to participate in rehabilitation
2. Acknowledge existence of pain; inform patient of available analgesic agents and advocate for preemptive analgesia (e.g., prior to physical therapy); record patient's baseline discomfort.	2. Reduces stress experienced by the patient by communicating concern and availability of help in dealing with pain. Documentation provides baseline data.	
3. Handle the affected extremity gently, supporting it with hands or pillow.	3. Movement of bone fragments is painful; muscle spasms occur with movement; adequate support diminishes soft tissue tension.	
4. Apply Buck's traction if prescribed; advocate for its removal if pain worsens or is not improved; use trochanter roll.		

5. Use pain-modifying strategies. a. Modify the environment. b. Administer prescribed analgesic agents preemptively and as needed. c. Encourage patient to use pain-relief measures to relieve pain. d. Evaluate patient's response to medications and other pain reduction techniques. e. Consult with primary provider if relief of pain is not obtained.	4. Routine use of Buck's traction has not been proven to be effective. 5. Pain perception can be diminished by distraction and refocusing of attention. a. Interaction with others, distraction, and environmental stimuli may modify pain experiences. b. Analgesics reduce the pain; muscle relaxants may be prescribed to decrease discomfort associated with muscle spasm. c. Mild pain is easier to control than severe pain. d. Assessment of effectiveness of measures provides basis for future management interventions; early identification of adverse reactions is necessary for corrective measures and care plan modifications. e. Change in treatment plan may be necessary.	activities within 24–48 hours after surgery. • Requests pain medications and uses pain-relief measures early in pain cycle. • Appears comfortable and relaxed. • Moves with increasing comfort as healing progresses.
6. Position for comfort and function.	6. Alignment of body facilitates comfort; positioning for function diminishes stress on musculoskeletal system.	
7. Assist with frequent changes in position.	7. Change of position relieves pressure and	

	associated discomfort.	

NURSING DIAGNOSIS: Impaired mobility associated with fractured hip
GOAL: Achieves pain-free, functional, stable hip

Nursing Interventions	Rationale	Expected Outcomes
1. Maintain neutral positioning of hip. 2. Use trochanter roll; roll to uninjured side. 3. Place pillow between legs when turning. 4. Instruct and assist in position changes and transfers. 5. Instruct in and supervise isometric and quadriceps and gluteal setting exercises. 6. Encourage the use of trapeze.	1. Prevents stress at the site of fixation. 2. Minimizes external rotation. 3. Supports leg; prevents adduction. 4. Encourages patient's active participation while preventing stress on hip fixation. 5. Strengthens muscles needed for walking. 6. Strengthens shoulder and arm muscles necessary for use of ambulatory aids.	• Patient engages in therapeutic positioning. • Uses pillow between legs when turning. • Assists in position changes; shows increased independence in transfers. • Exercises every 2 hours while awake.
7. In consultation with physical therapist, instruct in and supervise progressive safe ambulation within limitations of weight-bearing prescription. 8. Offer encouragement and support	7. Amount of weight bearing depends on the patient's condition, fracture stability, and fixation device; ambulatory aids are used to assist the patient with non–weight-bearing and partial–weight-bearing ambulation. 8. Reconditioning exercises can be uncomfortable and	• Uses trapeze. • Participates in progressive ambulation program. • Actively participates in exercise regimen. • Uses ambulatory aids correctly and safely.

exercise regimen. 9. Instruct in and supervise safe use of ambulatory aids.	fatiguing; encouragement helps patient adhere to the program. 9. Prevents injury from unsafe use.	

NURSING DIAGNOSIS: Risk for infection associated with surgical incision
GOAL: Maintains asepsis

Nursing Interventions	Rationale	Expected Outcomes
1. Monitor vital signs. 2. Perform aseptic dressing changes. 3. Assess wound appearance and character of drainage. 4. Assess report of pain. 5. Administer preoperative antibiotic as prescribed and postoperative antibiotics if prescribed, and observe for side effects.	1. Temperature, pulse, and respiration increase in response to infection. (Magnitude of response may be minimal in older adult patients.) 2. Avoids introducing infectious organisms. 3. Red, swollen, draining incision is indicative of infection. 4. Pain may be due to wound hematoma, a possible locus of infection, which needs to be surgically evacuated. 5. Administration of 1–3 doses of perioperative antibiotics improves outcomes and reduces the risk of wound infection.	• Patient maintains vital signs within normal range. • Exhibits well-approximated incision without drainage or excessive inflammatory response. • Relates minimal discomfort; demonstrates no hematoma. • Tolerates antibiotics if prescribed; exhibits no evidence of osteomyelitis.

NURSING DIAGNOSIS: Impaired urination associated with immobility
GOAL: Maintains normal urinary elimination patterns

Nursing Interventions	Rationale	Expected Outcomes
1. Monitor intake and output. 2. Avoid or minimize use of indwelling catheter.	1. Adequate fluid intake ensures hydration; adequate urinary output minimizes urinary stasis.	• Intake and output are adequate; patient exhibits normal voiding patterns.

3. Use bladder scanner if available to confirm urinary stasis or postvoid residual (see Chapter 47, Fig. 47-8); perform intermittent catheterization for urinary retention as prescribed.	2. Source of bladder infection. 3. Empties bladder; reduces urinary tract infections	• Demonstrates no evidence of urinary tract infection.

NURSING DIAGNOSIS: Stress overload associated with injury, anticipated surgery, and dependence
GOAL: Uses effective coping mechanisms to modify stress

Nursing Interventions	Rationale	Expected Outcomes
1. Encourage patient to express concerns and to discuss the possible impact of fractured hip. 2. Support the use of coping mechanisms. Involve significant others and support services as needed. 3. Contact social services, if needed. 4. Explain anticipated treatment regimen and routines to facilitate positive attitude in relation to rehabilitation. 5. Encourage patient to	1. Verbalization helps patient deal with problems and feelings. Clarification of thoughts and feelings promotes problem solving. 2. Coping mechanisms modify disabling effects of stress; sharing concerns lessens the burden and facilitates necessary modification. 3. Anxiety may be related to financial or social problems; facilitates management of problems associated with continuing care. 4. Understanding of plan of care helps to diminish fears of the unknown.	• Patient describes feelings concerning fractured hip and implications for lifestyle. • Uses available resources and coping mechanisms; develops health promotion strategies. • Uses community resources as needed. • Participates in development of health care plan.

participate in planning.	5. Participating in care provides for some control of self and environment.	

NURSING DIAGNOSIS: Risk for acute confusion associated with age, stress of trauma, unfamiliar surroundings, and medication therapy
GOAL: Remains oriented and participates in decision making

Nursing Interventions	Rationale	Expected Outcomes
1. Assess orientation status. 2. Interview family regarding patient's orientation and cognitive abilities before injury. 3. Assess patient for auditory and visual deficits. a. Assist patient with the use of sensory aids (e.g., glasses, hearing aid) b. Control environmental distractors. 4. Orient to and stabilize environment. a. Use orientation activities and aids (e.g., clock, calendar, pictures, introduction of self).	1. Evaluate presenting orientation of patient; confusion may result from stress of fracture, unfamiliar surroundings, coexisting systemic disease, cerebral ischemia, hypoxemia, or other factors. Baseline data are important for determining change. 2. Provides data for evaluation of current findings. 3. Diminished vision and auditory acuity frequently occur with aging; glasses and hearing aid may increase patient's ability to interact with environment. a. Aids must be in good working order and available for use. b. Facilitates communication 4. a. Short-term memory may be faulty in the older	• Patient establishes effective communication. • Demonstrates orientation to time, place, and person. • Participates in self-care activities. • Remains mentally alert. • Does not exhibit episodes of confusion.

b. Minimize number of staff working with patient.

5. Give simple explanations of procedures and plan of care.
6. Encourage participation in hygiene and nutritional activities.
7. Provide for safety.
   a. Keep light on at night.
   b. Have call bell available.
   c. Provide prompt response to requests for assistance.
8. Assess mental responses to medications, especially sedative and analgesic agents.

adult; frequent reorientation helps.

b. Consistency of caregivers promotes trust.

5. Promotes understanding and active participation.
6. Participation in routine activities promotes orientation and increases awareness of self.
7. Mechanism for securing assistance is available to patient; independent activities based on faulty judgment may result in injury.
8. Older adults tend to be more sensitive to medications; abnormal responses (e.g., hallucinations, depression) may occur.

Collaborative Problems: Hemorrhage; pulmonary complications; peripheral neurovascular dysfunction; venous thromboemboli; pressure injuries associated with surgery and immobility
GOAL: Absence of complications

Nursing Interventions	Rationale	Expected Outcomes
Hemorrhage		
1. Monitor vital signs, observing for shock. 2. Consider preinjury blood pressure values and management of coexisting hypertension, if present. 3. Note character and amount of drainage. 4. Notify primary provider if patient develops shock or excessive bleeding. 5. Note hemoglobin and hematocrit values, and report decreases in values.	1. Changes in pulse, blood pressure, and respirations may indicate development of shock; blood loss and stress may contribute to development of shock. 2. Necessary for interpretation of current blood pressure determinations. 3. Excessive drainage and bright red drainage may indicate active bleeding. 4. Corrective measures need to be instituted. 5. Anemia due to blood loss may develop; bleeding into tissues after hip fracture may be extensive; blood replacement may be needed.	• Vital signs are stabilized within normal limits. • Experiences no excessive or bright red drainage. • Exhibits stable postoperative hemoglobin and hematocrit values.
Pulmonary Complications		

1. Assess respiratory status: respiratory rate, depth, and duration; breath sounds; sputum. Monitor temperature.	1. Anesthesia and bed rest diminish respiratory effort and cause pooling of respiratory secretions. Adventitious breath sounds, pain on respiration, shortness of breath, blood-tinged sputum, cough may indicate pulmonary dysfunction.	• Vital signs are stabilized within normal limits. • Patient has clear breath sounds. • Breath sounds are present in all fields. • Exhibits no shortness of breath, chest pain, or elevated temperature. • Arterial oxygen saturation (SaO_2) on room air is within normal limits. • Performs respiratory exercises; uses incentive spirometer as instructed. • Changes position frequently. • Consumes adequate fluids.
2. Report adventitious and diminished breath sounds and elevated temperature.	2. Elevated temperature in the early postoperative period may be due to atelectasis or pneumonia.	
3. Supervise deep-breathing and coughing exercises. Encourage the use of incentive spirometer if prescribed.	3. Deep-breathing and coughing exercises promote optimal ventilation. Coexisting respiratory conditions diminish lung expansion.	
4. Administer oxygen as prescribed.	4. Reduced ventilatory efforts may diminish SaO_2 when patient is breathing room air.	
5. Turn and reposition patient at least every 2 hours. Mobilize patient (assist patient out of bed) as soon as possible.	5. Promotes optimal ventilation; diminishes pooling of respiratory secretions.	
6. Ensure adequate hydration.	6. Liquefies respiratory secretions; facilitates expectoration.	

Peripheral Neurovascular Dysfunction

1. Assess affected extremity for color and temperature.
2. Assess toes for capillary refill response.
3. Assess affected extremity for edema and swelling.
4. Elevate affected extremity.
5. Assess for deep, throbbing, unrelenting pain.
6. Assess for pain on passive flexion of foot.
7. Assess for sensations and numbness.
8. Assess ability to move foot and toes.
9. Assess pedal pulses in both feet.
10. Notify primary provider of changes in

1. The skin becomes pale and feels cool with decreased tissue perfusion. Venous congestion may cause cyanosis.
2. After compression of the nail, rapid return of pink color indicates good capillary perfusion.
3. The trauma of surgery will cause swelling; excessive swelling and hematoma formation can compromise circulation and function; edema may be due to coexisting cardiovascular disease.
4. Minimizes dependent edema.
5. Surgical pain can be controlled; pain due to neurovascular compromise is refractory to treatment with analgesic medications.
6. With nerve ischemia, there will be pain on passive stretch.
7. Diminished pain and paresthesia may indicate nerve damage. Sensation in web between great and second toe—peroneal nerve; sensation on sole of foot—tibial nerve.
8. Dorsiflexion of ankle and extension of toes indicate function of peroneal nerve. Plantar flexion of ankle and flexion of toes indicate functioning of tibial nerve.

- Patient has normal color and the extremity is warm.
- Demonstrates normal capillary refill response.
- Exhibits moderate swelling; tissue not palpably tense.
- States pain is tolerable.
- Reports no pain with passive dorsiflexion.
- Reports normal sensations and no paresthesia.
- Demonstrates normal motor abilities and no paresis or paralysis.
- Has strong and equal pulses bilaterally.

neurovascular status.	9. Indicates circulatory status of extremities. 10. Function of extremity needs to be preserved.	
Venous Thromboemboli		
1. Apply thigh-high anti-embolism stockings and/or sequential compression device as prescribed.	1. Compression aids venous blood return and prevents stasis.	• Wears thigh-high anti-embolism stockings. • Uses sequential compression device.
2. Remove stockings and/or sequential compression device for 20 minutes twice a day, and provide skin care.	2. Skin care is necessary to avoid skin breakdown. Extended removal of stocking or device defeats purpose.	
3. Assess popliteal, dorsalis pedis, and posterior tibial pulses.	3. Pulses indicate arterial perfusion of extremity. With coexisting arteriosclerotic vascular disease, pulses may be diminished or absent.	• Experiences no more warmth than usual in skin areas.
4. Assess skin temperature of legs.	4. Local inflammation increases local skin temperature.	• Exhibits no increase in calf circumference.
5. Assess calf intermittently for tenderness, warmth, redness, and swelling.	5. Unilateral calf tenderness, warmth, redness, and swelling may indicate deep vein thrombosis.	• Demonstrates no evidence of calf tenderness, warmth, redness, or swelling. • Changes position with assistance and supervision.
6. Measure calf circumference daily.	6. Increased calf circumference indicates	• Participates in exercise regimen.

7. Avoid pressure on popliteal blood vessels from appliances or pillows. 8. Change patient's position and increase activity as prescribed. 9. Supervise ankle exercises hourly while patient is awake. 10. Ensure adequate hydration. 11. Monitor body temperature.	edema or altered perfusion. 7. Compression of blood vessels diminishes blood flow. 8. Activity promotes circulation and diminishes venous stasis. 9. Muscle exercise promotes circulation. 10. Older adults may become dehydrated because of low fluid intake, resulting in hemoconcentration. 11. Body temperature increases with inflammation (magnitude of response minimal in older adults).	• Experiences no chest pain; has lungs clear to auscultation; presents no evidence of pulmonary emboli. • Exhibits no signs of dehydration; has normal hematocrit. • Maintains normal body temperature.
Pressure Injuries		
1. Monitor condition of skin at pressure points (e.g., heels, sacrum, shoulders); inspect heels at least twice a day. 2. Reposition patient at least every 2 hours. Avoid skin shearing. 3. Administer skin care,	1. Older adults are more prone to skin breakdown at points of pressure because of diminished subcutaneous tissue. 2. Avoids prolonged pressure and trauma to the skin. 3. Immobility causes pressure at bony prominences; position changes relieve pressure. 4. Devices minimize pressure on skin at bony prominences. 5. Early interventions prevent tissue destruction	• Patient exhibits no signs of skin breakdown. • Skin remains intact. • Repositions self frequently. • Uses protective devices.

especially to pressure points. 4. Use pressure redistribution mattress and other protective devices (e.g., heel protectors); support heel off the mattress. 5. Institute care according to protocol at first indication of potential skin breakdown.	and prolonged rehabilitation.

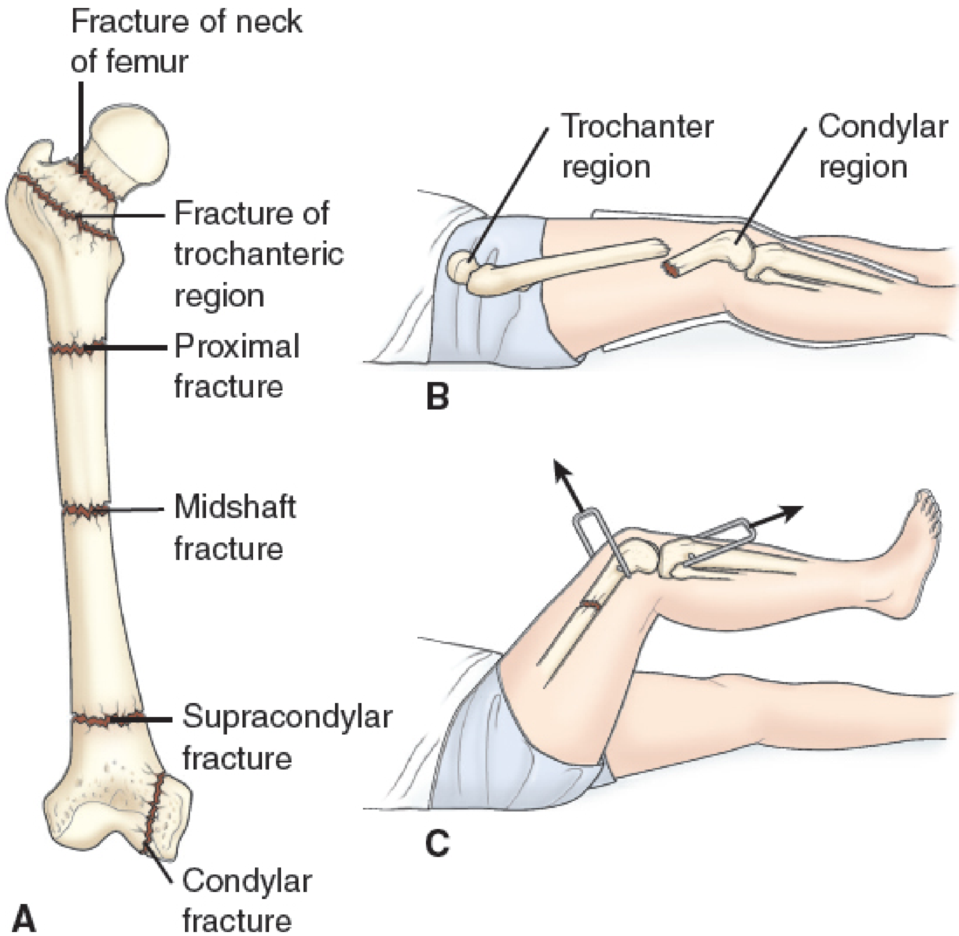

Figure 37-22 • **A.** Types of femoral fractures. **B.** Example of deformity on admission to hospital. **C.** Adequate reduction is achieved when additional wire is inserted in the lower femoral fragment and vertical lift is secured.

Assessment and Diagnostic Findings

Assessment includes checking the neurovascular status of the extremity, especially circulatory perfusion of the lower leg and foot (popliteal, posterior tibial, and pedal pulses and toe capillary refill time), and comparing with the unaffected leg. A Doppler ultrasound may be indicated to assess blood flow. X-rays are used to confirm the diagnosis and determine the extent of injury (Asplund & Mezzanotte, 2019). Dislocation of the hip and knee may accompany these fractures. Knee effusion suggests ligament damage and possible instability of the knee joint.

Management

Continued neurovascular monitoring and documentation are important. The fracture is immobilized so that additional soft tissue damage does not occur. Generally, skeletal traction (see Fig. 37-22B,C) or splinting is used to reduce the fracture to anatomic alignment which helps reduce pain and prevent hematoma formation (Keany & McKeever, 2019). IV opioid analgesic agents (e.g., morphine) are typically given to treat pain (Asplund & Mezzanotte, 2019).

Early fracture stabilization decreases morbidity and mortality; therefore, internal fixation usually is carried out as soon as the patient is physiologically stable. Intramedullary locking nail devices are typically used. Internal fixation permits early mobilization, which is associated with improved outcomes and recovery (Keany & McKeever, 2019).

Open femoral fractures require immediate and extensive irrigation and débridement in the operating suite (see previous discussion of treatment for open fractures). Tetanus toxoid (unless given within 5 years) and antibiotics with staphylococcal coverage and good tissue penetration are often administered. Depending on needs for continued débridement, intramedullary nailing may be delayed (Keany & McKeever, 2019).

Postoperatively, to preserve muscle strength, the patient is instructed to exercise the hip and the lower leg, foot, and toes on a regular basis. Active muscle movement enhances healing by increasing blood supply and electrical potentials at the fracture site. Prescribed weight-bearing limits are based on the type and location of the fracture and treatment approach. Physical therapy includes ROM and strengthening exercises, safe use of assistive devices, and gait training (Makhni et al., 2017).

A common complication after fracture of the femoral shaft is restriction of knee motion. Active and passive knee exercises begin as soon as possible, depending on the stability of the fracture and knee ligaments. Other complications in the immediate postoperative period can include hemorrhage, acute compartment syndrome, and neurovascular compromise. Long-term complications may include malrotation, malunion, delayed union, and nonunion (Keany & McKeever, 2019).

Tibia and Fibula

Fractures of the tibia and fibula often occur in association with each other and tend to result from a direct blow, falls with the foot in a flexed position, or a violent twisting motion. Most of these fractures tend to be more distal than proximal; distal fractures may extend into the ankle joint (e.g., distal fractures of the tibia that extend into the joint are collectively referred to as pilon fractures). The patient may present with severe pain, deformity or instability of the leg, obvious hematoma, swelling, and the inability to walk or bear weight on the leg (Norvell & Steele, 2017).

Assessment and Diagnostic Findings

The peroneal nerve is assessed; if damaged, the patient cannot dorsiflex the great toe and has diminished sensation in the first web space. The tibial artery is assessed for damage by evaluating pulses, skin temperature, and color and by testing the capillary refill response. The affected leg and ankle are compared with the unaffected leg and ankle. X-rays are indicated to determine the location, type, and extent of the fracture (Fields, 2020).

Management

Most closed, nondisplaced fractures that do not involve the ankle joint (e.g., extra-articular fractures) are treated with closed reduction and immobilization in a non–weight-bearing short leg cast or brace. The leg is elevated to control edema. Weight-bearing status varies and depends on the type of fracture. Activity decreases edema and increases circulation. Fracture healing, based upon clinical assessment and x-ray findings, takes about 10 to 14 weeks; it takes about 6 to 9 months until full function is restored (Eiff, Hatch, & Higgins, 2020e).

Displaced, open, or articular fractures may be treated with skeletal traction, internal fixation with intramedullary nails or plates and screws, or external fixation. External support may be used with internal fixation. Hip, foot, and knee exercises are encouraged within the limits of the immobilizing device. Partial weight bearing is begun when prescribed and is progressed as the fracture heals, which is dependent on the extent of injury (Eiff et al., 2020e).

As with any fracture, continued neurovascular evaluation is important. The development of acute compartment syndrome requires prompt recognition and communication to the primary provider. Other complications to monitor for include fat emboli, nonunion, delayed union, infection, impaired wound edge healing, long-term calf atrophy, sport limitation, and osteoarthritis (Fields, 2020).

Rib

Rib fractures are some of the most common thoracic injuries; they occur frequently in adults of all ages, typically from blunt trauma such as motor vehicle crashes or falls, and usually result in no impairment of function. They are typically diagnosed based on clinical presentation and confirmed with anteroposterior (AP) and lateral chest x-rays, CT scan (to rule out suspected thoracic or abdominal injury) or ultrasound (Eiff, Hatch, & Higgins, 2020f). Because these fractures cause pain with respiratory effort, the patient tends to decrease respiratory excursions and refrains from coughing. As a result, tracheobronchial secretions are not mobilized, aeration of the lung is diminished, and a predisposition to atelectasis and pneumonia results. The mainstay of treatment is pain control to decrease chest wall splinting and subsequent atelectasis. To help the patient cough and take deep breaths and use an incentive spirometer, the nurse may splint the chest with their hands, or may educate the patient on using a pillow to temporarily splint the affected site. Regularly scheduled analgesics such as acetaminophen in combination with an NSAID may be prescribed to provide analgesic relief. Topical anesthetic patches can provide local pain relief. Occasionally, an anesthesia care provider administers an intercostal nerve block, intrapleural infusion, or epidural infusion to relieve pain and to improve respiratory function (Eiff et al., 2020f).

Chest binders to immobilize the rib fracture are not used, because decreased chest expansion may result in atelectasis and pneumonia. Incentive spirometer use may aid in prevention of these complications.

The fracture heals within 6 weeks. The more ribs that are fractured, the greater the likelihood of complications. In addition to atelectasis and pneumonia, complications may include a flail chest, pneumothorax, and hemothorax (Melendez & Doty, 2017). The assessment and management of patients with these conditions are discussed in Chapter 19.

Gerontologic Considerations

Older adults sustaining rib fractures are at an increased risk for complications. Even in the presence of isolated rib trauma, hospital admission is recommended for the older adult with multiple rib fractures or for the older adult who cannot effectively cough and mobilize sputum (Melendez & Doty, 2017). Careful monitoring of respiratory status and encouraging the patient to mobilize early, and, for the patient on bed rest, encouraging turning, coughing, and deep breathing and use of an incentive spirometer, can prevent respiratory complications.

Thoracolumbar Spine

Fractures of the thoracolumbar spine may involve the vertebral body, the laminae and articulating processes, and the spinous processes or transverse processes. The T12 to L2 area of the spine, called the *thoracolumbar junction,* is the second most commonly injured region of the spinal column; 90% of all thoracolumbar spine injuries occur at this junction. Fractures generally result from indirect trauma caused by excessive loading, sudden muscle contraction, or excessive motion beyond physiologic limits. Osteoporosis contributes to vertebral body collapse (compression fracture) and accounts for 50% to 70% of all thoracolumbar fractures (Kaji & Hockberger, 2018).

Stable spinal fractures are caused by flexion, extension, lateral bending, or vertical loading. The anterior structural column (vertebral bodies and discs) or the posterior structural column (neural arch, articular processes, ligaments) is disrupted. Unstable fractures occur with fracture dislocations and involve disruption of both anterior and posterior structural columns.

The patient with a spinal fracture presents with acute tenderness, swelling, paravertebral muscle spasm, and change in the normal curves or in the gap between spinous processes. Pain is greater with moving, coughing, or weight bearing. Thoracolumbar fractures can also present with lower extremity paresis, lower extremity or saddle anesthesia (i.e., loss of sensation to the perineum), or loss of bladder or rectal continence (Kaji & Hockberger, 2018). Immobilization is essential until initial assessments have determined if there is any spinal cord injury and whether the fracture is stable or unstable. X-rays are initially indicated to confirm the fracture(s), and CT scans or MRI studies are then indicated to precisely determine the extent of injury and spinal cord involvement (Vinas, 2018). If spinal cord injury with neurologic deficit does occur, it usually requires immediate surgery (laminectomy with spinal fusion) to decompress the spinal cord.

Stable spinal fractures are treated conservatively with limited bed rest. Analgesic medications are prescribed for pain relief. A spinal brace or plastic thoraco-lumbar-sacral orthosis is applied for support during progressive ambulation and resumption of activities (Kaji & Hockberger, 2018).

The patient with an unstable fracture is treated with bed rest, possibly with the use of a special turning device or bed to maintain spinal alignment. Within 24 hours after fracture, open reduction, decompression, and fixation with spinal fusion and instrument stabilization are usually accomplished. Neurologic status is monitored closely during the preoperative and postoperative periods. Postoperatively, the patient may be cared for on the turning device or in a bed with a firm mattress. Progressive ambulation is begun a few days after surgery, with the patient using a molded lumbar or thoracolumbar orthosis for approximately 3 months. Patient education emphasizes good posture, good body mechanics, and, after healing is sufficient, back-strengthening exercises. X-rays with flexion and extension views are taken to monitor the healing process at 6 weeks, 3 months, 6 months postoperatively; a CT scan can provide a clearer evaluation (Vinas, 2018). See Chapter 63 for discussion of spinal cord injury.

Sports-Related Musculoskeletal Injuries

Sports-related injuries are common. Table 37-1 displays common musculoskeletal sports injuries, their mechanisms of injury, assessment findings, and acute care management.

Management

Patients who have experienced sports-related musculoskeletal injuries are often highly motivated to return to their previous level of activity.

Adherence to restriction of activities and gradual resumption of activities need to be reinforced. Injured athletes are at risk for reinjury and require follow-up and monitoring. With recurrence of symptoms, athletes need to diminish their level and intensity of activity to a comfortable level. The time required to recover from a sports-related injury can be as short as a few days or as long as 12 weeks, depending on the severity of the injury. The patient should be pain free with good ROM before returning to play (Norris, 2020).

Sports-related musculoskeletal injuries can often be prevented by using proper equipment and by effectively training and conditioning the body. Specific training needs to be tailored to the person and the sport. Stretching, maintaining hydration, and proper nutrition aid in injury prevention (Norris, 2020).

Occupation-Related Musculoskeletal Disorders

According to the U.S. Department of Labor, work-related musculoskeletal disorders (also called *ergonomic injuries*) are injuries or illnesses of the muscles, nerves, tendons, joints, cartilage, and spinal discs that occur because of exposure to work-related risks. In 2018, sprains, strains, or tears caused the highest incidence of days away from work among private industry workers in all occupations; soreness and pain accounted for the next highest incidence, with a smaller incidence related to fractures, cuts, lacerations, contusions, and bruises (U.S. Department of Labor, Bureau of Labor Statistics, 2019).

Occupation-Related Musculoskeletal Disorders in Nursing Personnel

Nurses working in all settings face workplace hazards performing their routines duties. The nursing profession is consistently ranked among the top 10 occupations that are most involved in occupation-related injuries and illnesses that result in lost days of work (Dressner & Kissinger, 2018). Nurses experience a higher-than-average incidence of musculoskeletal disorders that result from overexertion and strain due to heavy workloads and unsafe patient handling techniques. Organizations like the American Nurses Association (ANA) and the National Association of Orthopaedic Nurses (NAON) recognize the seriousness of work-related musculoskeletal disorders among nurses, and advocates for the implementation of evidence-based methods for safe patient handling and movement tasks whenever feasible (see Resources).

Amputation

Amputation is the removal of a body part by a surgical procedure or trauma. The majority of amputations are often consequences of vascular disease, especially from diabetes (see Chapters 26 and 46); trauma is the second most common indication. African Americans are at heightened risk of having amputations. Approximately 2 million individuals in the United States are living with some type of limb loss; by 2050, there will be an estimated 3.6 million (AAOS, 2019e).

TABLE 37-1 Common Musculoskeletal Sports Injuries

Anatomic Area	Mechanism of Injury	Assessment Findings	Sports Activity	Acute Management
Clavicle fracture	Fall on shoulder or outstretched arm Direct blow to the clavicle	Crepitus Holds arm closely to body Unable to raise affected arm above head Can feel movement of both ends of clavicle	Football Rugby Hockey Wrestling Gymnastics	Sling or shoulder immobilizer Ice NSAIDs
Dislocated shoulder	*Anterior:* Some combination of hyper-extension, external rotation, and abduction Anterior blow to shoulder *Posterior:* Fall on flexed and adducted arm Direct axial load to humerus	Pain Lack of motion May feel empty shoulder socket Uneven posture in comparison to other shoulder Affected arm appears longer Abduction limited	Rugby Hockey Wrestling Skiing	Closed reduction Immobilizer Pendulum exercises
Dislocated elbow	Falling on a hand with a flexed elbow Elbow overextended	Intense pain Edema Limited motion Deformity Ecchymosis	Football Gymnastics Squash Wrestling Cycling Skiing	Immobilization Ice ROM exercises
Wrist sprain or fracture	Falling on an outstretched arm	Pain Edema Ecchymosis Deformity Limited motion	Skating Hockey Wrestling Skiing Soccer Handball Horseback riding	Ice Elevation Immobilization Gentle ROM for 4–6 wks (for sprain only)
Knee sprain	Twisting injury that produces incomplete tear of ligaments and capsule around the joint	Pain Limited motion Edema Ecchymosis Tenderness over joint Joint appears stable	Basketball Football High jump	Ice Elevation Compression wrap Active ROM exercises Isometric exercises May immobilize
Knee strain	Sudden forced motion causing muscle to be stretched beyond normal capacity	Pain Limited motion Pain aggravated by activity	Soccer Swimming Skiing	Ice Elevation Rest Gradual return to activities
Meniscal tears of knee	Sharp, sudden pivot Direct blow to knee Forced internal rotation Wear from repetitive squatting or climbing Torsional weight-bearing force	Edema *Medial tear:* Pain occurs with hyperflexion, hyperextension, and turning in of knee with knee flexed. *Lateral tear:* Pain occurs with hyperflexion and hyper-extension and internal rotation of foot with knee flexed. *Displaced fragment:* Inability to extend knee; "locked" Positive McMurray sign[a]	Hockey Basketball Football	*Conservative:* RICE Exercising of quadriceps and hamstrings Resistive exercising NSAIDs Physical therapy *Surgical:* Arthroscopy
Ankle sprain	Foot is twisted, causing stretch-ing or tearing of ligaments.	Pain Edema Limited motion Ecchymosis	Tennis Basketball Football Skating	Immobilization in cast or brace Ice Elevation Rest
Ankle strain	Sudden forced motion, stretch-ing muscles beyond normal capacity	*Acute:* Severe pain *Chronic:* Achy pain	Running All ball sports	Immobilization in cast or brace Ice Elevation Rest
Ankle fracture	Inward turning on sole of foot and front of foot Supination with internal rotation Pronation with external rotation	Pain Edema Deformity Inability to bear weight	Contact sports Tennis Basketball	Ice Elevation Cast (4–6 wks) Surgery if fracture is displaced or unstable
Metatarsal stress fracture	Occurs with repeated loading of bone; often in an uncondi-tioned extremity	Forefoot pain that progressively worsens with activity Minimal or no forefoot swelling	Running Dance Skating	Rest Stop sports-related activity for 6 wks Ice Weight bearing as indicated

[a]McMurray sign—manipulation of tibia while knee flexed produces audible "click."
NSAIDs, nonsteroidal anti-inflammatory drugs; RICE, rest, ice, compression, elevation; ROM, range of motion.
Reprinted with permission from the National Association of Orthopedic Nurses (NAON). (2013). *Core curriculum for orthopaedic nursing* (7th ed.). Chicago, IL: NAON.

An amputation is performed to control pain or disease process, to improve function, and to save or improve the patient's quality of life. If the health care team communicates a positive attitude, the patient adjusts to the amputation more readily and actively participates in the rehabilitative plan, learning how to modify activities and how to use assistive devices for ADLs and mobility.

Level of Amputation

The level of amputation is performed at the most distal point that will heal successfully and should take into account the ability of the patient to achieve a successful rehabilitation. The site and extent of amputation is determined by circulation in the area (and whether or not necrosis is present), the degree of tissue loss and viability of the tissues, functional usefulness (i.e., meets the requirements for the use of a prosthesis) and the presence of infection (Guest, Marshall, & Stansby, 2019).

The circulatory status of the limb is evaluated through physical examination and diagnostic studies. Muscle and skin perfusion are important for healing. Doppler flow studies with duplex ultrasound, segmental pressure determinations, and transcutaneous oxygen measurements of the limb are valuable diagnostic aids. Angiography is performed if revascularization is considered an option.

The objective of surgery is to conserve as much limb length as needed to preserve function and possibly to achieve a good prosthetic fit. Preservation of knee and elbow joints is desirable. Figure 37-23 shows the levels at which a limb may be amputated. Most amputations involving limbs eventually can be fitted with a prosthesis.

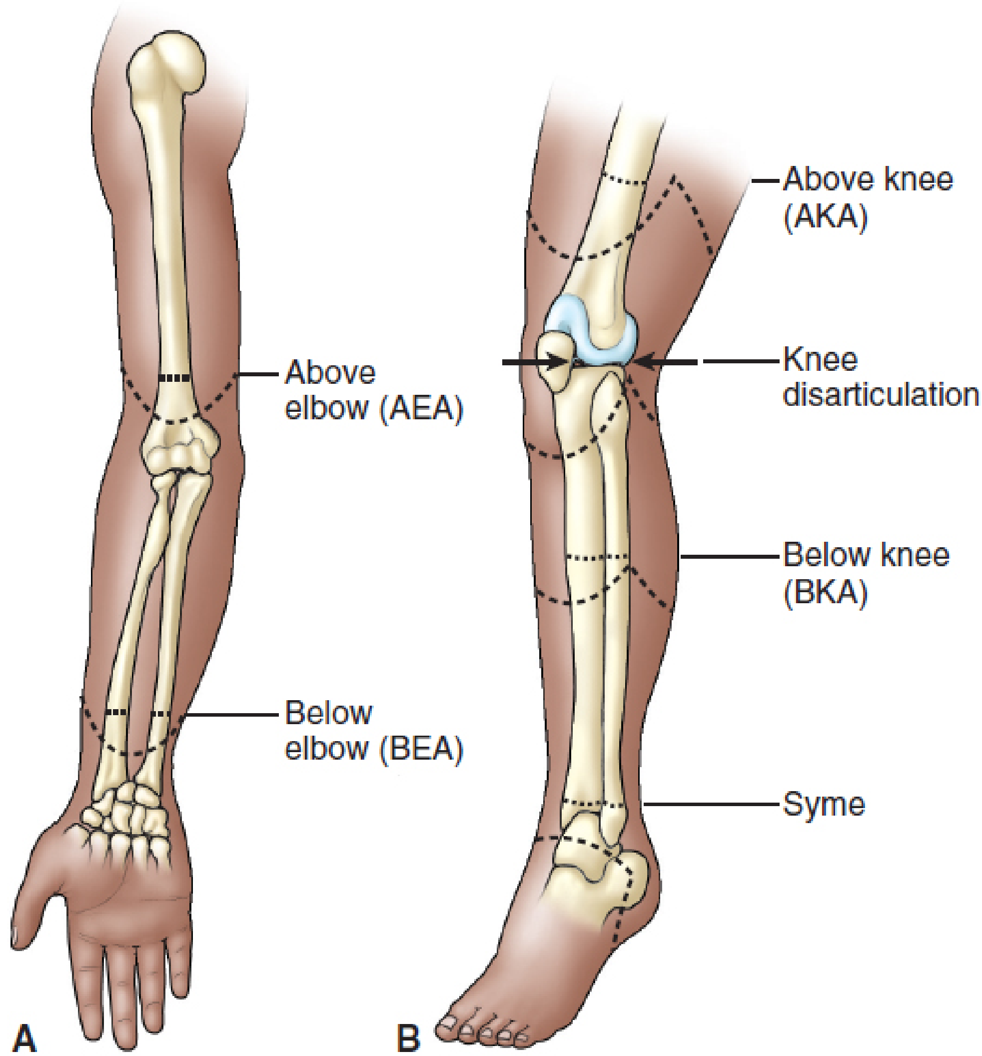

Figure 37-23 • Level of amputation is determined by circulatory adequacy, type of prosthesis, function of the part, and muscle balance. **A.** Level of amputation of upper limb. **B.** Level of amputation of lower limb.

The amputation of toes and portions of the foot can cause changes in gait and balance. A Syme amputation (modified ankle disarticulation amputation) is performed most frequently for extensive foot trauma and aims to produce a durable residual limb that can withstand full weight bearing. Below-knee amputation (BKA) is preferred to above-knee amputation (AKA) because of the importance of the knee joint and the energy requirements for walking. A knee **disarticulation** (e.g., amputation through the joint) is most successful with a young, active patient who can develop precise control of the prosthesis. When AKAs are performed, all possible length is preserved, muscles are stabilized and shaped, and hip contractures are prevented to maximize ambulatory potential (Guest et al., 2019). Most people who have a hip disarticulation amputation must rely on a wheelchair for mobility.

Upper limb amputations are performed with the goal of preserving maximal functional length. The prosthesis is fitted early to ensure maximum function.

A "staged" amputation may be used when gangrene and infection exist. Initially, a débriding amputation in the form of a guillotine amputation (i.e., transfemoral, transtibial) is performed to remove the infected and necrotic tissue. Once the infected limb is removed, systemic antibiotics are administered, and the wound is left open and allowed to drain. In a few days, after the infection has been controlled and the patient's condition has stabilized, a definitive amputation with skin closure is performed; a drain may be left in place (Kalapatapu, 2019).

Complications

Complications that may occur with amputation include hemorrhage, infection, skin breakdown, phantom limb pain, and joint contracture. Because major blood vessels have been severed, hemorrhage may occur. Infection is a risk with all surgical procedures. The risk of infection increases with contaminated wounds after traumatic amputation. Antibiotic prophylaxis prior to surgery is recommended. Skin irritation caused by the prosthesis may result in skin breakdown. **Phantom limb pain** (pain perceived in the amputated section) is caused by the severing of peripheral nerves. Joint contracture is caused by positioning and a protective flexion withdrawal pattern associated with pain and muscle imbalance (Kalapatapu, 2019). Associated comorbidities such as ischemic disease and psychological disorders such as depression and anxiety must also be monitored closely as they can contribute to further complications and chronic limb pain (Chung & Yoneda, 2020).

Medical Management

The objective of treatment is to achieve healing of the amputation wound, the result being a nontender residual limb with healthy skin for prosthetic use. Healing is enhanced by gentle handling of the residual limb, control of residual limb edema and pain, and the use of aseptic technique in wound care to avoid infection (Kalapatapu, 2019).

The primary postoperative dressings to support soft tissues, control pain and edema, and prevent joint contractures include nonremovable rigid dressings, removable rigid dressings, soft dressings (elastic and crepe), and weight-bearing immediate postoperative prostheses (Reichmann, Stevens, Rheinstein, et al., 2018).

The type of dressing used in patients with lower limb amputations varies. A reduction in edema, pain, contractures, healing time, time to prosthetic fitting, and injury due to falls has been shown for certain types of amputations (e.g., transtibial) with the use of removable rigid dressings as compared to soft dressings (Reichmann et al., 2018). However, a soft dressing with or without compression may be used if there is significant wound drainage, frequent inspection of the residual limb is required, and the patient has poor skin integrity (Kwah, Webb, Go, et al., 2019). An immobilizing splint may be incorporated in the soft dressing. Good clinical judgment over which dressing to use should consider the risks and benefits for each individual patient. A wound drain can be placed to remove excess blood and drainage from the surgical site (Schreiber, 2017). Staples or sutures maintain closure at the operative site and are typically removed approximately 3 weeks postoperatively.

Rehabilitation

The multidisciplinary rehabilitation team (patient, nurse, primary provider, social worker, physical therapist, occupational therapist, psychologist, prosthetist, vocational rehabilitation worker) helps the patient achieve the highest possible level of function and participation in life activities (see Fig. 37-24). Prosthetic clinics, amputee support programs, and peer visits (face-to-face, telephone, digital) for patients with a limb amputation facilitate the rehabilitation process, both physically and psychosocially (Reichmann & Bartman, 2018).

Patients who undergo amputation need support as they grieve the loss and change in body image. Their reactions can include anger, bitterness, and hostility. Psychological issues (e.g., denial, anxiety, avoidance) may be influenced by the type of support the patient receives from the rehabilitation team, the effectiveness of pain management, and by how quickly ADLs and the use of the prosthesis are learned. Providing education about the full options and capabilities available with the various prosthetic devices, as well as the recovery of walking capacity, if appropriate, can give the patient a sense of control over the resulting disability and promote independence (Luza, Ferreira, Minsky, et al., 2019).

Figure 37-24 • Many patients with amputations receive prostheses soon after surgery and begin learning how to use them with the help and support of the rehabilitation team, which includes nurses, primary providers, physical therapists, and others.

Patients undergoing amputation because of severe trauma are usually young and healthy. These patients heal rapidly and are physically able to participate in a vigorous rehabilitation program. Because the amputation is the result of an injury, the patient needs holistic multidisciplinary support from the beginning in order to accept the sudden change in body image and to deal with the stresses of hospitalization, long-term rehabilitation, and modification of lifestyle (Noblet, Lineham, Wiper, et al., 2019).

Veterans Considerations

Within the past two decades, numerous U.S. military personnel have sustained conflict-related amputations from exposure to blasts from improvised explosive devices. The Department of Veterans Affairs/Department of Defense (VA/DoD) follows its own set of periodically updated evidence-based guidelines to ensure that veterans with amputations consistently receive quality care (VA/DoD, 2017). In addition, so that the complex needs of these young, previously healthy men and women may be met, the U.S. Army instituted both a specialized treatment center for patients with amputations and a database registry to facilitate long-term treatment and management. Treatment for these injured service members addresses not only physical rehabilitation needs, but also ways to optimize psychosocial functioning (VA/DoD, 2017). A multidisciplinary rehabilitation team with referral to behavioral health services are considered key components to therapy.

NURSING PROCESS

The Patient Undergoing an Amputation

Assessment

Before surgery, the nurse must evaluate the neurovascular and functional status of the limb through history and physical assessment. If the patient has experienced a traumatic amputation, the nurse assesses the function and condition of the residual limb. The nurse also assesses the circulatory status and function of the unaffected limb. If infection or gangrene develops, the patient may have associated enlarged lymph nodes, fever, and purulent drainage. A culture and sensitivity test is obtained to determine the appropriate antibiotic therapy.

The nurse evaluates the patient's nutritional status and develops a postoperative plan for nutritional care in consultation with a dietitian or metabolic nutrition support team, if indicated. A diet with adequate protein and vitamins is essential to promote wound healing. Additional calories may be necessary due to the energy required for transfers and ADLs when using a prosthesis (Schreiber, 2017).

Any concurrent health problems (e.g., dehydration, anemia, cardiac insufficiency, chronic respiratory problems, diabetes) need to be identified and treated so that the patient is in the best possible condition to withstand the surgical procedure. The use of corticosteroids, anticoagulants, vasoconstrictors, or vasodilators may influence management and prolong or delay wound healing.

The nurse assesses the patient's psychological status. Evaluation of the patient's emotional reaction to amputation is important. Grief responses to permanent alterations in body image, function, and mobility are likely. Professional counseling and available support services can help the patient cope in the aftermath of amputation surgery.

Diagnosis

Nursing Diagnoses

Based on the assessment data, major nursing diagnoses may include the following:

- Acute pain associated with amputation
- Impaired skin integrity associated with surgical amputation
- Disturbed body image associated with amputation

- Grief and/or risk for dysfunctional grief associated with loss of body part and resulting disability
- Impaired ability to perform hygiene, impaired ability to dress, impaired self feeding, or impaired self toileting associated with amputation
- Impaired mobility associated with amputation

Collaborative Problems/Potential Complications

Potential complications may include the following:

- Hemorrhage
- Infection
- Skin breakdown

Planning and Goals

The major goals of the patient may include relief of pain, including phantom limb pain, wound healing, acceptance of altered body image, resolution of the grieving process, independence in self-care, restoration of physical mobility, and absence of complications.

Nursing Interventions

Relieving Pain

Pain may be incisional or may be caused by inflammation, infection, pressure on a bony prominence, hematoma, or phantom limb pain. Muscle spasms may add to the patient’s discomfort. Surgical pain can be effectively controlled with opioid analgesics that may be accompanied with evacuation of a hematoma or accumulated fluid. Changing the patient’s position or placing a light sandbag on the residual limb to counteract the muscle spasm may improve the patient’s level of comfort. Evaluation of the patient’s pain and responses to interventions is an important component of pain management.

Many patients who have amputations begin to experience phantom limb pain soon after surgery. It is a complex pain condition that has been reported in 60% to 80% of patients with amputations (Hall, Abd-Elsayed, & Eldabe, 2019). The patient reports pain in the missing limb as if it were still present. The pain is described as if the amputated limb feels crushed, cramped, or twisted in an abnormal position; this pain is sometimes accompanied by numbness, tingling, or sensations of burning or electric shock. Phantom limb pain occurs intermittently and unpredictably; episodes of pain may last seconds or hours. When a patient describes phantom pains or sensations, the nurse acknowledges these feelings as real and encourages the patient to verbalize when in pain so that effective treatment may be given. Phantom limb pain typically diminishes over time for most patients, with episodes gradually becoming less frequent and of lesser duration; however, some patients continue to experience phantom limb pain as long as 2 years after the amputation.

The pathogenesis of the phantom limb pain phenomenon is believed to involve changes in both peripheral and central neuronal mechanisms. Disruption in neuronal pathways are thought to cause neuroplastic changes that in turn result in changes in cortical representation, or the proprioceptive, tactile, and visual image of body parts as perceived by the cerebral cortex (Hall et al., 2019). Preoperative epidural analgesia (preemptive analgesia) may reduce the incidence and severity of phantom limb pain over the long term (Guest et al., 2019). Perioperatively, the patient may be managed with acetaminophen, NSAIDs, anticonvulsants (gabapentin), opioids, and NMDA receptor antagonists (ketamine infusion). Epidural and perineural catheter analgesia may be used during and immediately after the operation (Hall et al., 2019). Opioid analgesics may be effective in relieving postoperative pain. In addition, beta-blockers may relieve dull, burning discomfort; anticonvulsants control stabbing and cramping pain; and tricyclic antidepressants may not only alleviate phantom limb pain but may also be prescribed to improve mood and coping ability. Therapies that may be used as adjuncts to pharmacologic treatments include mirror therapy (i.e., the patient views and moves the unaffected limb in a mirror that is in a box or blocking the view of the affected limb), massage, biofeedback, acupuncture, repositioning, TENS, guided imagery, virtual reality, and neuromodulation (Hall et al., 2019; Herrador Colmenero, Perez Marmol, Marti-Garcia, et al., 2018). The nurse monitors the effectiveness of these treatments and collaborates with the multidisciplinary team to advocate for optimal pain control. Successful pain management following amputation promotes positive patient outcomes and lowers the cost of care (VA/DoD, 2017).

Promoting Wound Healing

Following amputation, the incision should be examined daily for signs of infection. The residual limb must be handled gently and should be measured once every 8 to 12 hours postoperatively to assess for edema formation. Neurovascular assessments (including the most distal pulse, movement, sensation, skin temperature) are also performed at these intervals, and compared to the unaffected limb to ensure that there is adequate blood supply. The dressing is changed as prescribed and whenever soiled, using aseptic technique to prevent infection and possible osteomyelitis (Kalapatapu, 2019). Drains are maintained and can be discontinued when the volume in the drain reservoir is minimal.

If the rigid or soft dressing inadvertently comes off, the nurse must immediately wrap the residual limb with an elastic compression bandage. If this is not done, excessive edema will develop in a short time, resulting in a delay in rehabilitation. The nurse notifies the surgeon if the dressing comes off so that another one can be applied promptly.

Chart 37-9 NURSING RESEARCH PROFILE

Patients’ Postamputation Viewing of Selves in the Mirror

Freysteinson, W., Thomas, L., Sebastian-Deutsch, A., et al. (2017). A study of the amputee experience of viewing self in the mirror. *Rehabilitation Nursing*, *37*(1), 22–32.

Purpose

Approximately two million individuals are living with the loss of a limb in the United States, and this incidence is expected to nearly double by 2050. The amputation of a limb is a traumatic event and affects an individual physically and psychologically. A visible disfigurement such as an amputation can lead to distortions in body image, depression, and low self-esteem as well as nonacceptance of a prosthesis in the rehabilitation phase. For a patient with an amputation, one of the most shocking and anxiety producing situations that can negatively impact the perception of body image is the mirror-viewing experience (viewing one’s self in a mirror after the amputation of a limb). However, the research evidence addressing this topic is limited. The purpose of this study was to describe the experience of viewing of self in a mirror after an amputation and the perceptions of what nurses should know about clinical mirror interventions.

Design

A hermeneutic phenomenologic design was used. Snowball sampling was used to recruit 17 participants who consented to be in the study. In order to be included in the study, participants had to be at least 18 years of age, have an amputation of an upper or lower limb, and have an ability to speak, read, and understand English. Five focus groups of 3 to 6 participants, lasting approximately 60 to 90 minutes, were conducted in a research rehabilitative hospital setting. Key questions asked included: Describe an experience about one of the first times you saw yourself in a mirror after amputation; what were your feelings and emotions? What was your self-talk before/during/after looking in the mirror? How would you describe the journey of viewing self in the mirror the first time to what it is like to view self in the mirror now, and what might each of the stages of this journey be called? The question which provided the most information about participant perceptions of potential mirror interventions was: What would you say is really important for health care providers to know about mirrors?

Findings

The interpretation of data revealed that the act of viewing self in a mirror at any time after an amputation had three key elements: decision, seeing self, and consent. The trajectory of mirror shock, mirror anguish, recognizing self, and accepting a new normal are key themes and adds to the existing literature. Reasons to decide to view self in the mirror included curiosity, appearance, care of incision or residual limb, and gait/posture assessment. The experience of viewing self in the mirror after an amputation changes over time, and each person's mirror trajectory begins when initially making the decision of viewing self in a mirror after the amputation. Participants recommend that the nurse facilitate the initial mirror viewing experience and use the mirror as a tool to assess for skin breakdown and to help correct gait and balance.

Nursing Implications

The viewing of self in the mirror after an amputation can be a very difficult and emotional experience. Nurses are in a unique position to show support and understanding of the situation by facilitating the initial mirror viewing of the patient's amputation in a proper and controlled setting. When nurses are present during the initial mirror viewing process, the patient realizes that they are not alone in this experience and that the nurse understands what they are going through. There appears to be a lack of mirrors in health care settings; therefore, it is recommended that rooms in private hospitals and rehabilitation facilities have more small and full-length mirrors.

Application of consistent pressure to the residual limb reduces edema formation and helps to shape the residual limb so that it may fit a prosthetic. The wound should be assessed to ensure that it is healing and that there are no signs of infection (e.g., redness, purulent drainage), which can also hamper optimal prosthetic fit. After the incision is healed and the limb is shaped appropriately, the patient is instructed how to care for the residual limb (VA/DoD, 2017).

Enhancing Body Image

Amputation is a procedure that alters the patient's body image. The nurse who has established a trusting relationship with the patient is better able to communicate acceptance of the patient who has experienced an amputation. The nurse encourages the patient to look at, feel, and care for the residual limb. Nursing research findings suggest that the nurse be present with patients who view themselves in mirrors after an amputation (Freysteinson, Thomas, Sebastian-Deutsch, et al., 2017) (see Nursing Research Profile: Chart 37-9). It is important to identify the patient's strengths and resources to facilitate rehabilitation. The nurse helps the patient regain the previous level of independent functioning. The patient who is accepted as a whole person is more readily able to resume responsibility for self-care; self-concept improves, and body image changes are accepted. Even with highly motivated patients, this process may take months.

Concept Mastery Alert

The nurse can provide the following interventions to foster a positive self-image: encouraging the patient to care for the residual limb, allowing the expression of grief, and promoting utilization of available resources.

Helping the Patient to Resolve Grieving

The loss of a limb (or part of one) may come as a shock even if the patient was prepared preoperatively. The patient's behavior (e.g., crying, withdrawal, apathy, anger) and expressed feelings (e.g., depression, fear, helplessness) reveal how the patient is coping with the loss and working through the grieving process.

The nurse creates an accepting and supportive atmosphere in which the patient and family are encouraged to express and share their feelings and work through the grief process. The support from family and friends promotes the patient's acceptance of the loss. The nurse helps the patient deal with immediate needs and become oriented to realistic rehabilitation goals and future independent functioning. Psychological needs can be further addressed by mental health professionals; referrals for support services and spiritual advisors (e.g., pastoral care) may be appropriate (Myers, VanDamme, & Pasquina, 2018).

Promoting Independent Self-Care

Amputation affects the patient's ability to provide adequate self-care. The patient is encouraged to be an active participant in self-care. The patient needs time to accomplish these tasks and must not be rushed. Practicing an activity with consistent, supportive supervision in a relaxed environment enables the patient to learn self-care skills. The patient and the nurse need to maintain positive attitudes and minimize fatigue and frustration during the learning process.

Independence in dressing, toileting, and bathing depends on balance, transfer abilities, and physiologic tolerance of the activities.

The nurse works with the physical therapist and occupational therapist to educate and supervise the patient in these self-care activities.

The patient with an upper limb amputation has self-care deficits in feeding, bathing, and dressing. Assistance is provided only as needed; the nurse encourages the patient to learn to do these tasks, using assistive feeding and dressing aids when needed. The nurse, therapists, and prosthetist work with the patient to achieve maximum independence.

Assisting the Patient to Achieve Physical Mobility

Assisting the Patient with a Lower Limb Amputation. Proper positioning of the residual limb prevents the development of hip or knee joint contracture in the patient with a lower limb amputation. The limb should be elevated for 24 hours after amputation to promote venous return and decrease edema (Schreiber, 2017). After this period, elevation, abduction, external rotation, and flexion of the lower limb are to be avoided. The patient is encouraged not to sit for long periods of time to prevent flexion contracture or with the affected extremity dangling or in a dependent position to prevent edema (Schreiber, 2017).

The residual limb should not be placed on a pillow because a flexion contracture of the hip may result. The nurse encourages the patient to turn from side to side and to assume a prone position, 20 to 30 minutes several times per day to stretch the flexor muscles and to prevent flexion contracture of the hip. The legs should remain close together to prevent an abduction deformity. The nurse encourages the patient to use assistive devices to more readily perform self-care activities and to identify what home modifications, if any, should be made to perform these activities in the home environment.

Postoperative ROM exercises are started early because contracture deformities develop rapidly. ROM exercises include hip and knee exercises for patients with BKAs and hip exercises for patients with AKAs. It is essential that the patient understands the importance of exercising the residual limb as well as the unaffected extremities for joint mobility and strengthening (Schreiber, 2017).

The upper limbs, trunk, and abdominal muscles are exercised and strengthened. The extensor muscles in the arm and the depressor muscles in the shoulder play an important part in crutch walking. The patient uses an overbed trapeze to change position and strengthen the biceps. The patient may flex and extend the arms while holding weights. Doing push-ups while seated strengthens the triceps muscles.

Exercises (such as hyperextension of the residual limb), conducted under the supervision of the physical therapist, also aid in strengthening muscles as well as increasing circulation, reducing edema, and preventing atrophy.

Strength and endurance are assessed, and activities are increased gradually to prevent fatigue. As the patient progresses to independent use of the wheelchair, the use of ambulatory aids, or ambulation with a prosthesis, the nurse emphasizes safety considerations. Environmental barriers (e.g., steps, inclines, doors, throw rugs, wet surfaces) are identified, and methods of managing them are implemented. It is important to anticipate, identify, and manage problems associated with the use of the mobility aids. Proper education in using assistive devices will help prevent these problems.

Amputation of the leg changes the center of gravity; therefore, the patient may need to practice position changes (e.g., standing from sitting, standing on one foot). The patient is taught transfer techniques early and is reminded to maintain good posture when getting out of bed. A well-fitting shoe with a nonskid sole should be worn. During position changes, the patient should be guarded and stabilized with a transfer belt at the waist to prevent falling.

As soon as possible, the patient with a lower limb amputation is assisted to stand between parallel bars to allow extension of the temporary prosthesis to the floor with minimal weight bearing. How soon after surgery the patient is allowed to bear full body weight on the prosthesis depends on the patient's physical status and wound healing. As endurance increases and balance is achieved, ambulation is started with the use of parallel bars or crutches. The patient learns to use a normal gait, with the residual limb moving back and forth while walking with the crutches. To prevent a permanent flexion deformity from occurring, the residual limb should not be held up in a flexed position (Kalapatapu, 2019).

Assisting the Patient with an Upper Limb Amputation. Because a patient who has had an upper limb amputated uses both shoulders to operate the prosthesis, the muscles of both shoulders are exercised. A patient with an above-elbow amputation or shoulder disarticulation is likely to develop a postural abnormality caused by loss of the weight of the amputated limb. Postural exercises are helpful.

The patient with an upper limb amputation is taught how to carry out ADLs with one arm. The patient is started on one-handed self-care activities as soon as possible. The use of a temporary prosthesis is encouraged. The patient who learns to use the prosthesis soon after the amputation is less dependent on one-handed self-care activities.

The patient with an upper limb amputation may wear a cotton T-shirt to prevent contact between the skin and shoulder harness and to promote absorption of perspiration. The prosthetist advises about cleaning the washable portions of the harness. Periodically, the prosthesis is inspected for potential problems.

Preparing the Patient for a Prosthesis. The residual limb must be conditioned and shaped into a conical form to permit accurate fit, maximum comfort, and function of the prosthetic device. Elastic bandages, an elastic residual limb shrinker, or an air splint is used to condition and shape the residual limb. The nurse educates the patient or a member of the family about the correct method of bandaging.

Bandaging supports the soft tissue and minimizes the formation of edema while the residual limb is in a dependent position. The bandage is applied in such a manner that the remaining muscles required to operate the prosthesis are as firm as possible. An improperly applied elastic bandage contributes to circulatory problems and a poorly shaped residual limb.

Effective preprosthetic care is important to ensure proper fitting of the prosthesis. The major problems that can delay prosthetic fitting during this period are flexion deformities, nonshrinkage of the residual limb, and abduction deformities of the hip.

The primary provider usually prescribes activities to condition or “toughen” the residual limb in preparation for a prosthesis. The patient begins by pushing the residual limb into a soft pillow, then into a firmer pillow, and finally against a hard surface. The patient is taught to massage the residual limb to mobilize the surgical incision site, decrease tenderness, and improve vascularity. Massage is usually started once healing has occurred and is first performed by the physical therapist. Skin inspection and preventive care are taught; mirrors may be used to visualize the skin on the residual limb (Rossbach, 2017).

The prosthesis socket is custom-shaped to the residual limb by the prosthetist. Prostheses are designed for specific activity levels and patient abilities. Types of prostheses include those that are hydraulic, pneumatic, biofeedback controlled, myoelectrically controlled, and synchronized. Adjustments of the prosthetic socket are made by the prosthetist to accommodate the residual limb changes that occur during the first 6 months to 1 year after surgery.

Assisting the Patient Who Is Not a Candidate for a Prosthesis. Some patients with amputations are not candidates for a prosthesis due to preexisting factors (e.g., nonambulatory before amputation, dementia, AKA). If the use of a prosthesis is not possible, the patient is educated in safe use of a wheelchair to achieve independence. A special wheelchair designed for a patient who has had an amputation is recommended. Because of the decreased weight in the front, a regular wheelchair may tip backward when the patient sits in it. In wheelchairs designed for patients who have had amputations, the rear axle is set back about 5 cm (2 inches) to compensate for the change in weight distribution.

Monitoring and Managing Potential Complications

After any surgery, efforts are made to reestablish homeostasis and to prevent complications related to surgery, anesthesia, and immobility. The nurse assesses body systems (e.g., respiratory, hematologic, gastrointestinal, genitourinary, skin) for problems associated with immobility (e.g., atelectasis, pneumonia, DVT, PE, anorexia, constipation, urinary stasis, pressure injuries).

Massive hemorrhage due to a loosened suture is a potentially life-threatening problem. The nurse monitors the patient for any signs or symptoms of bleeding and monitors the patient's vital signs and suction drainage.

Quality and Safety Nursing Alert

Immediate postoperative bleeding may develop slowly or may take the form of massive hemorrhage resulting from a loosened suture. A large tourniquet should be in plain sight at the patient's bedside so that if severe bleeding occurs, it can be applied to the residual limb to control the hemorrhage. The nurse immediately notifies the surgeon in the event of excessive bleeding.

Infection is a common complication of amputation. Patients who have undergone traumatic amputation have contaminated wounds. The nurse administers prophylactic antibiotics as prescribed. The nurse must monitor the incision, dressing, and drainage for indications of infection (e.g., change in color, odor, or consistency of drainage; increasing discomfort). The nurse also assesses for systemic indicators of infection (e.g., elevated temperature, leukocytosis with an increase of more than 10% bands on the differential) and promptly reports indications of infection to the surgeon.

Skin breakdown may result from immobilization or pressure from various sources. The prosthesis may cause pressure areas to develop. The nurse and the patient assess for breaks in the skin. Careful skin hygiene is essential to prevent skin irritation, infection, and breakdown. The healed residual limb is washed and dried (gently) at least twice daily. The skin is inspected for persistent erythema, pressure areas, dermatitis, and blisters. If they are present, the prosthesis should not be worn until the complication is evaluated and treated in order to prevent further skin breakdown. Usually, a residual limb sock is worn to absorb perspiration and to prevent direct contact between the skin and the prosthetic socket. The sock is changed daily and must fit smoothly to prevent irritation caused by wrinkles. The socket of the prosthesis is washed with a mild detergent, rinsed, and dried thoroughly with a clean cloth. It must be thoroughly dry before the prosthesis is applied (Rossbach, 2017).

Promoting Home, Community-Based, and Transitional Care

Educating the Patient About Self-Care. Before the patient is discharged to home or to a rehabilitation facility, the patient and family are encouraged to become active participants in care. They participate in care of the skin, residual limb, and prosthesis as appropriate. The patient receives ongoing education and practice sessions to learn to transfer and to use mobility aids and other assistive devices safely. The nurse explains the signs and symptoms of complications that must be reported to the primary provider (see Chart 37-10).

Continuing and Transitional Care. After the patient has achieved physiologic homeostasis and has demonstrated achievement of major health care goals, rehabilitation continues either in a rehabilitation facility or at home. An inpatient rehabilitation facility may be indicated; these facilities have been shown to improve quality of life, ambulation and patient confidence, mobility, and prosthesis use with less associated pain (VA/DoD, 2017). In any case, continued support and evaluation by the home health nurse is essential.

The patient's home environment should be assessed prior to discharge. Modifications are made to ensure the patient's continuing care, safety, and mobility. An overnight or weekend experience at home may be tried to identify problems that were not identified on the assessment visit. Physical therapy and occupational therapy may continue in the home or on an outpatient basis. Transportation to continuing health care appointments must be arranged. The social service department of the hospital or the home health agency may be of great assistance in securing personal assistance and transportation services.

Chart 37-10 **HOME CARE CHECKLIST**

The Patient with an Amputation

At the completion of education, the patient and/or caregiver will be able to:

- Name the procedure that was performed and identify any permanent changes in anatomic structure or function as well as changes in ADLs, IADLs, roles, relationships, and spirituality.
- Identify modification of home environment, interventions, and strategies (e.g., durable medical equipment, adaptive equipment, ADL assistance), used in safely adapting to changes in structure or function and promote effective recovery and rehabilitation.
  - Identify professionals and community agencies to help with transition to home.
- Describe ongoing postoperative therapeutic regimen, including diet and activities to perform (e.g., exercises) and to limit or avoid (e.g., lifting weights, driving a car, contact sports).
  - Describe care of residual limb and conditioning for prosthesis.
  - Consume a healthy diet to promote wound healing.
  - Participate in rehabilitation program to regain functional independence, promote circulation, maintain the health of unaffected muscles and those muscles now needed for safe transfer, mobility, etc.
  - If indicated, demonstrate safe use of mobility aid, assistive device, and transfer technique.
  - Observe prescribed weight-bearing and activity limits.
- State the name, dose, side effects, frequency, and schedule for all prescribed therapeutic and prophylactic medications (e.g., antibiotics, anticoagulants, analgesic agents).
- State how to obtain medical supplies and carry out dressing changes, wound care, and other prescribed regimens.
- Describe approaches to controlling pain (e.g., take analgesics as prescribed; use nonpharmacologic interventions).
- State indicators of complications to report promptly to primary provider (e.g., uncontrolled pain; signs of local or systemic infection; residual limb skin breakdown).
- Relate how to reach primary provider with questions or complications.

- State time and date of follow-up appointments, therapy, and testing.
- Identify community resources for peer and caregiver/family support:
  - Identify sources of support (e.g., friends, relatives, faith community).
  - Identify the contact details for support services for patients and their caregivers/families.
- Identify the need for health promotion, disease prevention, and screening activities.

Resources

See Chapter 2, Chart 2-6, for additional information related to durable medical equipment, adaptive equipment, and mobility skills.

ADLs, activities of daily living; IADLs, instrumental activities of daily living.

During follow-up health visits, the nurse evaluates the patient's physical and psychosocial adjustment. Periodic preventive health assessments are necessary. An older adult spouse may not be able to provide the assistance required if needed at home. Modifications in the plan of care are made on the basis of such findings. Often, the patient and family find involvement in a postamputation support group and peer support programs to be of value; here, they can share problems, solutions, and resources (Reichmann & Bartman, 2018). Talking with those who have successfully dealt with a similar problem may help the patient develop a satisfactory solution.

Because patients and their family members and health care providers tend to focus on the most obvious needs and issues, the nurse reminds the patient and family about the importance of continuing health promotion and screening practices, such as regular physical examinations and diagnostic screening tests. Accessible facilities for screening, health care, and exercise are identified. Patients are instructed about their importance and are referred to appropriate health care providers.

Evaluation

Expected patient outcomes may include:

1. Experiences no pain, including phantom limb pain
   a. Appears relaxed
   b. Verbalizes comfort

    c. Uses measures to increase comfort and mitigate pain
    d. Participates in self-care and rehabilitative activities
    e. Reports diminished phantom sensations
2. Achieves wound healing
    a. Controls residual limb edema
    b. Exhibits healed, nontender, nonadherent scar
    c. Demonstrates residual limb care
3. Demonstrates improved body image and effective coping
    a. Acknowledges change in body image
    b. Participates in self-care activities
    c. Demonstrates increasing independence
    d. Projects self as a whole person
    e. Resumes role-related responsibilities
    f. Reestablishes social contacts
    g. Demonstrates confidence in abilities
4. Exhibits resolution of grieving
5. Expresses grief
6. Works through feelings with family, friends, and health care professionals
7. Focuses on future functioning
8. Utilizes available support
9. Achieves independent self-care
    a. Asks for assistance when needed
    b. Uses aids and assistive devices to facilitate self-care
    c. Verbalizes satisfaction with abilities to perform ADLs
10. Achieves maximum independent mobility
    a. Avoids positions contributing to contracture development
    b. Demonstrates full active ROM
    c. Maintains balance when sitting and transferring
    d. Increases strength and endurance
    e. Demonstrates safe transferring technique
    f. Achieves functional use of prosthesis
    g. Overcomes environmental barriers to mobility
    h. Uses community services and resources as needed
11. Exhibits absence of complications of hemorrhage, infection, or skin breakdown

a. Does not experience excessive bleeding
b. Maintains normal blood values
c. Is free of local or systemic signs of infection
d. Repositions self frequently
e. Is free of pressure-related problems
f. Reports any skin discomfort and irritations promptly

CRITICAL THINKING EXERCISES

1 ebp A 74-year-old woman was admitted to the hospital after she fell down a flight of stairs and fractured her right hip. She is now 48 hours postoperative after a right ORIF to that hip. She is moderately overweight and has a history of smoking. She has been reluctant to get out of bed to ambulate and complains that her intermittent compression devices are uncomfortable, and she does not want to wear them. What is the strength of the evidence that supports the use of compression devices postoperatively for patients who have had ORIF post-hip fractures? What are her risks if she does not wear these devices postoperatively? How will you respond to the patient's request to not wear these devices?

2 ipc You are caring for a 30-year-old female who was involved in a motor vehicle crash and had a traumatic amputation of her left upper extremity at the scene. She is 7 days postoperative and is now complaining of phantom limb sensation and severe pain in the missing limb. She describes the quality of the pain as crushing, burning, and "electric shock like" and it spreads from her missing fingers to the length of her arm. She is becoming anxious with the severity of the pain and does not understand what is happening to her. Describe the assessments and interventions as you prioritize care for this patient. Identify the multidisciplinary collaboration necessary to provide a comprehensive treatment plan for this patient to promote the best outcomes.

2 pq You have been assigned to care for a 36-year-old male admitted to the inpatient orthopedic unit following a motorcycle crash. He had an external fixation device applied 8 hours ago for a fracture of the left tibia. During shift report, the nurse reports that the patient has been complaining of throbbing pain and paresthesia in his left lower leg that has not been alleviated despite administration of prescription opioid pain medication. Upon your initial assessment, you note that the patient's left calf is very swollen, shiny, and taut. Describe the additional physical assessments that should be conducted for this patient. What is your priority nursing diagnosis and plan of care?

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Resources

American Academy of Orthopedic Surgeons (AAOS), www.aaos.org

American College of Sports Medicine (ACSM), www.acsm.org

American Nurses Association (ANA), Safe Patient Handling and Mobility, www.nursingworld.org/practice-policy/work-environment/health-safety/handle-with-care/

Amputee Coalition, www.amputee-coalition.org

National Amputation Foundation (NAF), www.nationalamputation.org

National Association of Orthopaedic Nurses (NAON), www.orthonurse.org

National Institute for Occupational Safety and Health (NIOSH), www.cdc.gov/niosh/index.htm

U.S. Department of Labor, Occupational Safety and Health Administration (OSHA), www.osha.gov

Wounded Warrior Project, www.woundedwarriorproject.org