Chapter 2
Hip and Knee Osteoarthritis

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Key Points

- Osteoarthritis (OA) is the result of the loss of the ability of chondrocytes to maintain and restore articular cartilage.
- OA can be classified as primary (due to routine wear on the joint) or secondary (due to a specific etiology, i.e., posttraumatic, hemochromatosis, septic arthritis, etc.).
- Risk factors include modifiable (e.g., obesity, trauma, etc.) and non-modifiable (e.g., age, gender, genetics, etc.) factors.
- OA leads to classic changes within the joint including loss of articular cartilage, joint space narrowing, subchondral sclerosis, formation of subchondral cysts, and osteophyte formation.
- Nonsurgical and nonpharmacologic treatment includes exercise, weight loss, and bracing.
- Pharmacologic treatment includes oral nonsteroidal anti-inflammatory medications and intra-articular injection of corticosteroids, hyaluronic acid, and plasma-rich protein.
- Surgical management includes arthroscopy, osteotomy, arthrodesis, and arthroplasty.

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Introduction

OA is a debilitating disease that occurs most frequently in the hands, feet, knees, and spine but can develop in any synovial joint [1]. Although OA is most common in the hand, knee OA is most likely to lead to disability [1]. Incidence of symptomatic hand OA is at 100 per 100,000 compared to 240 per 100,000 for the knee [2]. About 95 % of total knee arthroplasties (TKA) and total hip arthroplasties (THA) are done for symptomatic OA. Currently, approximately 800,000 TKA and THA are performed in the USA annually, with the number expected to exceed 1.2 million by the year 2020 [3].

Clinical Evaluation

History

General symptoms associated with OA include joint pain, often worse in the morning, as well as stiffness and swelling. Advanced OA can also cause pain at rest and nighttime pain severe enough to wake the patient while sleeping. Pain is usually described as deep, aching, and poorly localized. Radiation of pain can also occur and should be considered while examining the patient.

Hip

Hip OA is usually associated with pain located in the groin; radiation of pain should be considered with hip OA. These patients may report knee pain rather than hip pain resulting from a branch of the obturator nerve. A patient may hold the hip with one hand, the so-called C-sign that is commonly seen in patients with hip pathology. Pain laterally or posteriorly over the buttock is unlikely from an intra-articular cause, and the history should be evaluated further. Differential diagnosis for articular causes of groin pain includes OA, osteonecrosis, hip dysplasia, FAI, infection, or femoral neck fractures.

Knee

The location of pain should be noted during patient history. Anterior knee pain that is exacerbated with squatting or stair climbing may indicate patellofemoral involvement. Pain at the joint line associated with mechanical symptoms may indicate meniscal pathology. Again, it is important to remember that referred pain from both the lumbar spine and ipsilateral hip may present as knee pain.

Physical Exam

A general screening musculoskeletal exam should be performed to assess for other potential pathologies. Moving on to the affected extremity, a detailed and thorough neurovascular examination should be completed and documented. Patients with OA often have altered gain secondary to both pain and deformity. Atrophy of muscles crossing the affected joint is often present in chronic disease.

Hip

Evaluation of gait is an important aspect of the hip exam. Gait can be antalgic, related to a leg-length difference or muscle weakness (Trendelenburg gait). Foot progression angle should also be noted. A detailed lumbar spine exam should be performed in addition to a distal neurovascular exam. The hip should be inspected looking for any previous scars, atrophy, or deformity. Palpation of lateral-based pain can help distinguish non-arthritic sources of pain such as greater trochanteric bursitis. Active and passive range of motion (ROM) should be assessed. It is important to stabilize the pelvis when examining the hip. ROM will usually reproduce pain in the arthritic hip, specifically flexion with internal rotation. Flexion contracture of the hip can be assessed with the Thomas test. Here, the patient lies supine on the exam table and brings one knee toward their chest while keeping the contralateral leg extended. The test is positive if the contralateral leg flexes, which is due to a tight iliopsoas.

Knee

Gait should also be examined, with specific attention to alignment and instability during gait analysis. Hip exam should be performed, as hip ROM can occasionally reproduce the knee pain. Inspection should be performed noting for any effusion, scars, deformity, and overall alignment. Ligaments should be examined assessing for any instability. Ability to correct the deformity should also be noted. The knee should then be palpated, attempting to localize areas of tenderness. ROM of the knee should be assessed, noting for flexion deformities and patellar tracking.

Imaging

Weight-bearing radiographs are effective at confirming the diagnosis of OA and also for assessment of deformity and potential operative planning. Radiographic changes associated with an arthritic joint include narrowing of the joint space, increased sclerosis or density of the subchondral bone, osteophyte formation, subchondral cyst (geode) formation, loose bodies, joint subluxation, deformity, and malalignment.

Absence of positive radiographic findings in a patient with symptoms of OA should not be interpreted as absence of disease, as the radiographs are not sensitive early in the disease process. There may also be a poor association between radiographic changes and functioning in patients with OA [4].

Hip

Standard radiographs for hip pathology should include an AP pelvis and a lateral of the affected hip joint. Hip OA is often associated with superolateral narrowing, which can then progress to global narrowing of the hip joint. Figure 2.1 demonstrates typical findings with hip OA including joint space narrowing (JSN), sclerosis, and osteophyte formation. Patients with an underlying coxa profunda may develop a more medial pattern of OA with preservation of the superior and lateral joint space. The Tönnis Classification has been established to characterize and describe radiographic findings associated with hip OA. Classification is as follows: 0, no signs of osteoarthritis; 1, mild (increased sclerosis, slight JSN, no or slight loss of head sphericity); 2, moderate (small cysts, moderate JSN, moderate loss of head sphericity); and 3, severe (large cysts, severe narrowing or obliteration of the joint space, severe deformity of the head).

Knee

Standard radiographs for knee pathology should include standing AP, lateral, merchant, and tunnel views. Figure 2.2 demonstrates some findings associated with knee OA including medial JSN. The same patient had an MRI, demonstrated in

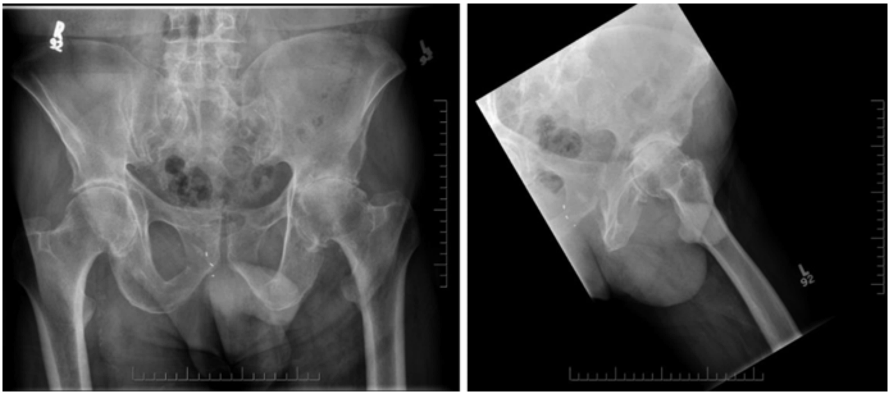

Fig. 2.1 AP pelvis and lateral radiograph of left hip showing typical findings of osteoarthritis including joint space narrowing, sclerosis, and osteophyte formation

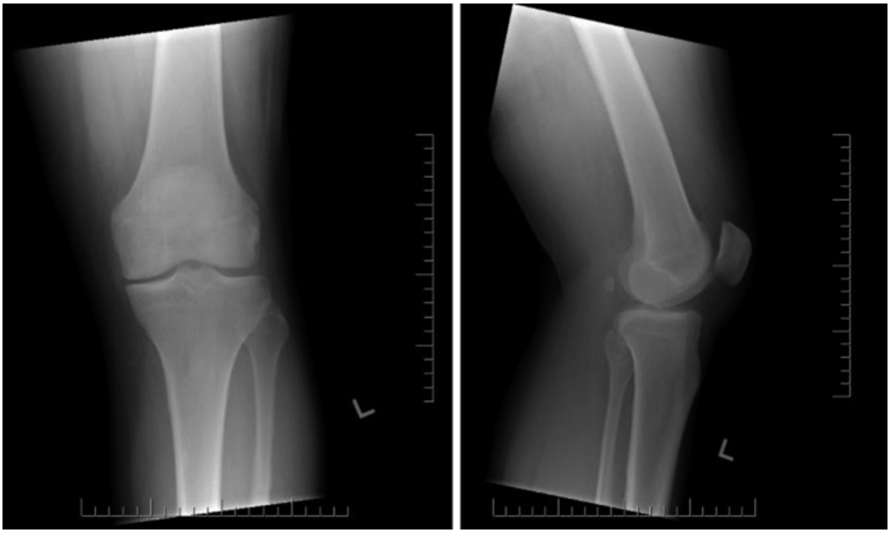

Fig. 2.2 AP and lateral radiograph of the left knee demonstrating decreased medial joint space compared to the lateral compartment

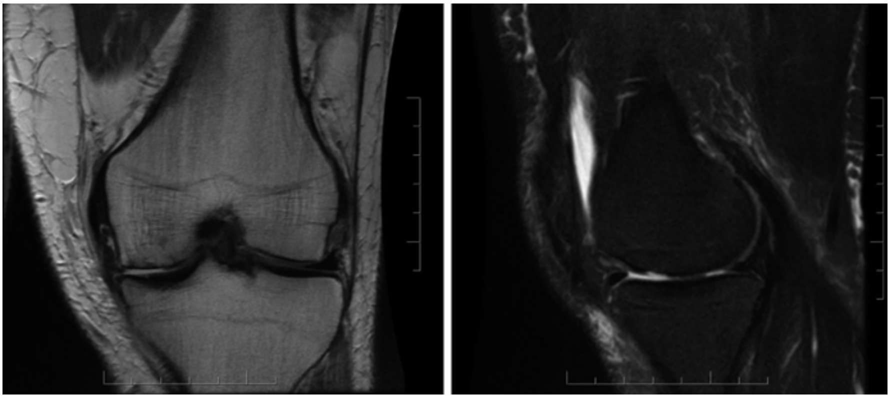

Fig. 2.3 Representative coronal and sagittal cut from a left knee MRI (same patient as in Fig. 2.2) demonstrating severe degenerative changes in the medial compartment

Fig. 2.3, which demonstrates more severe medial compartment degenerative changes than the radiographs would suggest. If the radiographs are not standing images, JSN and deformity may be minimized. Stress radiographs may be obtained to assess ligamentous instability. In patients with malalignment of the lower extremity, hip-to-ankle images can be obtained to better understand the location and cause of deformity.

Treatment

Nonsurgical and Nonpharmacologic

Nonsurgical and nonpharmacologic methods of treatment for OA do exist. An exercise program should be considered as first-line treatment for all patients with symptomatic arthritis. Strengthening the muscles surrounding the joint can help to relieve some symptoms. Weight loss in overweight patients can also help to decrease the stress the joint is forced to endure [5, 6]. Orthoses including shoe wedges and knee unloading braces can help to partially correct malalignment in the lower extremity and provide some relief.

Pharmacologic

Pharmacologic treatment can provide significant relief for patients suffering from OA. Nonsteroidal anti-inflammatory medications (NSAIDs) can help to alleviate pain due to inflammation associated with OA. These patients should be monitored by their general practitioner for adverse effects associated with use of these medications. Intra-articular injections can also be used as a treatment strategy; options include corticosteroids, hyaluronic acid (HA), as well as plasma-rich protein (PRP).

Surgical Treatment

Arthroscopy

Hip Arthroscopy

Arthroscopy can be used as a less invasive surgical procedure to treat various intra-articular hip disorders. This procedure has had an expanding role as of late in the treatment of prearthritic and early arthritic hip disease. Indications for hip arthroscopy currently include symptomatic labral tears, early articular cartilage disease (chondral flaps, chondromalacia), symptomatic hip impingement, synovitis, loose bodies, ligamentum teres ruptures, and diagnostic evaluation of the hip.

Contraindications to hip arthroscopy include advanced degenerative joint disease, disease states that limit arthroscopic access to the joint (morbid obesity, protrusio, joint ankylosis, heterotopic bone), and intra-articular hip disease (e.g., labral tears) associated with major structural abnormalities (developmental hip dysplasia) that require correction of the underlying structural problem.

Clinical results for hip arthroscopy depend on the initial indication for the procedure. Good to excellent clinical results are obtained at short-term follow-up in approximately 70–85 % of the patients treated for labral disease [7, 8]. A guarded prognosis is associated with moderate to advanced (grade IV) articular cartilage disease. The complication rate associated with hip arthroscopy is low (1–3 %). Neurovascular injury is a complication associated with this procedure.

Lateral femoral cutaneous nerve is the most at risk structure (anterior portal), while the most common neurovascular complication is a transient neuropraxia of the pudendal nerve related to traction. Other complications include deep vein thrombosis, instrumentation breakage, articular scuffing, wound hematoma, infection, and ankle strain or fracture.

Knee Arthroscopy

Knee arthroscopy is a common surgery used to treat a variety of intra-articular pathologies. With the arthritic knee, in the absence of mechanical symptoms, arthroscopic debridement is strongly recommended against [9]. At the time of arthroscopy, several strategies can be used to potentially help improve symptoms. Arthroscopic lavage and debridement of the arthritic knee is controversial but effective when properly indicated. Indications are limited to specific mechanical symptoms caused by loose bone, cartilage flaps or particles, meniscal tears, or synovial impingement. Irrigation during arthroscopy dilutes the joint fluid, which reduces the concentration of degradative enzymes. Chondroplasty, specifically removing or stabilizing diseased cartilage, can help to improve mechanical symptoms. Abrasion arthroplasty may have some benefit in this patient population. An arthroscopic shaver is used to debride cartilage defects and penetrate the subchondral bone plate to cause bleeding. The goal is to have a blood clot form, which will undergo metaplasia into fibrocartilage after several weeks. Microfracture has less of a role in more advanced diffuse OA. Here, cartilage defects are debrided to a stable rim, and the resulting exposed subchondral bone is penetrated with a small drill or awl. The goal is to create bleeding bone, which will produce a blood clot and subsequent fibrocartilage.

Osteotomy

Pelvic and Proximal Femoral Osteotomies

The goal of pelvic and proximal femoral osteotomies is to correct abnormal anatomy, thus alleviating pain, enhancing function, and preventing or delaying secondary OA. Patient selection for surgery is critical to optimize surgical outcomes. Major conditions amenable to osteotomy correction include acetabular dysplasia, post-traumatic disorders (malunion/nonunion proximal femur, including femoral neck nonunion), proximal femoral dysplasia (coxa valga), and femoral neck nonunion.

Pelvic osteotomy is a complex surgery that should be done by highly subspecialized surgeons. Indications for pelvic osteotomy include relatively young physiologic age (<55 years), symptomatic dysplasia, prearthritic or early arthritic joint disease, adequate hip motion, and correctable structural abnormality.

Relative contraindications include advanced physiologic age, morbid obesity, restricted hip motion, and moderate to advanced degenerative joint disease.

When patients are selected carefully, outcomes are favorable. Survivorship for periacetabular osteotomy with dysplasia of the hip at 20 years for Tönnis 1 and 2 is 80 % [10, 11].

High Tibial Osteotomy

High tibial osteotomy (HTO) can be considered in the younger patient with unicompartmental disease. It can be effective for treating arthritis due to a varus or valgus malalignment and can delay the need for TKA. Osteotomy of the knee is frequently combined with cartilage restoration procedures to provide a better mechanical environment for the biologic repair. HTO is ideal for the young, active patient with isolated medial or lateral compartment disease because it realigns the limb and reduces stresses on the articular cartilage of the diseased compartment.

Medial compartment arthritis in the varus malaligned limb is common and can be considered for treatment with a valgus-producing HTO. Techniques available include a lateral closing wedge osteotomy, a medial opening wedge osteotomy, or a dome osteotomy. Slight overcorrection of the varus deformity to 8–10° of valgus has produced good results [12, 13]. Lateral compartment arthritis in the valgus malaligned limb is less common. These patients can be considered for treatment with a varus-producing distal femoral osteotomy (DFO). Varus-producing osteotomy of the proximal tibia can create joint line obliquity; as such, the osteotomy should be carried out in the distal femur.

Contraindications to HTO include tricompartmental arthritic change, >15° flexion contracture, less than 90° of knee flexion, loss of lateral meniscus in a valgus-producing HTO, or loss of medial meniscus in a varus-producing DFO. Complications of HTO or DFO include recurrence of deformity, 60 % failure rate after 3 years when there is failure to overcorrect or if patient is overweight, loss of posterior slope or patella baja, and shortened patellar tendon, which decreases the distance of patellar tendon from the inferior joint line. This can be caused by:

- Raising tibiofemoral joint line in opening wedge osteotomy
- Retropatellar scarring and tendon contracture
- Bony impingement of the patella on the tibia

Other complications include compartment syndrome, peroneal nerve palsy (more common in lateral opening wedge), malunion, or nonunion.

Results associated with osteotomy of either the distal femur or proximal tibia will depend on appropriate patient selection. Valgus-producing HTO has been successful in approximately 50–85 % of patients at 10 years (96 % at 5 years, 80 % at 10 years, 57 % at 15 years) [13–15].

When considering osteotomy around the knee, it is important to realize challenges with TKA after osteotomy should the patient continue to have symptomatic arthritis. TKA is technically challenging because of previous incisions, scar tissue, retained hardware, and tibial and femoral abnormalities. Patella baja seen after HTO makes exposure more difficult and increases the need for lateral release. Survivorship of TKA after HTO does not seem to be affected, as several studies have shown excellent long-term results [16].

Arthrodesis

Hip

Hip arthrodesis is an uncommon procedure used to treat advanced hip degeneration in a very specific patient population. The position of fusion is critical for optimizing function and minimizing deterioration of neighboring joints. The preferred position of fusion is 25–30° of hip flexion, 0–5° of adduction, and 5–10° of lower extremity external rotation. Indications should be carefully considered and include young age (<30 years of age), high activity level (e.g., manual labor), severe pain and stiffness, posttraumatic arthritis or end-stage disease associated with previous infection, and normal neighboring joints (lumbar spine, contralateral hip, ipsilateral knee). Similarly, contraindications to arthrodesis include disease in neighboring joints (lumbar spine, ipsilateral knee, contralateral hip), major limb-length discrepancy (>2.0 cm), and active infection.

Patients with previous fusions may eventually want the procedure reversed. Indication for fusion takedown includes back or knee pain, leg-length discrepancy, or malposition of the fusion. Patients should be counseled on expected outcomes, as the rehabilitation is prolonged because of profound hip abductor weakness and the associated limp.

Knee

Knee arthrodesis is also an uncommon procedure and indications should be carefully selected. The most common indication is the unrevisable TKA (usually because of infection). Less common indications include septic arthritis, osteomyelitis, posttraumatic arthritis in a young manual laborer, painful ankylosis, neuropathic knee, and paralytic deformity. Contraindications to knee fusion include bilateral knee involvement or ipsilateral hip arthrodesis.

Position of fusion is important and can vary based on patient anatomy or leg-length discrepancy. If the limb-length discrepancy is <2 cm, arthrodesis should be placed in 5–7° of valgus and 15° of flexion. If the limb-length discrepancy is 2–4 cm, arthrodesis should be placed with the knee in full extension. If the limb-length discrepancy is >4 cm, consider bone grafting or a prosthetic spacer to limit gait abnormalities. Prior to fusion, the leg can be immobilized in a cast to prepare the patient for the fusion.

Complications associated with knee arthrodesis include painful nonunion, infection, deep venous thrombosis (DVT), peroneal nerve palsy, and wound dehiscence. Long-term complications include hip, spine, and ankle pain due to the altered gait pattern.

Arthroplasty

Hip

Total hip arthroplasty (THA) has proved to be an extremely successful surgery at relieving pain and improving function. Technical aspects of the surgery should be respected to improve chances of a good outcome. Achieving stability of the articulation between the ball and socket is critical. THA stability is determined by the following variables:

(a) *Component design*: The primary determinant of arc range (or the total arc of motion available between the ball and cup before dislocation) is the head-neck ratio. Other component design characteristics can affect the arc range. An example includes skirted heads, which leads to smaller head-neck ratios and excursion distance (or the distance the head must travel to dislocate after primary impingement).
(b) *Component alignment*: Ideal cup alignment to minimize chance of dislocation is 45° of cup abduction and 15° of cup anteversion. Stem alignment should be in 10–15° of anteversion.
(c) *Soft tissue tensioning*: The abductor complex helps to restore tension via head offset and neck length. Trochanteric deficiency or escape leads to deficient abductor complex contributing to hip instability.

Potential complications associated with THA include heterotopic ossification (HO) or calcification of the soft tissue around the hip. Risk factors for the formation of HO include prolonged surgical time, subtype of OA (hypertrophic), and handling of soft tissues during surgery. The Brooker classification characterizes the amount of HO visible on radiographs: I, islands; II, bone spurs leaving at least 1 cm between bony surfaces; III, spurs from pelvis and proximal femur with space less than 1 cm; and IV, radiographic ankyloses. Vascular injury during screw insertion has a low incidence (less than 1 %) [17]. Although less common than nerve injury, it can be life threatening. Wasielewski proposed the hip quadrant system as a guide for safe screw insertion [18]. Screws are safest when inserted posterior and superior to line A (a line drawn between the ASIS and the center of the acetabulum) and line B (line perpendicular to line A). Nerve injury has an incidence ranging from 0 to 3 % [19]. The peroneal branch of the sciatic nerve is most commonly injured. Risk factors for nerve injury include revision surgery, congenital hip dislocation, female gender, and lengthening the extremity by greater than 4 cm. Dislocation has an incidence of 1–3 %, with 70 % occurring within the first month after surgery [20, 21]. Risk factors for dislocation include female gender, prior hip surgery (most significant risk factor), posterior approach, and malposition of components. Initial treatment of a dislocated THA includes closed reduction. If component malposition is present soon after hip arthroplasty, immediate revision arthroplasty may be required. Venous thromboembolic events are common after THA in patients that are not on prophylaxis (incidence of DVT being 45–57 % in unprotected patients). Pulmonary embolism (PE) occurs in 0.7–2 % of patients with THA without prophylaxis [22, 23]. After THA, patients should therefore be protected with some form of anticoagulant to minimize the chance of these events.

Knee

Similar to THA, TKA has proven to be a reliable surgery at relieving symptoms and improving function. Technical goals of TKA include restoring mechanical alignment (restoring the joint line allows proper function of preserved ligaments). Elevating the joint line can lead to midflexion instability and patellofemoral tracking problems. Lowering the joint line can lead to lack of flexion and flexion instability, balancing ligaments by creating equal flexion and extension gaps, maintaining a normal Q angle (angle formed from the intersection of the extensor mechanism axis above the patella with the axis of the patellar tendon), and thus ensuring proper patellar femoral tracking. Errors that increase the Q angle include internal rotation of the femoral prosthesis, medialization of the femoral component, internal rotation of the tibial prosthesis, or placing the patellar prosthesis lateral on the patella.

Ligament balancing in TKA is crucial to obtaining a stable knee. The goal is to achieve equal symmetric flexion and extension gaps. In a varus-aligned knee, most ligament balancing occurs at the time of exposure through controlled posteromedial release. Femoral and tibial osteophytes should be removed followed by the meniscus. Deep medial collateral ligament (MCL) release can be performed. Reduction osteotomy (placing the tibial tray as far lateral as possible and recutting the tibia around it) is another technique to help with balancing. Superficial MCL release, medial epicondyle osteotomy, and lateral collateral ligament tightening are other options available to the surgeon once other methods have been exhausted. With valgus deformity, balancing follows different steps. Care should be taken to prevent overly aggressive release of the medial side during exposure. Valgus knees are often found to have hypoplastic lateral femoral condyles. As such, secondary checks should be used when determining femoral rotation, such as Whiteside's line (a vertical line extending from the deepest part of the trochlear groove and the center of the intercondylar notch) and the epicondylar axis. Osteophytes should be resected and soft tissue released as deemed appropriate can be helpful to balance a valgus knee. The iliotibial band can be released if the knee is tight in extension, and the popliteus can be released if the knee is tight in flexion. Alternatively, a laminar spreader can be inserted to open up the lateral compartment, and tight structures can be released as they are encountered.

Knee prostheses come in varying levels of constraint. Unconstrained knees are available in posterior cruciate-retaining and posterior cruciate-substituting designs. If increased constraint is required, constrained nonhinged (varus-valgus constrained) implants are available. Finally, constrained hinges are available for grossly unstable knees.

There are many potential complications associated with TKA. Some of these include:

(a) *Instability:* This complication accounts for 10–20 % of all TKA revisions [24, 25]. It can occur in the mediolateral (axial instability) and the anteroposterior (flexion instability) planes. Factors leading to instability include ligament imbalance, component malalignment or failure, bone loss from over-resection of femur, bone loss from femoral or tibial component loosening, soft tissue laxity of collateral ligaments, or connective tissue disorders.
(b) *Rotational malalignment:* Patellofemoral (PF) maltracking must be avoided when performing a TKA. The most common complications in TKA involve abnormal patellar tracking. Surgeons must avoid an increased Q angle to avoid increased lateral patellar subluxation forces. Femoral component internal rotation should be avoided because it causes lateral patellar tilt and a net increase in the Q angle. The femoral component should be placed in 3° of external rotation to the neutral axis to maintain a symmetric flexion gap. The femoral component should be biased to the lateralized position because medialization places the trochlear groove in a medial position and increases the Q angle. Midpoint of the tibial component should align over the medial third of the tibial tubercle, and care should be taken to avoid an internally rotated position and err toward external rotation. Internal rotation of the tibia results in external rotation of the tubercle and increases the Q angle. The patella should be placed medially and superiorly on the undersurface of the patella.
(c) *Vascular injury*: Incidence of these injuries is low. To minimize these events, one should avoid sharp dissection in the posterior compartment of the knee. Posterior retractor placement must also be performed carefully and should be biased medially away from the popliteal artery (artery has been shown to lie 9 mm posterior to the posterior cortex of the tibia at 90° of flexion). If arterial injury is suspected, drop tourniquet to check artery. Popliteal artery injury can lead to acute ischemia, compartment syndrome, and potential amputation.
(d) *Nerve palsy*: Incidence is reported at 0.3 %. In patients with severe valgus, rate of peroneal nerve injury increases to 3–4 % [26, 27]. If a peroneal nerve injury is suspected following TKA, the leg should be immediately flexed and all compressive dressings should be removed. Initial management should include use of ankle foot orthoses and physiotherapy to maintain a supple joint.
(e) *Wound complications:* These can be challenging for both surgeon and patient. Systemic risk factors include diabetes, vascular disease, rheumatoid arthritis, nutritional status, and obesity.
(f) *Stiffness*: Poor motion after TKA leads to suboptimal outcomes. Patient factors that affect ROM include preoperative ROM, body habitus, patient compliance,

and pain tolerance. Technical factors affecting ROM include overstuffing the patellofemoral joint, mismatched extension and flexion gaps, inaccurate balancing, component malposition, oversized components, joint line elevation, and excessive tightening of the extensor mechanism at closure.

Conclusions

OA is a common cause of pain and disability, which can develop in any synovial joint. Symptoms include activity related pain, rest pain, as well as nighttime pain. ROM of the affected joint demonstrates a painful and stiff arc of motion. Radiographs demonstrate JSN, increased sclerosis at the joint surfaces, osteophyte formation, and subchondral cysts. Nonoperative treatment includes physiotherapy, weight loss, orthoses, NSAIDs, and intra-articular injections. Surgical management includes arthroscopy, osteotomy, arthrodesis, and arthroplasty.

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