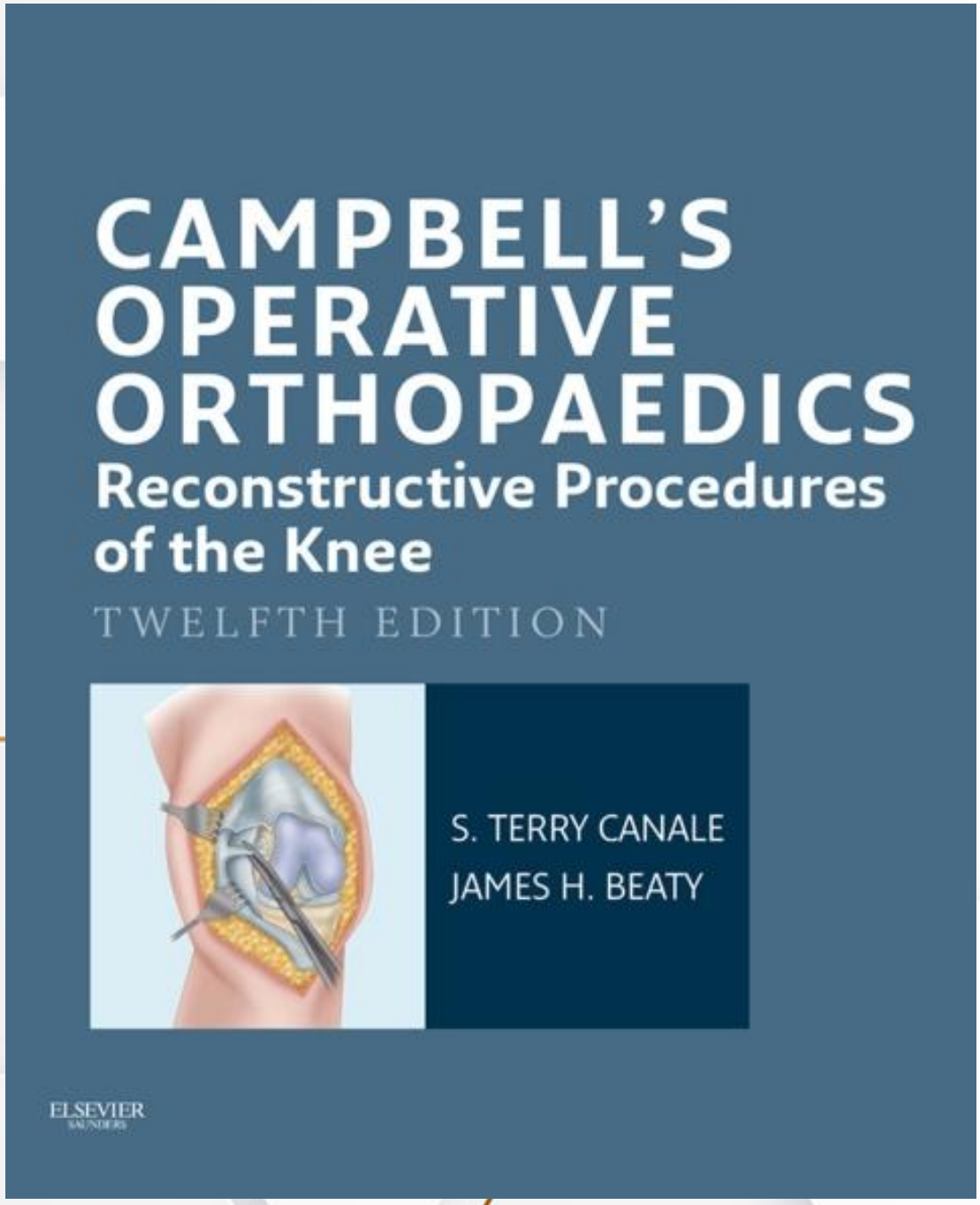
Campbell's Operative Orthopaedics Reconstructive Procedures of the Knee 12th Edition



CAMPBELL'S OPERATIVE ORTHOPAEDICS

TWELFTH EDITION

VOLUME I

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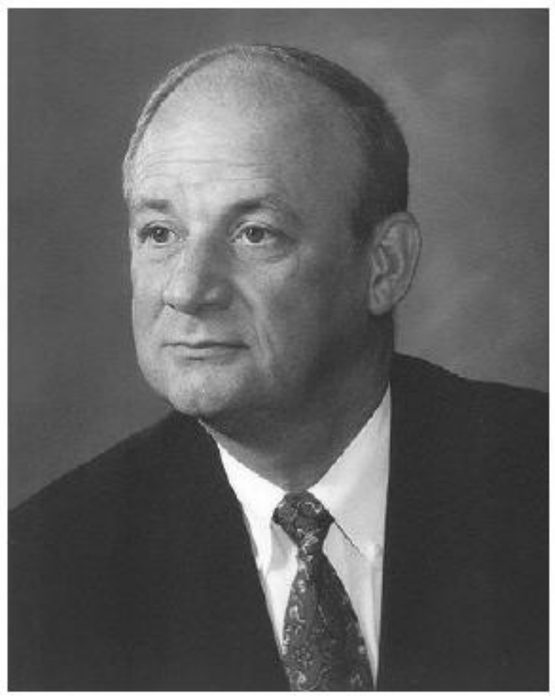
IN MEMORY

ALLEN EDMONSON, MD
1927–2011



T. DAVID SISK, MD
1937–2009

Since the last edition of this text, we have lost two of our friends and mentors. Dr. Allen Edmonson and Dr. David Sisk both made huge contributions to several editions of *Campbell's Operative Orthopaedics*. In addition to his classic work on scoliosis, Dr. Edmonson served as editor of the 6th edition, and Dr. Sisk contributed the first chapters on arthroscopy to appear in this text. We are grateful for their commitment to "The Book" and the inspiration they have provided.

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PREFACE

As with every edition of this text, we have been amazed by the multitude of new techniques, new equipment, and new information generated by our orthopaedic colleagues worldwide. The emphasis on less-invasive surgical techniques for everything from hallux valgus correction to spine surgery to total joint arthroplasty has produced a variety of new approaches and new devices. The use of arthroscopy and endoscopy continues to expand its boundaries. We have attempted to include the latest orthopaedic procedures, while retaining many of the classic techniques that remain the "gold standards."

Some of the changes in this edition that we believe will make it easier to use include the complete redrawing of the thousands of illustrations, the combining of some chapters and rearrangement of others to achieve a more logical flow of information, the addition of several new chapters, and the placement of references published before 2000 on the website only. Full access to the text and to an increased number of surgical videos is available on ExpertConsult.com, which is included with the purchase of the text. This combination of traditional and electronic formats, we believe, will make this edition of *Campbell's Operative Orthopaedics* easily accessible and useable in any situation, making it easier for orthopaedists to ensure the highest quality of patient care.

The true "heroes" of this work are our dedicated authors, who are willing to endure time away from their families and their practices to make sure that their contributions are as up-to-date and informational as possible. The revision process is lengthy and arduous, and we are truly appreciative of the time and effort expended by all of our contributors. As always, the personnel of the Campbell Foundation—Kay Daugherty, Barry Burns, Linda Jones, and Joan Crowson—were essential in getting the ideas and information from 40 authors into a workable form. The progress of the book was marked by the proliferation of paper-stuffed file folders spread across their offices. Managing to transform all of that raw material into readable text and illustrative images is always an amazing accomplishment. Our thanks, too, to the individuals at Elsevier publishing who provided much guidance, encouragement, and assistance: Taylor Ball, Content Development Editor; Dolores Meloni, Executive Content Strategist; Mary Gatsch, Publishing Director; and John Casey, Project Manager.

We are most grateful to our families, especially our wives, Sissie Canale and Terry Beaty, who patiently endured our total immersion in the publication process.

The individuals who often are overlooked, or at least not recognized often enough, are the community of orthopaedic surgeons to whom we are indebted for their expertise and innovation that make a textbook such as ours necessary. As Dr. Campbell noted in the preface to the first edition of this text, "In some of the chapters we have drawn heavily from authoritative articles on special subjects; the author gratefully acknowledges his indebtedness for this material." We are indeed grateful, and honored and humbled, to be the conduit of such remarkable skill and knowledge that help us to make the most current information available to our readers. We hope that this latest edition of *Campbell's Operative Orthopaedics* will prove to be a valuable tool in providing the best of care to orthopaedic patients.

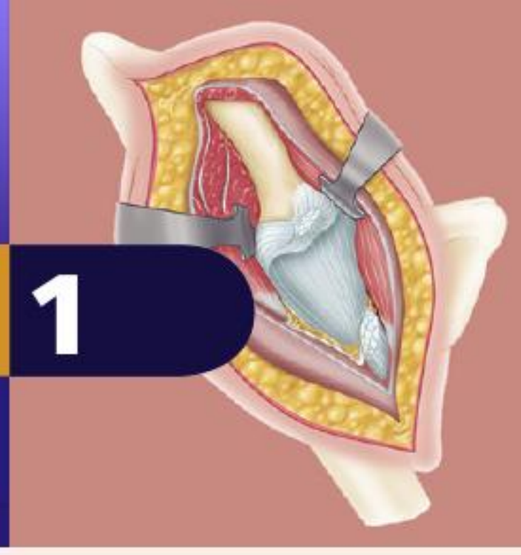
S. Terry Canale, MD
James H. Beaty, MD

VIDEO CONTENTS

SURGICAL TECHNIQUES AND APPROACHES

Andrew H. Crenshaw, Jr.

CHAPTER 1



SURGICAL TECHNIQUES

There are several surgical techniques especially important in orthopaedics: use of tourniquets, use of radiographs and image intensifiers in the operating room, positioning of the patient, local preparation of the patient, and draping of the appropriate part or parts. To avoid repetition in other chapters, operative techniques common to many procedures, fixation of tendons or fascia to bone, and bone grafting also are described.

TOURNIQUETS

Operations on the extremities are made easier by the use of a tourniquet. The tourniquet is a potentially dangerous instrument that must be used with proper knowledge and care. In some procedures a tourniquet is a luxury, whereas in others, such as delicate operations on the hand, it is a necessity. A pneumatic tourniquet is safer than an Esmarch tourniquet or the Martin sheet rubber bandage.

A pneumatic tourniquet with a hand pump and an accurate pressure gauge probably is the safest, but a constantly regulated pressure tourniquet is satisfactory if it is properly maintained and checked. A tourniquet should be applied by an individual experienced in its use.

Several sizes of pneumatic tourniquets are available for the upper and lower extremities. The upper arm or the thigh is wrapped with several thicknesses of smoothly applied cast padding. Rajpura et al. showed that application of more than two layers of padding resulted in a significant reduction in the actual transmitted pressure. When applying a tourniquet on an obese patient, an assistant manually grasps the flesh of the extremity just distal to the level of tourniquet application and firmly pulls this loose tissue distally before the cast padding is placed. Traction on the soft tissue is maintained while the padding and tourniquet are applied, and the latter is secured. The assistant's grasp is released, resulting in a greater proportion of the subcutaneous tissue remaining distal to the tourniquet. This bulky tissue tends to support the tourniquet and push it into an even more proximal position. All air is expressed from the sphygmomanometer or pneumatic tourniquet before application. When a sphygmomanometer cuff is used, it should be wrapped with a gauze bandage to prevent its slipping during inflation. The extremity is elevated for 2 minutes, or the blood is expressed by a sterile sheet rubber bandage or a cotton elastic bandage. Beginning at the fingertips or toes, the extremity is wrapped proximally to within 2.5 to 5 cm of the tourniquet. If a Martin sheet rubber bandage or an elastic bandage is applied up to the level of the tourniquet, the latter tends to slip distally at the time of inflation. The tourniquet should be inflated quickly to prevent filling of the superficial veins before the arterial blood flow has been occluded. Every effort is made to decrease tourniquet time; the extremity often is prepared and ready before the tourniquet is inflated. Hirota et al., using transesophageal echocardiography during arthroscopic knee surgery, showed that asymptomatic pulmonary embolism can occur within 1 minute after tourniquet release. They also found that the number of small emboli depends on the duration of tourniquet inflation.

The exact pressure to which the tourniquet should be inflated has not been determined. Evidence indicates that pressures greater than necessary have been used for many years. The correct pressure depends on the age of the patient, the blood pressure, and the size of the extremity. Reid, Camp, and Jacob used pneumatic tourniquet pressures determined by the pressure required to obliterate the peripheral pulse (limb occlusion pressure) using a Doppler stethoscope; they then added 50 to 75 mm Hg to allow for collateral circulation and blood pressure changes. Tourniquet pressures of 135 to 255 mm Hg for the upper extremity and 175 to 305 mm Hg for the lower extremity were satisfactory for maintaining hemostasis. Younger et al. showed, with a prototype automated limb occlusion pressure apparatus, that tourniquet pressures could be reduced by 43%. Devices of this type are now available from several companies.

According to Crenshaw et al., wide tourniquet cuffs are more effective at lower inflation pressures than are narrow ones. Pedowitz et al. showed that curved tourniquets on conical extremities require significantly lower arterial occlusion pressures than straight (rectangular) tourniquets (Fig. 1-1). The use of straight tourniquets on conical thighs should be avoided, especially in extremely muscular or obese individuals.

Any solution applied to skin must not be allowed to run beneath the tourniquet, or a chemical burn may result. A circumferential adhesive-backed plastic drape applied to the skin just distal to the tourniquet prevents solutions from

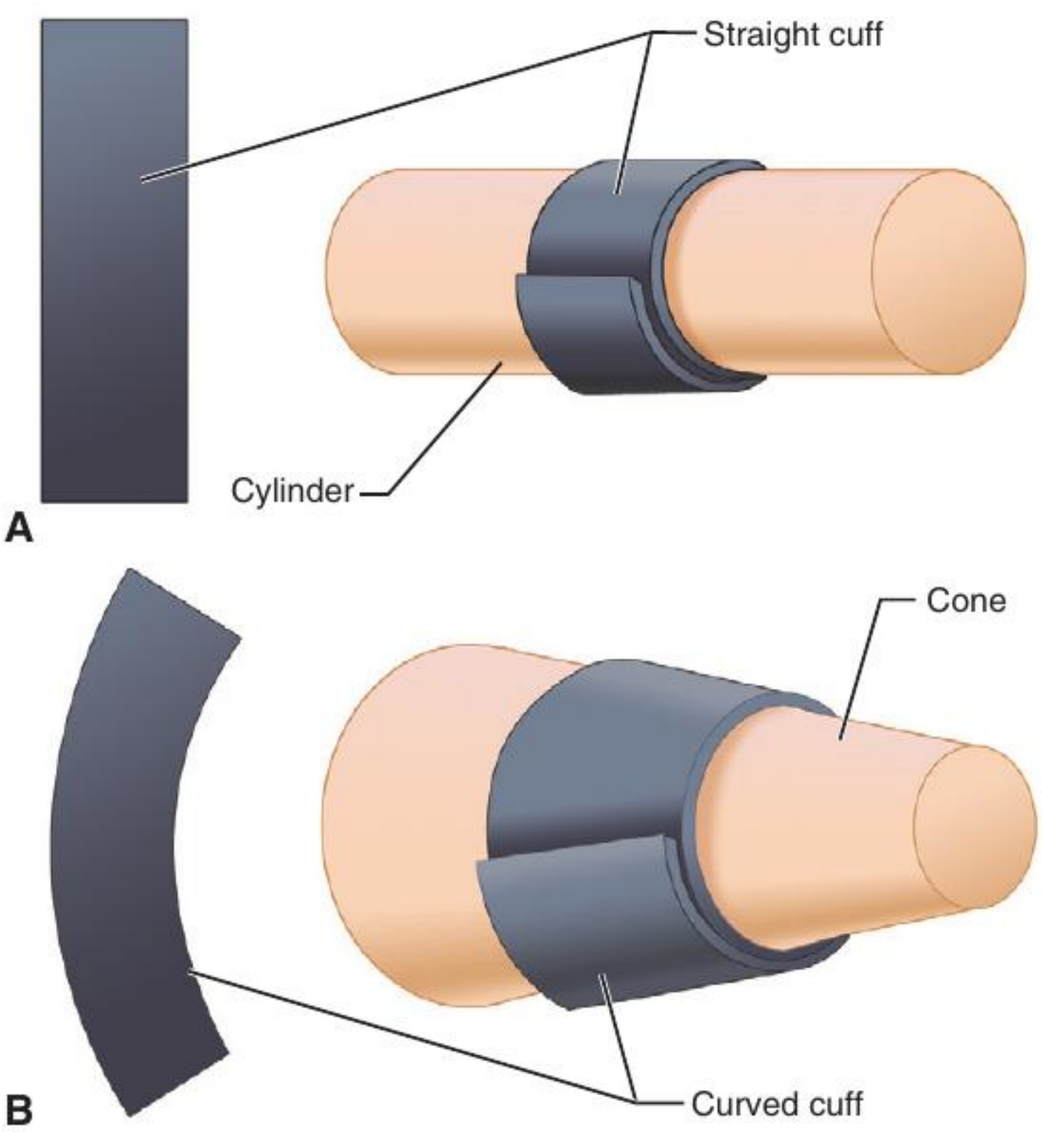


FIGURE 1-1 **A,** Straight (rectangular) tourniquets fit optimally on cylindrical limbs. **B,** Curved tourniquets best fit conical limbs. (From Pedowitz RA, Gershuni DH, Botte MJ, et al: The use of lower tourniquet inflation pressures in extremity surgery facilitated by curved and wide tourniquets and integrated cuff inflation system, *Clin Orthop Relat Res* 287:237, 1993.)

TABLE 1-1 Braithwaite and Klenerman's Modification of Bruner's Ten Rules

APPLICATION	Apply only to a healthy limb or with caution to an unhealthy limb
SIZE OF TOURNIQUET	Arm, 10 cm; leg, 15 cm or wider in large legs
SITE OF APPLICATION	Upper arm; mid/upper thigh ideally
PADDING	At least two layers of orthopaedic wool
SKIN PREPARATION	Occlude to prevent soaking of wool. Use 50-100 mm Hg above systolic for the arm; double systolic for the thigh; or arm 200-250 mm Hg, leg 250-350 mm Hg (large cuffs are recommended for larger limbs instead of increasing pressure)
TIME	Absolute maximum 3 hr (recovers in 5-7 days) generally not to exceed 2 hr
TEMPERATURE	Avoid heating (e.g., hot lights), cool if feasible, and keep tissues moist
DOCUMENTATION	Duration and pressure at least weekly calibration and against mercury manometer or test maintenance gauge; maintenance every 3 months

Modified from Kutty S, McElwain JP: Padding under tourniquets in tourniquet controlled surgery: Bruner's ten rules revisited, *Injury* 33:75, 2002.

running under the tourniquet. Sterile pneumatic tourniquets are available for operations around the elbow and knee. The limb may be prepared and draped before the tourniquet is applied. Rarely, a superficial slough of the skin may occur at the upper margin of the tourniquet in the region of the gluteal fold. This slough usually occurs in obese individuals and is probably related to the use of a straight, instead of a curved, tourniquet.

Pneumatic tourniquets should be kept in good repair, and all valves and gauges must be checked routinely. The inner tube should be completely enclosed in a casing to prevent the tube from ballooning through an opening, allowing the pressure to fall or causing a "blowout." The cuff also should be inspected carefully. Single-use sterile disposable tourniquets are preferable, because reusable tourniquets must be thoroughly decontaminated after each use to prevent microbial colonization.

Any aneroid gauge must be calibrated frequently. Newer gauges carry instruction cards with them. They are sold with test gauges so that the gauges on the tourniquets can be tested for proper calibration. The test gauge also is an aneroid gauge, however, and is subject to error. The test gauge must be tested for accuracy by a mercury manometer. The test gauge should be checked once a week, and each tourniquet gauge should be tested with a test gauge before it is used. If a discrepancy of more than 20 mm between the tourniquet and the test gauge is present, the equipment should be discarded. One of the greatest dangers in the use of a tourniquet is an improperly registering gauge; gauges have been found to be 300 mm off calibration. In many tourniquet injuries, the gauges were later checked and found to be grossly inaccurate, allowing excessive pressure.

Tourniquet paralysis can result from (1) excessive pressure; (2) insufficient pressure, resulting in passive congestion of the part, with hemorrhagic infiltration of the nerve; (3) keeping the tourniquet on too long; or (4) application without consideration of the local anatomy. There is no rule as to how long a tourniquet may be safely inflated. The time may vary with the age of the patient and the vascular supply of the extremity. In an average healthy adult younger than 50 years of age, we prefer to leave the tourniquet inflated for no more than 2 hours. If an operation on the lower extremity takes longer than 2 hours, it is better to finish it as rapidly as possible than to deflate the tourniquet for 10 minutes and then reinflate it. It has been found that 40 minutes is required for the tissues to return to normal after prolonged use of a tourniquet. Consequently, the previous practice of deflating the tourniquet for 10 minutes seems to be inadequate. Post-tourniquet syndrome, as first recognized by Bunnell, is a common reaction to prolonged ischemia and is characterized by edema, pallor, joint stiffness, motor weakness, and subjective numbness. This complication is thought to be related to the duration of ischemia and not to the mechanical effect of the tourniquet. Post-tourniquet syndrome interferes with early motion and results in increased requirement for narcotics. Spontaneous resolution usually occurs within 1 week.

Compartment syndrome, rhabdomyolysis, and pulmonary emboli are rare complications of tourniquet use. Vascular complications can occur in patients with severe arteriosclerosis or prosthetic grafts. A tourniquet should not be applied over a prosthetic vascular graft.

Pneumatic tourniquets usually are applied to the upper arm and thigh, and a well-padded proximal calf tourniquet is safe for foot and ankle surgery. General guidelines for the safe use of pneumatic tourniquets are outlined in Table 1-1.

The Esmarch tourniquet is still in use in some areas and is the safest and most practical of the elastic tourniquets. It is never used except in the middle and upper thirds of the thigh. This tourniquet has a definite, although limited, use in that it can be applied higher on the thigh than can the pneumatic tourniquet. The Esmarch tourniquet is applied in layers, one on the top of the other; a narrow band produces less tissue damage than does a wide one.

A Martin rubber sheet bandage can be safely used as a tourniquet for short procedures on the foot. The leg is elevated and exsanguinated by wrapping the rubber bandage up over the malleoli of the ankle and securing it with a clamp. The distal portion of the bandage is released to expose the operative area.

Special attention should be given when using tourniquets on fingers and toes. A rubber ring tourniquet or a tourniquet made from a glove finger that is rolled onto the digit should not be used because it can be inadvertently left in place under a dressing, resulting in loss of the digit. A glove finger or Penrose drain can be looped around the proximal portion of the digit, stretched, and secured with a hemostat. This is a much safer method for digital surgery. It is difficult to include a hemostat inadvertently in a digital dressing.

Sterile disposable rubber ring tourniquets are now available for use on the upper and lower extremities. These tourniquets are wrapped in stockinette and are applied by rolling the rubber ring and stockinette up the extremity, which

FIGURE 1-2 **A** and **B,** Portable C-arm image intensifier television fluoroscopy setup for fracture repair. C-arm rotates 90 degrees to obtain lateral view. **C** and **D,** Technique for two-plane radiographs during hip surgery with a portable machine for anteroposterior and lateral views. Film cassette for lateral view is positioned over superolateral aspect of hip.

exsanguinates the extremity. The stockinette is then cut away at the operative site. Rubber ring tourniquets are not indicated in the presence of malignancy, infections, significant skin lesions, unstable fractures or dislocations, poor peripheral blood flow, edema, or deep venous thrombosis. Sizing of these tourniquets is based on systolic blood pressure.

RADIOGRAPHS IN THE OPERATING ROOM

Often it is necessary to obtain radiographs during an orthopaedic procedure. Radiography technicians who work in the operating room must wear the same clothing and masks as the circulating personnel. These technicians must have a clear understanding of aseptic surgical technique and draping to avoid contaminating the drapes in the operative field. Portable radiograph units used in the operating room should be cleaned regularly and ideally are not used in any other area of the hospital.

When an unsterile radiograph cassette is to be introduced into the sterile field, it should be placed inside a sterile double pillowcase or sterile plastic bag that is folded over so that the exterior remains sterile. The pillowcase or plastic bag is covered by a large sterile towel, ensuring at least two layers of sterile drapes on the cassette. The operative wound should be covered with a sterile towel when anteroposterior view radiographs are made to avoid possible contamination from the machine as it is moved into position.

Portable C-arm image intensifier television fluoroscopy allows instantaneous evaluation of the position of fracture fragments and internal fixation devices. Many of these machines have the ability to make permanent radiographs. When used near the sterile field, the C-arm portion of the machine must be draped in a sterile fashion (Fig. 1-2A and B). As with any electronic device, failure of an image intensifier can occur. In this event, backup plain radiographs are necessary. Two-plane radiographs can be made, even of the hip when necessary, using portable equipment (Fig. 1-2C and D). Closed intramedullary nailing or percutaneous fracture fixation techniques may need to be abandoned for an open technique if the image intensifier fails.

All operating room personnel should avoid exposure to radiographs. Proper lead-lined aprons should be worn beneath sterile operating gowns. Thyroid shields, lead-impregnated eyeglasses, and rubber gloves are available to decrease exposure.

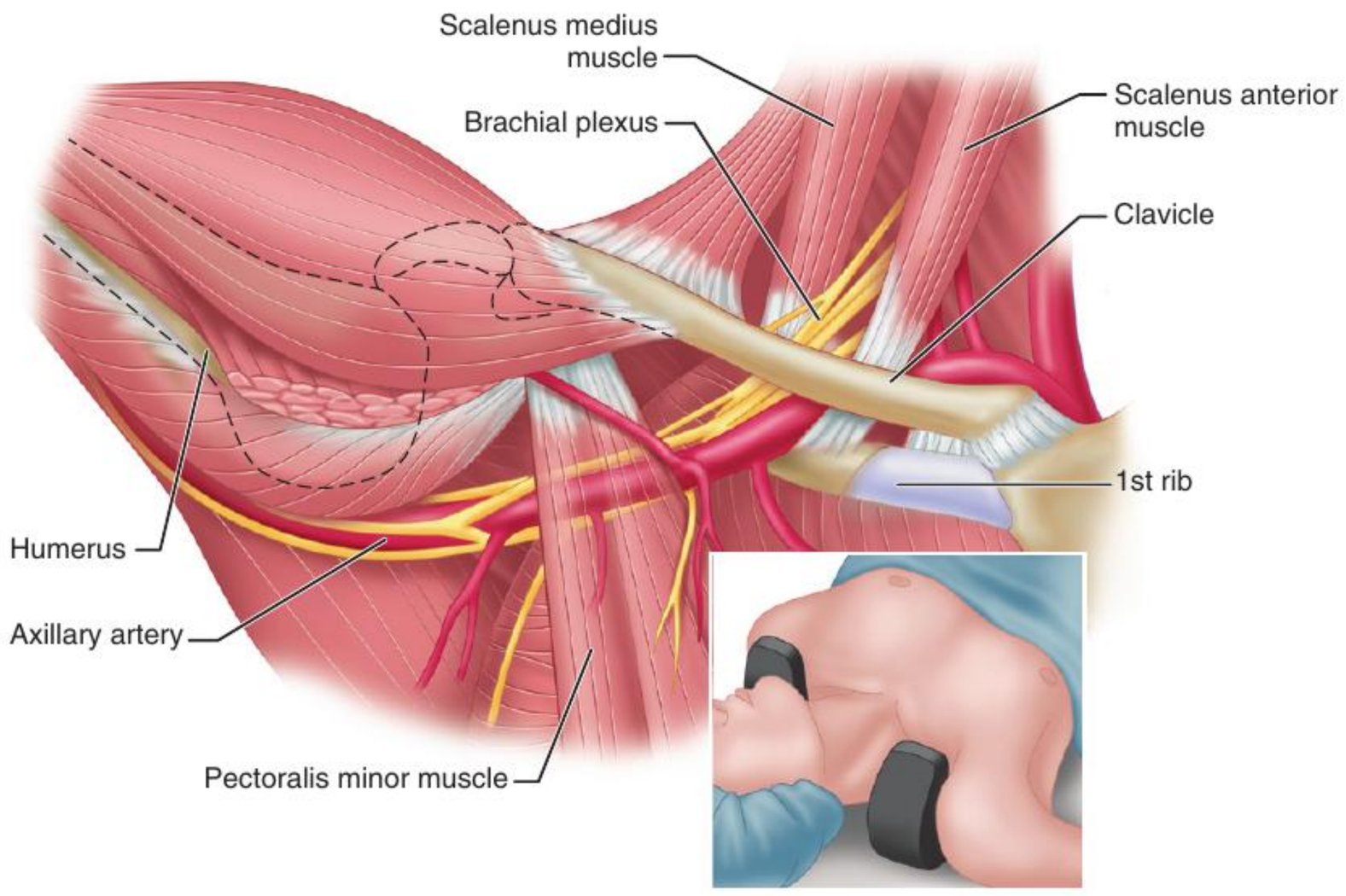


FIGURE 1-3 Anatomical relationships of brachial plexus when limb is hyperabducted. *Inset,* With patient in Trendelenburg position, brace at shoulder is in poor position because limb has been abducted and placed on arm board.

POSITIONING OF THE PATIENT

Before entering the operating room, the surgeon and the awake, alert patient should agree on the surgical site, and the surgeon should mark this clearly to prevent a "wrong-site" error. The position of a patient on the operating table should be adjusted to afford maximal safety to the patient and convenience for the surgeon. A free airway must be maintained at all times, and unnecessary pressure on the chest or abdomen should be avoided. This is of particular importance when the patient is prone; in this position, sandbags are placed beneath the shoulders, and a thin pillow is placed beneath the symphysis pubis and hips to minimize pressure on the abdomen and chest. Large, moderately firm chest rolls extending from the iliac crests to the clavicular areas may serve the same purpose.

When the patient is supine, the sacrum must be well padded; and when the patient is lying on his or her side, the greater trochanter and the fibular neck should be similarly protected. When a muscle relaxant drug is used, the danger of stretching a nerve or a group of nerves is increased. Figure 1-3 shows traction on the brachial plexus from improper positioning of the arm. The brachial plexus can be stretched when the arm is on an arm board, particularly if it is hyperabducted to make room for the surgeon or an assistant or for administration of intravenous therapy. The arm should never be tied above the head in abduction and external rotation while a body cast is applied because this position may cause a brachial plexus paralysis. Rather, the arm should be suspended in flexion from an overhead frame, and the position should be changed frequently. Figure 1-4 shows the position of the arm on the operating table that may cause pressure on the ulnar nerve, particularly if someone on the operating team leans against the arm. The arm must never be allowed to hang over the edge of the table. Padding should be placed over the area where a nerve may be pressed against the bone (i.e., the radial nerve in the arm, the ulnar nerve at the elbow, and the peroneal nerve at the neck of the fibula).

LOCAL PREPARATION OF THE PATIENT

Superficial oil and skin debris are removed with a thorough 10-minute soap-and-water scrub. We prefer a skin cleanser containing 7.5% povidone-iodine solution that is diluted approximately 50% with sterile saline solution. Hexachlorophene-containing skin cleanser is substituted when allergy to shellfish or iodine is present or suspected. After scrubbing, the skin is blotted dry with sterile towels. This scrub can be performed in the patient's room just before surgery or in the operating room. If performed outside the operating room, the extremity must be wrapped securely with sterile sheets.

After a tourniquet has been placed, if one is required, the sterile dressings applied during the earlier preparation should be removed. Care should be taken that the operative field does not become contaminated because the effectiveness of the preparation would be partially lost. With the patient in the proper position, the solutions are applied, each with a separate sterile sponge stick, beginning in the central area of the site of the incision and proceeding peripherally. Tincture of iodine containing 85% alcohol is still widely used as a skin preparation. Once painted on, it is allowed to dry and then is taken off with plain alcohol. Some surgeons routinely use povidone-iodine solution, especially when the risk of a chemical burn from tincture of iodine is significant. The immediate operative field is prepared first; the area is enlarged to include

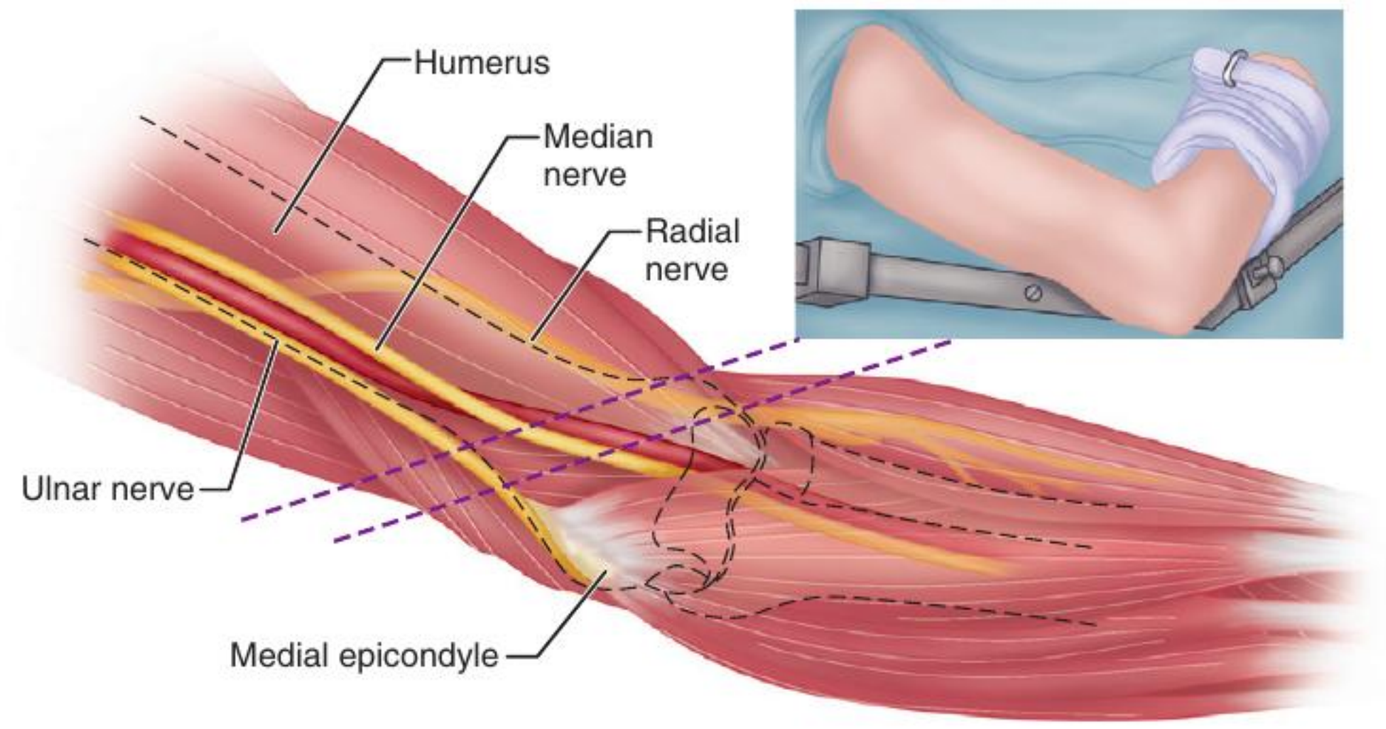


FIGURE 1-4 Points at which nerves of arm may be damaged by pressure. *Inset,* Pressure is applied to medial side of arm because patient is poorly positioned on operating table.

ample surrounding skin. The sponges used to prepare the lumbar spine are carried toward the gluteal cleft and anus rather than in the opposite direction. Sponges should not be saturated because the solution would extend beyond the operative field and must be removed. Excessive iodine, even in the operative field, should be removed with alcohol to prevent chemical dermatitis. If the linen on the table or the sterile drapes become saturated with strong antiseptic solutions, they should be replaced by fresh linen or drapes. Solutions should not be allowed to flow underneath a tourniquet. Alcohol-based solutions should be removed from the field because they can be ignited by a spark from a cautery unit.

If a patient is allergic to iodine, plain alcohol can be used as a skin preparation. Colored proprietary antiseptics, commonly used in abdominal surgery, are not suitable in surgery of the extremities when preparation of the toes or fingernails is involved. Most of these solutions are difficult to remove, and the residual red, pink, or orange color makes evaluation of the circulation difficult after surgery.

When traumatic wounds are present, tincture of iodine and other alcohol-containing solutions should not be used for antiseptic wound preparation. Povidone-iodine or hexachlorophene solutions without alcohol should be used instead to avoid tissue death.

In operations around the upper third of the thigh, the pelvis, or the lower lumbar spine in male patients, the genitalia should be displaced and held away from the operative field with adhesive tape. A long, wide strip of tape similarly helps cover the gluteal cleft, from which there is the potential of infection. In female patients, the genital area and gluteal cleft also are covered longitudinally by strips of adhesive tape. Adherent, sterile, plastic drapes can be used for these purposes.

Before the operative field in the region of the lower lumbar spine, sacroiliac joints, or buttocks is prepared, the gluteal cleft is sponged with alcohol and sterile dry gauze is inserted around the anus so that iodine or other solutions are prevented from running down to this region, causing dermatitis.

Brown et al. and others recommended that before total joint arthroplasty the extremity should be held by a scrubbed and gowned assistant, because this reduces bacterial air counts by almost half. They also recommended that instrument packs not be opened until skin preparation and draping are completed.

When these preparations are done in haste, the gown or gloves of the sterile assistant preparing the area may become contaminated without the assistant's knowledge. To prevent this, a nurse or anesthetist should be appointed to watch this stage of preparation.

WOUND IRRIGATING SOLUTIONS

At my institution, we routinely irrigate clean surgical wounds to keep them moist with sterile isotonic saline or lactated Ringer solution. Occasionally, if the risk of wound contamination is high, antimicrobial irrigating solutions are used. Dirschl and Wilson recommend a triple antibiotic solution of bacitracin, neomycin, and polymyxin because it provides the most complete coverage in clean and contaminated wounds. Antibiotic solutions should remain in the wound for at least 1 minute. Pulsatile lavage systems are more effective in wound irrigation than are simple basting-type syringes.

DRAPING

Draping is an important step in any surgical procedure and should not be assigned to an inexperienced assistant. Haphazard draping that results in exposure of unprepared areas of skin in the middle of an operation can be catastrophic. Considerable experience is required in placing the drapes, not only to prevent them from becoming disarranged during the operation but also to avoid contamination of the surgeon and the drapes. If there is the least doubt as to the sterility of the drapes or the surgeon when draping is complete, the entire process should be repeated. Unless assistants are well trained, the surgeon should drape the patient.

In the foundation layer of drapes, towel clips or skin staples are placed not only through the drapes but also through the skin to prevent slipping of the drapes and exposure of the contaminated skin. In every case, the foundation drapes should be placed to overlap the prepared area of skin

FIGURE 1-5 Disposable drape package for knee surgery.

FIGURE 1-6 Disposable drape package for hip surgery.

at least 3 inches (7.5 cm). During draping, the gloved hands should not come in contact with the prepared skin.

Cloth drapes are being replaced with disposable paper and plastic drape packages specifically designed for the area to be draped (Figs. 1-5 and 1-6). A disposable drape package should have at least one layer made of waterproof plastic to prevent fluids from soaking through to unprepared areas of the body. Drape packages for bilateral knee and foot surgery also are available. Paper drapes give off lint that collects on exposed horizontal surfaces in the operating room if those surfaces are not cleaned daily.

DRAPING THE EDGES OF THE INCISION

The gloved hand should not come in contact with the skin before the incision is made. For the extremities, a section of sterile stockinette is drawn proximally over the operative field. The stockinette is grasped proximally and distally and cut with scissors to uncover the area of the proposed incision. Its cut edges are pulled apart, and the area is covered by a transparent adhesive-coated material (Fig. 1-7). A large transparent plastic adhesive drape may be wrapped entirely around the extremity or over the entire operative field so that the stockinette is not needed. The incision is made through the material and the skin at the same time. The edges of the incision are neatly draped, and the operative field is virtually waterproof; this prevents the drapes in some areas from becoming soaked with blood, which can be a source of contamination. The plastic adhesive drape minimizes the need for towel clips or staples around the wound edge and allows the entire undraped field to be seen easily. Visibility is especially important when there are scars from previous injuries or surgery that must be accommodated by a new incision.

FIGURE 1-7 Iodoform-impregnated plastic adhesive drape.

PREVENTION OF HUMAN IMMUNODEFICIENCY VIRUS TRANSMISSION

At my institution, we agree with the American Academy of Orthopaedic Surgeons (AAOS) Task Force recommendations on acquired immunodeficiency syndrome (AIDS), which go beyond those recommended for health care personnel by the Centers for Disease Control and Prevention and the American Hospital Association. Every effort should be made to prevent further transmission of human immunodeficiency virus (HIV)/AIDS in all areas of medical care. For specific recommendations, the reader is referred to the AAOS Task Force guidelines. We strongly agree with the following AAOS recommendations regarding HIV precautions in the operating room:

1. Do not hurry an operation. Excess speed results in injury. The most experienced surgeon should be responsible for the surgical procedure if the risk of injury to operating room personnel is high.
2. Wear surgical garb that offers protection against contact with blood. Knee-high, waterproof, surgical shoe covers, water-impervious gowns or undergarments, and full head covers should be worn.
3. Double gloves should be worn at all times.
4. Surgical masks should be changed if they become moist or splattered.
5. Protective eyewear (goggles or full face shields) that covers exposed skin and mucous membranes should be used.