CHAPTER 46

General Evaluation of the Knee Patient

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I. Osteoarthritis

A. Etiology and diagnosis
   1. Primary changes of osteoarthritis (OA)
      a. Loss of articular cartilage
      b. Remodeling of subchondral bone
      c. Formation of osteophytes
   2. The disease process usually involves all of the tissues that form the synovial joint, including the articular cartilage, subchondral bone, metaphyseal bone, synovium, ligaments, joint capsule, and muscles crossing the joint.
   3. OA is the leading cause of disability and impaired quality of life in developed countries in patients older than 65 years. As the population ages, the prevalence of OA is expected to increase 66% to 100% by 2030.
      a. OA affects all ethnic groups and geographic locations.
      b. It is more common in women than in men.
      c. The knee is the most commonly affected joint, with 12% of adults older than 60 years diagnosed with knee OA.
   4. Although the name implies that it is an inflammatory disease, inflammation does not appear to be a major component of OA in most patients.

5. Risk factors
    a. Advancing age (perhaps the most important risk factor)
    b. Female sex; the loss of estrogen over time increases risk
    c. Genetics
    d. Obesity
6. A strong association exists between age and OA, but OA is no simply the result of mechanical wear from joint use.
7. The etiology of OA is multifactorial.
    a. On a cellular level, it appears that OA is the result of deterioration in the ability of chondrocytes to maintain and restore articular cartilage.
    b. Evidence exists that chondrocytes undergo age-related telomere erosion, and increased expression of the senescence marker, β-galactosidase, suggests that cell senescence is responsible for the age-related loss of chondrocyte function.
    c. The known causes of secondary OA are listed in Table 1.
    d. The age at onset of secondary OA depends on the underlying cause.
    e. Overall, women are disproportionately affected at a higher rate than men; men younger than 55 years are diagnosed at a higher rate than women.

B. Evaluation of the knee
1. History
    a. Pain often is exacerbated with activity and relieved by rest.
    b. Patients may describe a deep aching pain with decreased range of motion and swelling.
2. Physical examination
    a. Physical examination of the knee often reveals restricted range of motion, crepitus, tenderness along the joint line, an effusion, and some degree of deformity.
    b. Patellar tracking and ligament stability should be assessed.
    c. Varus or valgus alignment should be noted, as well as any gait abnormality.
3. Atrophy in muscles crossing the affected joint is often present in

chronic disease.

4. Patients with OA have an altered gait and increased energy cost.

C. Radiographs

1. Weight-bearing radiographs are the most sensitive for confirming the diagnosis of OA.
2. In the knee, sunrise views and AP views in flexion may demonstrate OA not visible on standard AP and lateral views.
3. Radiographic changes
   a. Narrowing of the cartilage space.
   b. Increased density of the subchondral bone (sclerosis).
   c. Osteophytes.
   d. In more severe cases, subchondral cysts (geodes), loose bodies, joint subluxation, deformity, and malalignment may be present.
   e. Bony ankylosis is rare but may occur.

D. Treatment based on AAOS Clinical Practice Guidelines for Knee OA

1. We recommend that patients with symptomatic osteoarthritis of the knee participate in self-management programs, strengthening, low-impact aerobic exercises, and neuromuscular education and engage in physical activity consistent with national guidelines (Strength of Recommendation: Strong).
2. We suggest weight loss for patients with symptomatic osteoarthritis of the knee and a body mass index (BMI) ≥25 (Strength o Recommendation: Moderate).
3. We cannot recommend using acupuncture in patients with symptomatic osteoarthritis of the knee (Strength of Recommendation: Strong).
4. We are unable to recommend for or against the use of physical agents (including electrotherapeutic modalities) in patients with symptomatic osteoarthritis of the knee (Strength of Recommendation: Inconclusive).
5. We are unable to recommend for or against manual therapy in patients with symptomatic osteoarthritis of the knee (Strength of Recommendation: Inconclusive).

6. We are unable to recommend for or against the use of a valgus directing force brace (medial compartment unloader) for patients with symptomatic osteoarthritis of the knee (Strength of Recommendation: Inconclusive).
7. We cannot suggest that lateral wedge insoles be used for patients with symptomatic medial compartment osteoarthritis of the knee (Strength of Recommendation: Moderate).
8. We cannot recommend using glucosamine and chondroitin for patients with symptomatic osteoarthritis of the knee (Strength of Recommendation: Strong).
9. We recommend NSAIDs (oral or topical) or tramadol for patient with symptomatic osteoarthritis of the knee (Strength of Recommendation: Strong).

    NSAIDs shoulld be the first line of treatment, with tramado reserved for refractory cases, or short term use for acute, severe pain.
10. We are unable to recommend for or against the use of acetaminophen, opioids, or pain patches for patients with symptomatic osteoarthritis of the knee (Strength of Recommendation: Inconclusive).
11. We are unable to recommend for or against the use of intra-articular (IA) corticosteroids for patients with symptomatic osteoarthritis of the knee (Strength of Recommendation: Inconclusive).
12. We cannot recommend using hyaluronic acid for patients with symptomatic osteoarthritis of the knee (Strength of Recommendation: Strong).
13. We are unable to recommend for or against growth factor injections and/or platelet-rich plasma for patients with symptomatic osteoarthritis of the knee (Strength of Recommendation: Inconclusive).
14. We cannot suggest that the practitioner use needle lavage for patients with symptomatic osteoarthritis of the knee (Strength of Recommendation: Moderate).

TABLE 1

Causes of Secondary Osteoarthritis

Acromegaly
Aseptic necrosis
Ehlers-Danlos syndrome
Gaucher disease
Hemochromatosis
Hemorrhagic conditions
Hemophilia
Pigmented villonodular synovitis
Sickle cell anemia
Joint dysplasias
Neuropathic arthropathies
Amyloidosis
Charcot joints
Congenital insensitivity to pain
Diabetes mellitus
Leprosy
Myelomeningocele
Syphilis
Syringomyelia
Ochronosis
Paget disease
Posttraumatic
High-impact joint loading

Intra-articular fractures
Ligament injuries
Septic arthritides
Fungal
Lyme disease
Pyogenic
Tuberculosis
Stickler syndrome

II. Inflammatory Arthropathy

A. Rheumatoid arthritis (RA)
   1. Inflammatory arthropathies often are associated with poor host bone quality as a result of oral corticosteroid treatment or disuse osteopenia.
   2. The rates of systemic complications, infection, revision, and 90-day readmission after total knee arthroplasty (TKA) in patients with different types of inflammatory arthritis were significantly higher than those in control patients with osteoarthritis.
   3. Of patients with RA, 90% have cervical spine involvement.
      a. Patients with RA should undergo cervical spine lateral flexion/extension imaging before elective surgery to rule out atlantoaxial instability.
      b. A difference of more than 9 to 10 mm in the atlanto-dens interval on flexion/extension views or less than 14 mm of space available for the cord is associated with an increased risk of neurologic injury and usually requires surgical management.
   4. Patients with RA also may have micrognathia or loss of motion in

the temporomandibular joint.

5. Preoperative planning in patients with juvenile RA is imperative to ensure that appropriately sized (small) components are available.

B. Seronegative arthropathies

1. The risk of infection with total joint arthroplasty is increased in patients with psoriatic arthritis.
    a. Skin incision through active psoriatic lesions should be avoided because the lesions can be highly colonized by bacteria.
    b. Preoperative treatment of lesions in an incision area is recommended.
2. Patients with ankylosing spondylitis may have an increased risk of heterotopic ossification, although this risk is not supported by strong data.
    a. These patients are also at greater risk for pulmonary complications because of chest wall constriction and fibrotic changes.
    b. Preoperative cardiopulmonary evaluation is recommended.
    c. The risk of systemic complications, infection, revision, and 90-day readmission after TKA in patients with different types of inflammatory arthritis were significantly higher than those in control patients with osteoarthritis.

III. Osteonecrosis

A. Diagnosis and management options for the knee

1. Secondary osteonecrosis of the knee is much less common than osteonecrosis of the femoral head (approximately 10%).
2. Three distinct osteonecrosis pathologic entities with similar presentations exist:
    a. Spontaneous osteonecrosis of the knee (SPONK; Figure 1)
        SPONK is more common in women older than 55 years.
        In 99% of patients, SPONK involves only one joint and only one condyle (typically, the epiphysis of the medial femoral

condyle). Some evidence shows that these lesions actually represent microfractures.

- Controversy exists about whether SPONK is part of progression of OA or an insufficiency fracture.

b. Secondary osteonecrosis of the knee

- Secondary osteonecrosis typically involves more than one compartment of the knee or even the metaphyseal bone.
- Multifactorial etiology; characterized by loss of bone circulation.
- Approximately 80% of cases have bilateral involvement, and many cases are multifocal.
- Patients with secondary osteonecrosis also are typically women (3:1 ratio), but they are usually younger than 55 years and have associated risk factors for osteonecrosis (Table 2).
- Osteonecrotic lesions can occur in the epiphysis, diaphysis, or metaphysis.
- Patients with secondary osteonecrosis should be screened clinically for other joint involvement.

c. Postarthroscopic osteonecrosis of the knee

- Associated with subchondral collapse
- Usually involves the medial femoral condyle

B. Classification—Based on radiographic changes (Figure 2)

C. Evaluation

1. Differential diagnosis—It is important not to confuse osteonecrosis with similar knee disorders such as osteochondritis dissecans, transient osteoporosis, bone bruises, or occult fractures.
   a. Osteochondritis dissecans is more common in the lateral condyle of adolescent (age, 15 to 20 years) males.
   b. Transient osteoporosis is more common in young to middle-aged men.
      - Transient osteoporosis is most common in the hip, followed by the knee and the foot or ankle.
      - Multiple joint involvement, referred to as transient migratory

osteoporosis, is present in about 40% of patients with transient osteoporosis.

c. Occult fractures and bone bruises generally are associated with trauma, bone fragility, or overuse.

2. Imaging—MRI is the most useful study for differentiating osteonecrosis from other conditions.

a. Bone edema on MRI is a common feature of OA, osteonecrosis cartilage injury, and transient regional osteoporosis.

b. Serpentine lesions within a well-demarcated border is a specific finding on MRI for osteonecrosis.

D. Treatment

1. Nonsurgical

a. Nonsurgical treatment includes analgesics (NSAIDs tramadol), protected weight bearing, and physical therapy directed at quadriceps strengthening.

b. Good results have been demonstrated with nonsurgical management of SPONK and postarthroscopic osteonecrosi but not with secondary osteonecrosis.

c. Secondary osteonecrosis progresses to advanced OA in 80% of patients treated nonsurgically.

d. Bisphosphonates have been used to manage osteonecrosis of the hip, but no evidence is available regarding their efficacy in osteonecrosis of the knee.

2. Surgical options for SPONK and postarthroscopic osteonecrosis

a. High tibial osteotomy when angular malalignment is present; bone grafting, osteochondral autograft transfer, or mosaicplasty are options if subchondral collapse is present.

b. Unicondylar knee arthroplasty (UKA) when a smaller total area of bone is involved.

c. TKA for larger lesions or bone collapse that precludes the use of unicondylar knee arthroplasty.

3. Surgical options for secondary osteonecrosis

a. Diagnostic arthroscopy (to remove small, unstable osteochondral fragments)

b. Core decompression (for lesions that do not involve the articular surface)
c. Osteochondral allograft (for larger compartmental lesions in younger patients)
d. TKA when a large area is involved or in articular collapse or multiple compartment involvement

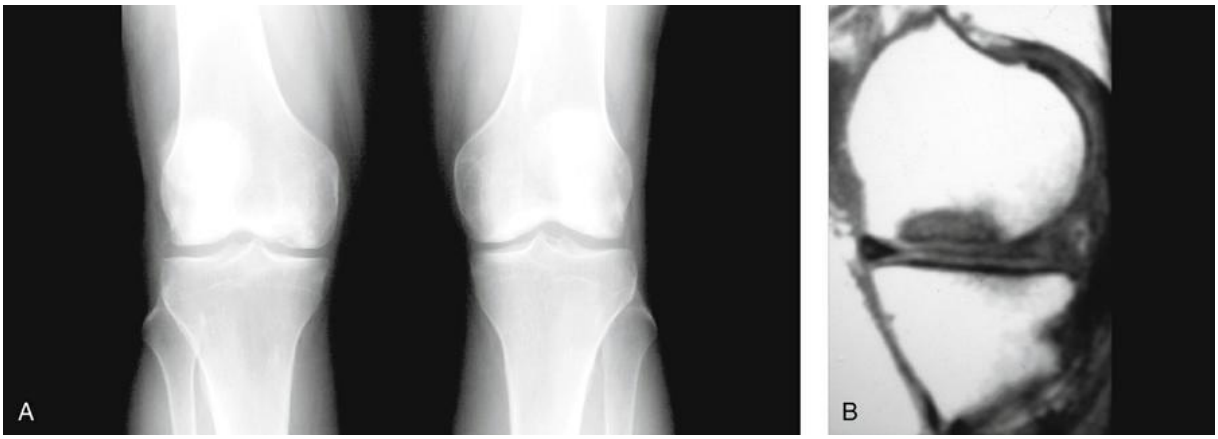

FIGURE 1 Spontaneous osteonecrosis of the knee (SPONK). **A**, AP radiograph of both knees shows a SPONK lesion in the medial condyle of the right knee. **B**, Sagittal T1-weighted MRI shows a unilateral SPONK lesion.(Panel A courtesy of Thomas Parker Vail, MD, San Francisco, CA. Panel B reproduced from MontMA , LonnerJH , RaglandPS , McCarthyJC : Osteonecrosis of the knee, in BarrackRL , BoothRE Jr , LonnerJH , McCarthyJC , MontMA , RubashHE , eds: Orthopaedic Knowledge Update: Hip and Knee Reconstruction, ed 3. Rosemont, IL, American Academy of Orthopaedic Surgeons, 2006, pp 157-162.)

TABLE 2
Risk Factors Associated With Osteonecrosis of the Femoral Head

Direct causes
Trama
Irradiation
Hematologic disorders (leukemias, lymphomas)

Cytotoxins
Dysbaric osteonecrosis (caisson disease)
Gaucher disease
Sickle cell disease or trait
Indirect causes
Corticosteroids
Alcohol abuse
Systemic lupus erythematosus
Renal failure
Organ transplant
Idiopathic osteonecrosis
Hemophilia
Thrombophilia
Hypofibrinolysis

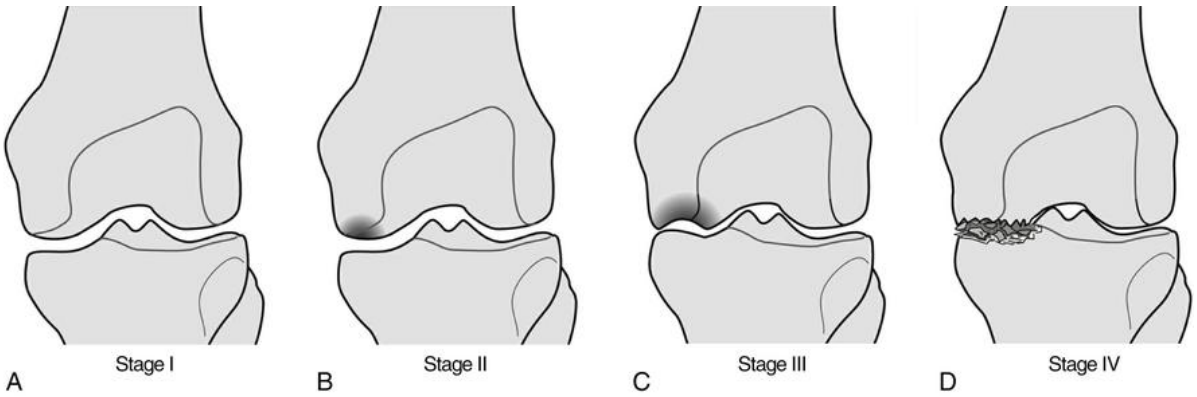

FIGURE 2 Illustrations of the Ficat stages of knee osteonecrosis demonstrate the

progression from precollapse lesions to late-stage disease and cortical bone collapse. **A**, Stage I: no radiographic evidence of knee osteonecrosis. The femoral condyles appear normal, with no sclerosis and maintained curvature. **B**, Stage II: signs of mottled sclerosis are evident, but the normal curvature of the bone remains intact. **C**, Stage III: the presence of a crescent sign indicates subchondral fracture, which defines this stage. **D**, Stage IV: collapse of the subchondral bone.(Reproduced from MontMA , MarkerDR , ZywielMG , CarrinoJA : Osteonecrosis of the knee and related conditions. J Am Acad Orthop Surg 2011;19[8]:482-494.)

IV. Effect of Comorbidities

A. Neuromuscular diseases
    1. Parkinson disease
        a. Parkinson disease originally was considered an absolute contraindication to TKA because of failed rehabilitation due to hamstring rigidity, flexion contracture, and inhibition of the extensor mechanism, but several studies have shown that TKA can be successful in improving function and relieving pain in these patients.
        b. Function after TKA appears to be related to the stage of the neurologic disease.
    2. Neuropathic arthropathy (Charcot arthropathy secondary to diabetes mellitus, neurosyphilis, central cord syndromes)
        a. Historically, Charcot arthropathy was considered a contraindication to TKA, but good results can be obtained with careful limb alignment, reinforcement of bone defects, and the use of stems and constrained devices to treat joint subluxation.
        b. Complication rates are higher in patients with neuropathic arthropathy than in those with other diagnoses.
        c. The outcome of joint arthroplasty in patients with neuropathic arthropathy secondary to neurosyphilis appears to be worse than in patients with neuropathic arthropathy secondary to diabetes.
B. Obesity

1. Data regarding the risks, benefits, and potential complications of TKA in the obese population are conflicting.
2. Preoperative considerations are optimization of nutritional status, safe weight loss strategies, and bariatric surgery. Intraoperative concerns unique to this population include inadequate exposure, implant alignment, and durable implant fixation.
3. Postoperative issues include tibial loosening, wound complications, cardiovascular events, and respiratory complications.
4. In general, studies focusing on weight change after surgery show that patients remain obese after joint arthroplasty.

V. Thromboembolic Disease

A. Epidemiology
   1. TKA is associated with a risk of symptomatic venous thromboembolism (VTE), which includes deep vein thrombosis (DVT) and pulmonary embolism (PE).
   2. The prevalence of fatal PE after TKA ranges from 0% to 0.32%, and the prevalence of symptomatic PE is approximately 1%.

B. Prophylaxis
   1. Experts agree that prophylaxis is required, but the range of appropriate regimens remains controversial, with some lack of consistency between the recommendations made by the American College of Chest Physicians and the American Academy of Orthopaedic Surgeons and real-world practice patterns.
   2. The selection of a prophylactic agent involves a balance between safety and efficacy.
   3. Several pharmacologic and mechanical agents have been shown to be effective for the prevention of VTE in TKA patients.
      a. Warfarin
      b. Low-molecular-weight heparin
      c. Fondaparinux
      d. **Apixaban, dabigatran, rivaroxaban—direct inhibitors**

e. Mechanical compression—Pneumatic compression has been shown to be effective in limiting clot formation after TKA
f. Aspirin

4. The ideal duration of therapy has not been established.
   a. The median time to diagnosis of DVT was 7 days in TKA.
   b. Prophylaxis should be continued for a minimum of 10 to 14 days beyond hospital discharge.
   c. Only limited evidence suggests that prolonged prophylaxis (beyond 2 weeks) is beneficial for TKA patients.
5. Guidelines developed by the American Academy of Orthopaedic Surgeons recommend the following:
   a. Early mobilization
   b. Neuraxial anesthesia
   c. Pharmacologic +/− mechanical compression
   d. Discontinuation of antiplatelet drugs
6. Inheritable thrombophilia
   a. Antithrombin III deficiency, protein C deficiency, and the prothrombin 20210A gene mutation appear to increase the chance of VTE in total joint arthroplasty patients.
   b. Factor V Leiden and methylene tetrahydrofolate reductase mutations do not appear to increase the chance of VTE.
   c. Identification of specific genetic risk factors for VTE is needed.

Top Testing Facts

1. Weight-bearing radiographs are the most sensitive in confirming the diagnosis of OA.
2. Weight loss and exercise are supported by good evidence in the treatment of patients with symptomatic knee OA.
3. A difference of more than 9 to 10 mm in the atlanto-dens interval on flexion/extension views or less than 14 mm space available for the cord is associated with an increased risk of neurologic injury and usually requires surgical management.
4. The risk of systemic complications, infection, revision, and 90-day

readmission after TKA in patients with different types of inflammatory arthritis were significantly higher than those in control patients with osteoarthritis.

5. Osteochondritis dissecans is more common in the lateral condyle of adolescent (age, 15 to 20 years) males.
6. MRI is the most useful study when evaluating a patient for suspected osteonecrosis of the knee.
7. Secondary osteonecrosis progresses to advanced OA in 80% of patients treated nonsurgically, and many patients will require TKA.
8. Data regarding the risks, benefits, and potential complications of TKA in the obese population are conflicting.
9. Obese patients are at increased risk for various complications after TKA, including infection, loosening, and revision arthroplasty.
10. DVT prophylaxis is required after TKA. The selection of a prophylactic agent involves a balance between efficacy and safety.

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Neither of the following authors nor any immediate family member has received anything of value from or has stock or stock options held in a commercial company or institution related directly or indirectly to the subject of this chapter: Dr. Pinkowsky and Dr. Maish

CHAPTER 47

Radiographic Evaluation and Surgical Anatomy of the Knee

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I. Radiographic Evaluation

A. Introduction
   1. Radiographic studies help confirm the clinical diagnosis of a joint disorder determined using the patient's history and physical examination. Plain radiographs are appropriate initial imaging studies for most knee conditions because they allow the assessment of traumatic injury, arthritis, patellofemoral alignment, osteochondral injury, bone neoplasm, and surgical implants. Advanced radiographic imaging studies may help assess overall limb alignment and further delineate intra-articular and extra-articular soft tissues, including cartilage, menisci, ligaments, tendons, muscles, and nerve and vascular structures.

B. Plain radiography
   1. General information
      a. Orthogonal views—Imaging studies should include at least two perpendicular views: AP (Figure 1) and lateral (Figure 2)
      b. Weight-bearing views—An axial load compresses the joint space
         AP (extension)—Used to assess cartilage loss from the distal femur and tibial plateau
         PA (Rosenberg; flexion)—Used to assess cartilage loss from the posterior femur and tibial plateau

c. Patellofemoral views—Used to assess patellofemoral alignment (tilt/subluxation), patellar and trochlear morphology, osteochondral injury, and patellofemoral arthritis
d. Notch view—Used to assess posterior femoral cartilage, notch width, and osteophytes

2. Clinical indications
   a. Trauma—Non–weight-bearing radiographs may identify acute injury without the risk of fracture displacement
      Fracture of the distal femur, proximal tibia, patella, or tibial tuberosity
      Dislocation of the tibiofemoral or patellofemoral joint
      Injury of the anterior cruciate ligament (ACL)/Segond fracture. Lateral capsular avulsion (meniscotibial ligament) is pathognomonic but not essential for ACL injury. Hemarthrosis is frequently present.
      Injury of the medial collateral ligament (MCL). Avulsion of the medial femoral epicondyle (Pellegrini-Stieda lesion) may appear within a few weeks of proximal MCL avulsion injury.
   b. Knee pain
      Osteoarthritis—Radiography may identify subchondral sclerosis, joint space narrowing, subchondral cysts (variable), osteophytes (variable), and joint subluxation.
      Inflammatory arthropathy—Joint space loss, peripheral bone erosion
      Osteochondral defects—Subchondral radiolucency, most common in the medial femoral condyle
      Stress fracture—Linear radiolucency or radiodensity, most common in the proximal medial tibia
      Osteonecrosis—Mixed sclerotic pattern with a subchondral, epiphyseal, or metaphyseal location. May be a stable lesion or associated with collapse.
      Patellofemoral disease—Malalignment, osteophytes, cysts, joint space loss

C. Computed tomography
    1. General information
        a. Three-dimensional study performed with ionizing radiation; provides enhanced bone detail
    2. Clinical indications
        a. Imaging in the axial, sagittal, and coronal planes may help visualize fracture lines and displacement, osteolytic lesions around joint arthroplasty, and cortical disruption in cases of infection or neoplasia.
        b. Three-dimensional reconstructions may help with preoperative planning for complex intra-articular fractures, multiplanar osteotomy for limb malalignment, and reconstitution of bone loss in joint arthroplasty.
        c. Axial plane imaging of the hip and knee can help assess the rotational alignment of components of a total knee arthroplasty in cases of patellar maltracking.

D. Magnetic resonance imaging
    1. General information
        a. Increasing strength of the magnetic field (measured in Tesla units) increases the resolution of images.
        b. An injected contrast agent (intravenous or intra-articular) may help delineate specific tissues of interest.
    2. Clinical indications (Figures 3 and 4)
        a. Cruciate ligaments (ACL/posterior cruciate ligament [PCL])-The presence of edema, intra-articular fluid, disruption of ligament fibers, and an atypical ligament contour may suggest injury.
        b. Meniscus—Patterns of meniscal injury can be identified by location (anterior, midbody, posterior, peripheral, articular), pattern (horizontal, longitudinal, radial, complex), and displacement.
        c. Articular cartilage—MRI may identify the degree of articular cartilage injury (chondrosis, full-thickness cartilage loss), the presence of associated bone marrow edema, and the location

(medial condyle, lateral condyle, trochlea, patella; anterior, posterior).

d. Extra-articular ligaments—Edema, avulsion, or discontinuity may be identified for the MCL/lateral collateral ligament (LCL or associated posteromedial and posterolateral ligamentous complexes.

e. Tendon injury—MRI may be used to assess the continuity of the quadriceps or patellar tendon.

f. Neurovascular structures—MRI may be used to assess the margin of resection for a neoplasm, identify vascular malformation, or define the location of nerves or vessels relative to popliteal cysts.

E. Nuclear medicine

1. General information

a. Labeled radionuclide injection followed by delayed imaging of gamma radiation

b. Areas of increased radionuclide concentration appear bright or "hot."

c. Provides a nonspecific study that does not define the etiology of an abnormality but rather the presence of an abnormality that may correlate with a clinical concern

d. Increased radionuclide activity in bone may be a normal postoperative finding for up to 6 to 12 months after a fracture repair or arthroplasty.

2. Clinical indications (Figure 5)

a. Technetium-99 (Tc-99) is a radionuclide that may help identify infection, neoplasia, occult fracture, bone healing, active phases of heterotopic ossification, implant loosening, or failure of osseointegration.

b. Gallium-67 (Ga-67) is a radionuclide that may help differentiate between aseptic and septic prosthetic loosening; 24 to 72 hours are needed for a complete study.

c. Indium-111 (In-111) is a radionuclide used in leukocyte scanning, in which white blood cells are labeled and assessed.

In-111 is more likely to concentrate in areas of infection and may help delineate the etiology of prosthetic loosening or identify the foci of osteomyelitis.

FIGURE 1 Weight-bearing AP radiograph of both knees. Right knee demonstrates moderate loss of medial compartment joint space.