The Painful Total Knee Arthroplasty

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Total knee arthroplasty is one of the most successful operations performed, with 95–98% good to excellent results reported at 10–15 years [1–3]. Up to 20% of patients, however, report dissatisfaction with their outcomes due to persistent pain [4]. A thoughtful and systematic approach to these patients can help elucidate the mechanism of failure and develop an appropriate treatment paradigm. The results of exploration for debilitating pain of unknown etiology in a total knee replacement remain poor, with only 59% fair or poor results reported after surgery [5]. Thus, it is paramount to consider all potential causes of pain about a total knee arthroplasty before considering intervention. We shall consider the diagnosis and treatment of the painful total knee replacement from an anatomical perspective, stratified into

intra-articular, periarticular, and extra-articular/systemic causes (Table 3.1).

Intra-Articular

Infection

Infection *must* be considered in the evaluation of every patient with a painful total knee replacement. It is a most devastating and feared complication that often threatens the function of the joint, the preservation of the limb, and the health of the patient. Deep infections occur in 0.39–3.9% of primary total knee replacements and, on average, three times higher in revision cases [6, 7]. Body mass index ≥35, diabetes mellitus, male sex, American Society of Anesthesiologists (ASA) score ≥ 3, diagnosis of osteonecrosis, and a diagnosis of posttraumatic arthritis have been shown to increase the relative risk of deep infection [8]. The most common organisms are *Staphylococcus aureus* and *Staphylococcus epidermidis.* Methicillin- and vancomycin-resistant organisms have become increasingly prevalent and difficult to treat. The diagnosis of infection should start with a thorough history and physical examination. Persistent pain is the only consistent finding with infection, although a draining wound or history of wound problems or any erythema must also raise the suspicion for infection (Fig. 3.1) [9]. Serum studies including white

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Table 3.1 Differential diagnosis for painful total knee arthroplasty

Intra-articular
Infection
Patellofemoral
Resurfaced vs. unresurfaced patella
Maltracking
Fracture
Avascular necrosis
Loosening
Patellar fibrosis
Overstuffing joint
Wear
Osteolysis
Instability
Valgus-varus
Axial including midflexion
Malalignment
Arthrofibrosis
Recurrent hemarthrosis
Popliteus impingement
Loose bodies
Persistent synovitis
Overhanging component
Gout/CPPD
Periarticular
Neuroma
Fracture
Heterotopic ossification
Bursitis
Extra-articular
Complex regional pain syndrome
Hip/spine pathology
Vascular etiology
Unrealistic expectations
Psychological profile

Fig. 3.1 Infection must always be excluded

blood cell count, erythrocyte sedimentation rate, and C-reactive protein are useful, particularly in following the course of treatment. In patients undergoing revision knee arthroplasty, erythrocyte sedimentation rate >30 mm/h has a 63% sensitivity and 55% specificity for infection, whereas C-reactive protein >10 mg/L had a 60% sensitivity and 63% specificity [10]. Bone scans are also helpful, with sensitivities and specificities of approximately 84% [11]. Aspiration of the knee should be performed, and the fluid should be analyzed for cell count with differential and culture. Cell count and neutrophil differential both below a cutoff value of >1100 cells and >64%, respectively, yield a negative predictive value of 98.2% [12]. However, the existing diagnostic criteria for periprosthetic joint infection in the literature vary widely, and even when the results of the aspirate are combined with serum inflammatory markers, there remains a large variance in sensitivity (54%–100%) and specificity (39%–100%) [13]. Finally, tissue taken intraoperatively may be sent for frozen section pathological examination. Greater than ten polymorphonuclear leukocytes per high-power field is implicated in infection with a sensitivity of 84% and a specificity of 99% [14]. Hence, the diagnosis of infection must be made based on careful history and physical examination using all available data, rather than basing the diagnosis on one particular test.

Treatment of a total knee infection is often based on the timing and duration of the infection as well as the implicated organism and the status of patient's overall health. Decisions must then be made whether to attempt prosthesis retention, one-stage exchange, or two-stage exchange. A glycocalyx layer formed around the prosthesis may prevent antibiotic penetration to the prosthesis, rendering antibiotic treatment alone ineffective. Surgical treatment remains the mainstay. Aggressive treatment for *superficial* wound

infections is recommended, as many of these infections actually involve deeper tissues. Primary debridement within 10 days of symptom onset has a reported success rate of 56% in patients with low-grade organisms, but the success rate is diminished to 8% in the presence of *Staphylococcus aureus* infections [15]. Even lower rates of success are reported for using this approach for chronic infections. Arthroscopic debridement has only seen moderate success in the eradication of acute (within 4 weeks of surgery) infections, providing eradication in 52% of patients [16].

Prosthetic exchange is the primary mode of treatment when eradication of the infection is the goal. Single-stage exchange may be considered when an acute infection with a relatively low-virulence gram-positive infection is encountered in a competent host. One study showed 89.2% success with single-stage exchange in which there were gram-positive infection, absence of sinus tract, antibiotic-impregnated cement in the new prosthesis, and 12 weeks of adjuvant antibiotic treatment [16]. The most widely accepted approach, however, is the two-stage exchange in which aggressive irrigation, debridement, synovectomy, and prosthesis removal are performed, followed by reimplantation after a period of intravenous antibiotics. During the interim, a spacer of antibiotic-impregnated methyl methacrylate is often used. With this technique, overall infection-free survivorship was shown to be 85% at 5 years and 78% at 10 years [17]. Up to 97% eradication rates are reported with this technique [12]. The use of a PROSTALAC functional spacer made of antibiotic-laden cement with a small metal-on-polyethylene articulation is of interest because of its potential for enhanced function and maintenance of good alignment and stability of the knee. This facilitates second-stage procedures. Using this technique in a two-stage exchange with a mean 4-year follow-up, cure rates of 91% have been demonstrated [18]. Although this is promising, further outcome-based studies are necessary.

It is critical to always maintain a high index of suspicion for infection and to treat infections aggressively. All painful total knee replacements must be evaluated for the possibility of an indolent infection.

Patellofemoral Problems

Anterior knee pain is a relatively common complication after total knee arthroplasty and is often attributed to the patellofemoral articulation. It is, however, important to exclude other causes of anterior knee pain, such as peripatellar tendinitis, bursitis, Sinding-Larsen-Johansson disease, residual from Osgood-Schlatter disease, neuromas, and complex regional pain syndrome. The prevalence of anterior knee pain after total knee replacement has been reported as high as 25.1% in knees with unresurfaced patellae and 5.3% in resurfaced patellae [19]. Overall, approximately 10% of patients with total knee replacement may be expected to have anterior knee pain [20]. Analysis of 8530 total knee arthroplasties at an average follow-up of 7 years found an incidence of patellar component loosening of 4.8% and patellar fracture 5.2% [21]. Problems with the patellofemoral articulation in a total knee may be referable to malalignment and maltracking of the patella, osteonecrosis, fracture, loosening, component failure, tendon rupture, and peripatellar fibrosis. Evaluation of this pain must first identify whether the patella has been resurfaced, as unresurfaced patellae have been shown to have a significantly higher incidence of pain. The patella should be resurfaced in obese patients, patients with inflammatory arthritis, preoperative maltracking, significant loss of cartilage and exposed subchondral bone on the patella, gross surface irregularities, and those with significant anterior knee pain preoperatively [22]. When anterior knee pain is diagnosed in a patient with an unresurfaced patella, consideration to revision to a resurfaced patella must be given after other etiologies have been excluded. With newer three-lugged, cemented, all-polyethylene components available and careful attention to technical detail, the authors advocate patellar resurfacing in all total knee arthroplasties.

Patella maltracking is evident when the patella fails to maintain a congruent articulation with the trochlear groove of the femoral component (Fig. 3.2). Failure to achieve adequate tracking

Fig. 3.2 Merchant radiographs permit diagnosis of patellofemoral dislocation

may cause pain and crepitus as well as wear, failure of the patellar component, loosening, and fracture. Maltracking is most commonly caused by an imbalance of the extensor mechanism, especially with tightness of the lateral retinaculum and weakness of the vastus medialis. It may also be attributed to malposition of the femoral, tibial, or patellar components themselves. Placing the femoral component into excessive valgus increases the Q-angle and elicits an increase in the lateral force vector, tending to displace the patella laterally. Likewise, internal rotation or medial shift of the femoral component also displaces the patella laterally. Internal rotation of the tibia causes lateralization of the tibial tubercle, also detrimentally increasing the Q-angle. Lateral placement of the patellar component also contributes to maltracking. It is essential to perform diligent intraoperative assessment of patellar tracking to avoid patellofemoral instability. Alteration of the joint line itself may result in patella alta or infera, which could exacerbate abnormal tracking, impingement, or recurrent dislocation. An asymmetrical patellar resection may also contribute to patellar maltracking. The medial facet is thicker than the lateral facet. Thus, it is essential to resect the same amounts of bone from the medial and lateral facets to maintain this orientation. An oblique resection, taking too much bone off laterally, results in maltracking. The diagnosis of patellar instability can usually be made by physical examination, but may be evident on Merchant radiographic views. Computed tomography may provide essential

information in determining the rotational alignment of the femoral and tibial components. Treatment of patellar subluxation begins with aggressive quadriceps rehabilitation, patellofemoral bracing, and avoidance of deep squatting exercises. Malrotated components should be revised as necessary. Additional soft tissue procedures, such as lateral release and medial advance as well as tibial tubercle osteotomy, may be added as indicated.

Fractures of the patella are generally rare, with reported rates ranging from 0.5 to 5.2% [21, 23, 24]. Fractures include occult stress fractures as well as intraoperative and postoperative fractures (Fig. 3.3). They may be associated with trauma, patellar subluxation, inadequate resection, excessive resection, thinning the patella to less than 15 mm, and operative disruption of the patellar blood supply, particularly when median parapatellar exposure is accompanied by lateral release [25]. Treatment typically depends on the competence of the extensor mechanism, the degree of displacement, and the integrity of prosthetic fixation. Nonoperative treatment has been successful in non-displaced fractures with a well-fixed component and a competent extensor mechanism. Surgical fixation with tension band and/or revision of the component is indicated in the more severe injuries. Patellectomy should be avoided whenever possible.

Loosening of the patellar component is rare, with a reported rate of 0.6–4.8% of cases [21, 26]. It is associated more with metal-backed designs, which have largely fallen out of favor. Risk factors for failure of the patellar component include excessive body weight, recalling that the patellofemoral articulation can bear up to seven times body weight during squatting, increased knee flexion, and a high level of activity. The diagnosis is usually apparent with symptoms of effusion and crepitus, which are more pronounced with activities that load the patellofemoral joint. Plain radiographs confirm the diagnosis, and treatment involves revision.

Patellar fibrosis or *patellar clunk syndrome* occurs when a fibrous nodule forms at the junction of the posterior aspect of the quadriceps tendon and the proximal pole of the patella (Fig. 3.4).

Fig. 3.3 Fractures of the patella are generally rare and include occult stress fractures as well as intraoperative and postoperative fractures
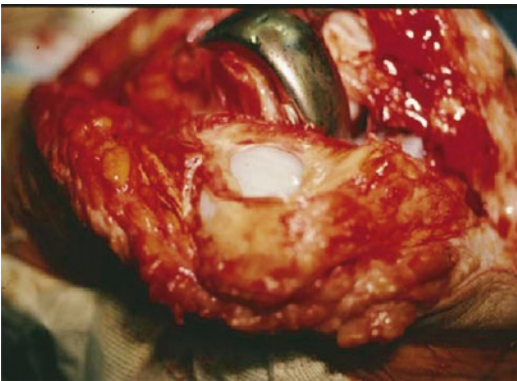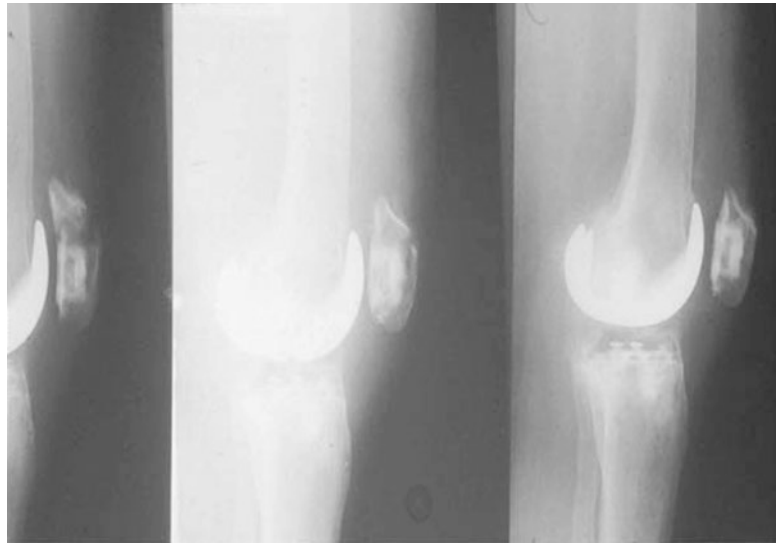
Fig. 3.4 Patellar fibrosis occurs when a fibrous nodule forms at the junction of the posterior aspect of the quadriceps tendon and proximal pole of the patella

With flexion, this nodule enters the intercondylar notch. Then, as the knee is extended from 30 to 60°, the fibrotic lesion *clunks* out of the notch. This syndrome is classically associated with posterior stabilized components but has been reported in cruciate-retaining designs, as well as in cases in which the patella remains unresurfaced [27, 28]. Extensive excision of the synovium in the suprapatellar region may prevent this. Treatment involves debridement of the fibrotic nodule, either by arthroscopy or arthrotomy. If the clunk involves a malpositioned patella or inappropriately sized femoral component, revision is recommended. In one series, arthroscopic debridement yielded reliable improvement in patient-reported knee pain and crepitus as well as Knee Society score [29]. A similar entity, synovial entrapment, is described in which hypertrophic synovium causes pain during extension from 90° of flexion. Patients typically had pain when arising from a chair or climbing stairs but had no symptoms with level walking. Treatment with synovectomy resulted in relief of symptoms in all patients studied [30].

A number of entities may cause anterior knee pain in patients with total knee replacements. A systematic approach and inclusive differential diagnosis can yield the appropriate diagnosis and guide treatment.

Osteolysis

Polyethylene wear in total knee arthroplasty continues to affect the longevity of modern total knee replacements. Wear and aseptic loosening have been shown to be the second most common modes of failure requiring revision surgery in the United States, accounting for up to 16.1% of revision operations [31]. From a basic science standpoint, osteolysis is the granulomatous response to polyethylene, polymethyl methacrylate, and metal debris, which are formed by both the articulating and nonarticulating (undersurface) surfaces of
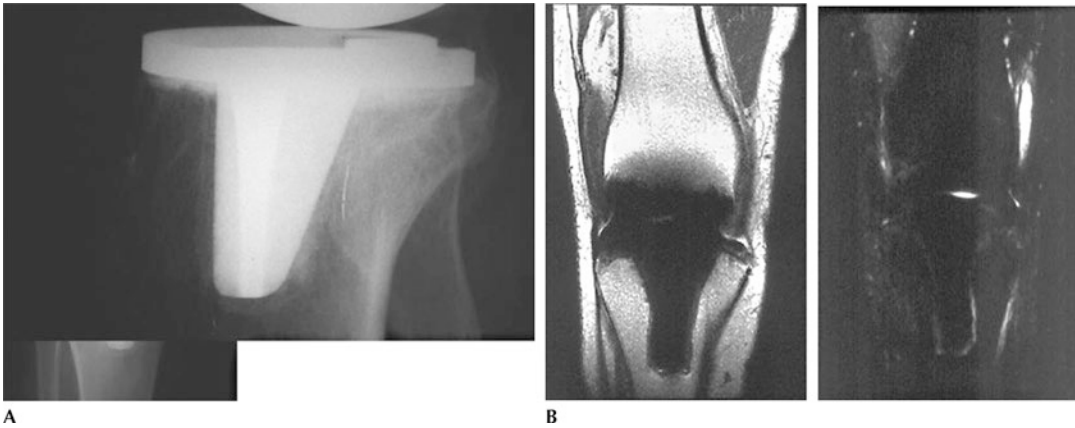
Fig. 3.5 Loose component. (**a**) Identification of a lytic osseous defect, absence of bone trabeculae, and geographic demarcation make the diagnosis radiographically. (**b**) Additional tests such as magnetic resonance imaging and bone scans may also facilitate the diagnosis of loose components

the prosthetic knee. Delamination, adhesion, and abrasion cause the liberation of loose particles that contribute to osteolysis. Osteolysis was implicated in 2% of early and 9% of late failures of total knee arthroplasties requiring revision surgery [32]. Risk factors include incongruent articulations, poor tibial locking mechanisms, thin polyethylene, sterilization of polyethylene with gamma irradiation in air, fixation screws in the tibial base plate, and an extended shelf life of the polyethylene implants. Most patients remain asymptomatic. However, some patients have a boggy synovitis and mild to moderate pain with activity. A triad of effusion, pain, and change in coronal alignment, usually into varus, is strongly suggestive of accelerated polyethylene wear. Identification of a lytic osseous defect, absence of bone trabeculae, and geographic demarcation makes the diagnosis radiographically (Fig. 3.5). The presence of the components may obscure the lesions on radiography, particularly as they are most commonly found within 2 mm of the tibial component and in the posterior femoral condyles. If osteolysis is suspected, computed tomography is a useful tool to evaluate the size of the osteolytic lesion [33]. Nuclear medicine studies may also demonstrate increased uptake around loose components. Osteolysis must be distinguished from radiolucent lines that are a common finding in radiographic surveillance of total knees. Lysis

requires a complete radiolucent line of greater than 2 mm in length. Smaller lines are of unknown significance and may be followed clinically. Ranawat et al. noted radiolucent lines in 72% of the tibiae, 54% of the femurs, and 33% of patellae [3]. Not all of these represented osteolysis. Treatment of these lesions primarily depends on whether the osteolysis is associated with loose prosthetic components. It is essential to review serial radiographs to determine if radiolucent lines are progressive. Well-fixed components with lytic lesions may be treated with exchange of the polyethylene insert and bone grafting of the lesions. However, isolated tibial insert exchange resulted in a 63.5% cumulative survival rate at 5.5 years [34]. They recommended that limited revision of the polyethylene should be avoided if severe delamination is present, if there is significant undersurface wear of the polyethylene suggesting an inadequate locking mechanism, and if there is early failure within 10 years of the index operation. Revision of loose components with bone graft is indicated for lysis associated with loose components. It is important to have a full complement of revision instruments available with stems, wedges, and allograft when performing these revisions, as radiographs not only underestimate lesion size but do not take into account bone loss with explanation of the loose components (Fig. 3.6).

Fig. 3.6 Revision for loose components. Radiographs often underestimate lesion size and do not take into account bone loss with explanation of the loose components
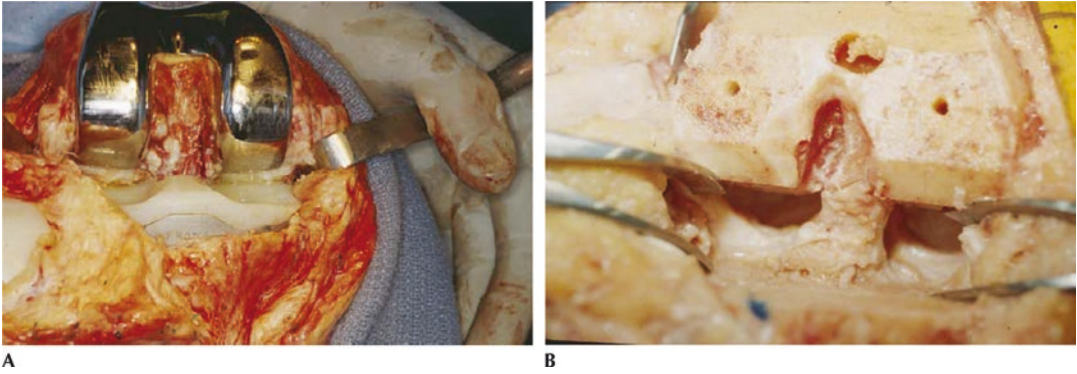
Instability

Symptomatic axial instability of a total knee arthroplasty, including valgus-varus and flexion-extension instability, is a potential cause for pain and disability following total knee replacement. It occurs in 1–2% of patients and may be present in either posterior stabilized or cruciate-retaining knees. Overall, instability accounts for 10–20% of all total knee revisions, following only infection and aseptic loosening in prevalence [35]. Instability may be caused by trauma, ligamentous stretch, inadequate balance at the time of surgery, or a systemic disorder such as Ehlers-Danlos disease.

Patients with mediolateral, valgus-varus instability often present with pain, buckling, giving way, and progressive weight-bearing deformity. This instability may be the result of traumatic injury but is often the result of failure to achieve appropriate soft tissue balance at the time of surgery. The diagnosis can usually be made by history and physical examination and may be

confirmed by stress radiographs or video fluoroscopy. Using a systematic approach and meticulous technique, good results may be achieved in knees with severe varus or valgus alignment. Prevention is the best treatment. Revision to correct soft tissue imbalance or revision to a higher degree of prosthetic constraint with stems and wedges may be necessary. Kim and Kim reported reproducible results of revision surgery for patients with valgus-varus constrained implants, with a 96% 10-year survival rate [36].

Failure to balance the flexion and extension gaps properly may lead to symptomatic instability in the sagittal plane. This entity was first recognized and reported with the obvious acute dislocation of a posterior stabilized prosthesis. Subsequently this has been reported to occur in 1–2% of posterior stabilized knees [37]. Cam-post design, large lateral soft tissue release in valgus knees, and above average range of motion have all been implicated as risk factors for the dislocation of a posterior stabilized knee. The diagnosis is usually obvious, and treatment involves reduction and revision to balance the flexion-extension gaps or increase constraint if necessary.

Flexion instability in posterior cruciate-retaining knees is also evident. However, this entity is much more subtle than its counterpart in posterior stabilized knees (Fig. 3.7a). Patients typically present with anterior knee pain, a sense of instability, recurrent effusions, soft tissue tenderness of the pes tendons, and posterior instability, evidenced by a positive posterior drawer sign or sag. Symptoms may occur early in the postoperative period if there is inadequate flexion-extension or posterior cruciate ligament (PCL) balance. Late PCL rupture or attenuation may give a delayed presentation of symptoms. The diagnosis may be made by careful history and physical examination. Medial and lateral translocation of the polyethylene eminence under the medial or lateral femoral condyle performed passively with the knee flexed is a hallmark of flexion instability. Performing a posterior drawer test and examining for flexion instability should be routine in evaluating every painful total knee. A common cause for this pattern of imbalance

A   **B**

Fig. 3.7 (**a**) Flexion instability in posterior cruciate-retaining knees. (**b**) The revision operation balances the flexion-extension gaps in conjunction with revision to a posterior stabilized knee

occurs when treating patients with residual flexion contractures. Proper balance in flexion but excess tightness in extension may entice the placement of a thinner polyethylene liner or further tibial resection. Although this may correct the flexion contracture, it is a setup for symptomatic flexion instability. A better remedy is to perform a posterior capsular release or resect more distal femur. The treatment of flexion instability may be difficult because it often involves considering revision of well-aligned, well-fixed components with the resultant bone loss and potential elevation of the joint line. There have been several reports on the results of treatment by isolated revision to a thicker polyethylene insert. Overall the results have been marginal. Seventy-one percent success with polyethylene liner exchange alone has been reported, with this technique being favored if the etiology was primarily soft tissue imbalance. If incompetent ligaments were identified, revision to more highly constrained components was recommended [38]. Eighty-six percent success is reported when revising to a more constrained component. A revision operation that focuses on balancing the flexion-extension gaps in conjunction with revision to a posterior stabilized knee is the most reliable treatment for symptomatic flexion instability after cruciate-retaining prosthesis (Fig. 3.7b) [39]. It is essential to always include valgus-varus and flexion-extension instability in the differential diagnosis of the painful total knee.

Arthrofibrosis

Most patients achieve a satisfactory range of motion after total knee replacement and are able to perform their activities of daily living without limitation. Typically, 63° is needed for the swing phase of gait, 83° for stair ascent, 84° for stair descent, at least 93° to rise from a chair, and 106° to fasten a shoelace [40]. However, postoperative stiffness occurs, and patients may not achieve these degrees of motion. This expectedly causes significant functional limitation and patient dissatisfaction. Stiffness occurs in both posterior stabilized and posterior cruciate-retaining implant designs. The etiology is largely unknown but may be biologic, related to an underlying collagen disorder characterized by rapid fibrous metaplasia of scar tissue, or mechanical, related to technical errors in operative technique, such as failure to properly balance the flexion and extension gaps or release the posterior capsule and remove posterior osteophytes when present. Actin and myosin fibrils have been identified histologically in arthrofibrotic tissue and may also be implicated. Risk factors for limited postoperative range of motion include limited preoperative range of motion, contractures, obesity in which posterior soft tissue impingement limits flexion, excessive intra-articular scar from previous operations, and poor patient compliance with postoperative rehabilitation protocols (Fig. 3.8). Excessive tension or laxity in the PCL may also

Fig. 3.8 Arthrofibrosis and patella infera limit range of motion postoperatively

result in limited motion. A lax PCL allows paradoxical anterior femoral translation with increased knee flexion, resulting in loss of flexion. It is important to recognize that arthrofibrosis may be the hallmark of other knee pathology such as infection, component loosening, periprosthetic fracture, complex regional pain syndrome, or heterotopic ossification. Thus, these must be considered in the evaluation of a stiff knee. Furthermore, it is particularly important to accurately document with a goniometer preoperative and intraoperative range of motion so that the patient, surgeon, and physical therapist appreciate realistic motion goals before embarking on an aggressive campaign to restore motion. Moreover, as shorter hospital stays mandate the majority of physical therapy as outpatient, the surgeon must convey to the therapist the patient's preoperative, intraoperative, and expected goals for postoperative motion.

Treatment of a stiff knee initially involves aggressive physiotherapy and closed manipulation under anesthesia. This is particularly advantageous in the first 3–6 weeks postoperatively when the scar tissue has not matured. After 8 weeks, the scar tends to mature, and the risk of supracondylar femoral fracture increases. Although continuous passive motion (CPM) is controversial, particularly when range of motion at 1 year postoperatively is considered, it is recommended after manipulation. Barring success with this, surgical intervention with arthroscopic or open arthrolysis is considered. Arthroscopy has been shown to provide gains in range of motion in 43% of patients treated for arthrofibrosis following total knee replacement [41]. Open procedures have the benefit of allowing radical scar excision, ligament rebalancing, and exchange of the polyethylene insert if necessary. Should these fail, revision arthroplasty with definitive reestablishment of flexion-extension gaps, ligament balance, and possibly a higher degree of prosthetic constraint may be necessary. Revision has shown satisfactory results in terms of pain and range of motion in several small studies [42, 43].

Recurrent Hemarthrosis

Recurrent hemarthrosis is an uncommon but significantly disabling cause of pain following total knee arthroplasty. Kindsfater and Scott reviewed 30 cases of patients who experienced painful recurrent hemarthrosis after total knee replacement [44]. The patients developed their first hemarthrosis an average of 2 years after their replacements. Most experienced multiple episodes of bleeding. Approximately one-third of the patients had resolution of symptoms with aspiration, rest, ice, and elevation followed by gradual return to activities. Of the patients who underwent surgical exploration, only 43% had an identifiable etiology for their bleeding. Proliferative synovium entrapped between the prosthetic articulations and a vascular leash was both implicated and treated. Usually an associated soft tissue laxity necessitates use of a more conforming or a thicker polyethylene insert. With synovectomy, 14 of 15 no longer bled. Thus, hemarthrosis must be considered in the differential diagnosis of the painful total knee.

Most resolve with aspiration, but some require open synovectomy that provides reliable relief of symptoms.

Popliteus Impingement

The popliteus tendon may subluxate anteriorly or posteriorly over a lateral femoral condylar osteophyte or an overhanging edge of the posterior femoral condylar prosthesis, causing a painful snap or even audible *popping* sensation in the posterolateral corner of the knee after total knee arthroplasty. Such symptomatic snapping is reported in 0.2% of total knee replacements [45]. Patients with valgus deformity and female patients, who require relatively larger components in the mediolateral dimension to compensate for their larger AP dimension, appear to be at increased risk for this. The diagnosis can only be made by placing the knee through a range of motion with the capsule closed. Treatment includes releasing the popliteus or removing the offending osteophytes at the time of the total knee replacement. Barnes and Scott diagnosed and intraoperatively addressed this in 2.7% of 300 consecutive knees [46]. Successful treatment with arthroscopic release has been reported for those symptomatic cases, which present after surgery.

Miscellaneous

Other significant intra-articular causes of a painful total knee replacement include the presence of loose bodies, loose polymethyl methacrylate cement, overhanging components, or incomplete seating of modular inserts. Persistent synovitis and gout or calcium pyrophosphate deposition disease (CPPD) may also present as a painful total knee replacement. Loose bodies and cement particles may be avoided by meticulous inspection and irrigation of the joint after implantation. It is particularly important to examine the posterior aspects of the knee for the presence of loose bodies and cement particles after polymerization of the bone cement. Many loose particles in the knee are asymptomatic because the knee is self-cleansing. Most particles tend to migrate away from the prosthetic articulations. Nevertheless, some cause persistent effusion, pain, and synovitis. Patients may even report a sensation of something moving in their knees. The diagnosis is made by history and physical examination, although some loose bodies may be apparent on high-quality plain radiographs. Treatment involves their removal, either arthroscopically or by arthrotomy. Overhanging components, particularly those overhanging anteriorly or impinging the popliteus, may also be painful. Such cases present with pain, synovitis, and recurrent effusion. History, physical examination, and radiographs revealing component overhang make the diagnosis. A localized anesthetic injection may be diagnostic and therapeutic. Treatment in the most severe cases involves removal of osteophytes or revision of the component.

Periarticular Causes of Pain

Neuroma

Extensive anatomical mapping of the cutaneous innervation of the skin and soft tissues around the knee has provided significant insight into the presence of symptomatic neuromas as an etiology of pain about the knee. While the infrapatellar branch of the saphenous nerve has a distribution across the tibial tuberosity, and the medial cutaneous nerve of the thigh has a distribution across the patella, the inferior cutaneous nerve of the thigh, the proximal tibiofibular nerve, the medial retinacular nerve, the common peroneal nerve, and the lateral reticular nerve all also have specific, known cutaneous distributions about the knee [47]. This knowledge, combined with detailed mapping of the patient's pain, may provide a diagnosis for previously enigmatic complaints. When suspected, neuromas should initially be treated with physical modalities such as moist heat, massage, topical steroid-containing creams, iontophoresis, and neuropathic pain medications. Diagnosis can be confirmed by positive Tinel's sign and by selective anesthetic

injections. Dellon et al. studied the results of 70 patients treated with selective surgical denervation of persistent neuroma pain about the knee. Having excluded other causes for knee pain, such as infection, they considered this procedure for patients who had persistent pain for at least 6 months and had no effusion or obvious mechanical cause for pain. Eighty-six percent of the patients were satisfied and demonstrated relief of their pain as well as significant improvement in their Knee Society scores, which increased from a mean of 51 to mean of 82 [48]. Pathological confirmation of nerve resection correlated with good results.

Heterotopic Ossification

Heterotopic ossification (HO) is the formation of mature lamellar bone in the soft tissues (Fig. 3.9). Reports suggest that the incidence of heterotopic ossification after total knee arthroplasty ranges from 15 [49] to 39% [50]. Although most cases are asymptomatic, pain and limited range of motion have been reported. Barrack et al. also
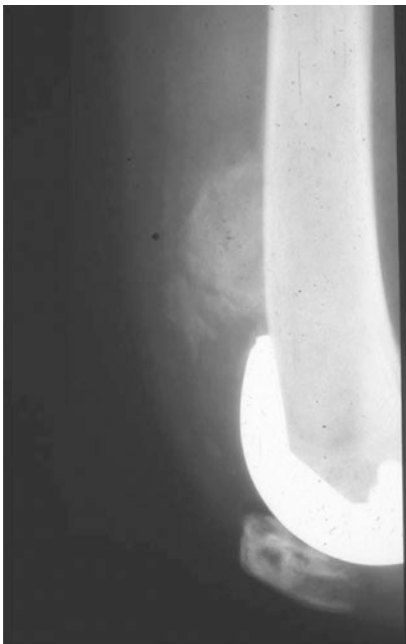
Fig. 3.9 The formation of mature lamellar bone in the soft tissues is shown in heterotopic ossification

demonstrated lower functional and Knee Society scores in patients with heterotopic ossification [51]. HO in the knee usually occurs in the quadriceps expansion. Predisposing factors include a previous history of heterotopic ossification, trauma, prior operations, postoperative manipulation, osteoarthritis, and immobilization, as well as intraoperative risks including excessive trauma to the muscles, periosteal exposure of the femur, notching of the femur, and hematoma formation. Infection is also a significant risk factor for HO. Prophylaxis against HO may be considered in primary or revision total knee arthroplasty if there are considerable risk factors. Treatment with a single fraction of 7-Gy radiation to the knee is effective prophylaxis with minimal documented morbidity [52].

Bursitis

Pes anserine bursitis and patellar tendinitis may also be responsible for a painful total knee arthroplasty. Periarticular pain located approximately 5 cm below the knee joint on the anterior and medial portion of the tibia may indicate pes bursitis. The diagnosis is usually made by history and physical examination. Selective anesthetic injection including corticosteroids may also prove diagnostic and therapeutic. Patellar tendinitis presents as localized pain along the patellar tendon and tibial tubercle. Scrutiny of patella tracking and the patellofemoral articulation is necessary. Stress fractures must be excluded. Isolated patellar tendinitis responds to physical therapy, stressing hamstring stretching, bracing, and vastus medialis strengthening.

Extra-Articular Pain

Complex Regional Pain Syndromes

Complex regional pain syndrome (CRPS) has been reported following total knee arthroplasty with a prevalence of 0.8% [53]. Although this syndrome is well described for the upper extremity, knowledge of its presentation in the knee and,

in particular, total knee arthroplasty is evolving. Intense, prolonged pain out of proportion to physical findings, vasomotor disturbance, delayed functional recovery, and various trophic changes should raise suspicion of CRPS. Typically, arthroplasty patients have an uncomplicated postoperative course but rapidly plateau and do not achieve their expected recovery. The presence of infection or other pathological process in the knee must be excluded. The prognosis of CRPS in the knee depends on early diagnosis and treatment. Institution of treatment within 6 months is the most favorable prognostic indicator in the treatment of CRPS [54]. Initially, mobilization and physical therapy should be stressed, followed closely by a lumbar sympathetic block if rapid improvement does not ensue. A good response to the block, characterized by 75% relief of symptoms, is the sine qua non of the diagnosis. Unfortunately, only 64% of the patients achieved some relief with sympathetic blockade. None achieved complete relief of symptoms, and most patients considered their knee replacements a failure. Patients who have had multiple operations on their knees and experience significant debilitating pain before their arthroplasties are at increased risk. Given the severity of this pathologically exaggerated physiological response, total knee arthroplasty should be approached cautiously in patients who may be at risk, and when the diagnosis is questioned, early, aggressive intervention should ensue.

Referred Pain

Pain may be referred to the knee from a number of sources including ipsilateral hip, lumbar spine, or vascular pathology. These sources of referred pain may be readily identified by complete and thoughtful history and physical examination. Ipsilateral hip pathology presents as knee pain by irritation of the continuation of the branch of the obturator nerve to the adductor magnus (Fig. 3.10). Thus, the presence of arthrosis or fracture of the ipsilateral hip must be explored. Selective intra-articular injections may help distinguish the primary source of pain if both joints

Fig. 3.10 Ipsilateral hip pathology presents as knee pain by irritation of the continuation of the branch of the obturator nerve to the adductor magnus

are arthritic. It is essential to exclude the possibility of such referred pain before performing a total knee replacement. Degeneration or spinal stenosis of the lumbar spine may also present as pain in the knee, particularly when affecting the L3/4 level. Careful history and neurological examination provide the diagnosis. CT myelography or MRI may confirm the clinical diagnosis and guide treatment accordingly. Vascular insufficiency and claudication and deep vein thrombosis may also present as pain in the knee. Once again, a careful history and physical examination make the diagnosis and permit appropriate referral. Moreover, depression, anxiety, and anger may all detrimentally affect a patient's expectations and results from a total knee replacement. Limited objective knee pathology before arthroplasty may also correlate with unsatisfactory results. Good communication between the patient and the surgeon helps clarify expectations and provides realistic goals for the patient. It is essential to take into account the patient's overall psychological and physical condition and to determine the role that the prosthetic knee plays

in the patient's life. Often, counseling and pharmacological management provide important adjunctive treatment for the patient's knee pain.

Summary

Although total knee arthroplasty predictably provides relief of pain and good functional results, a number of potential etiologies exist for a painful total knee replacement. It is paramount to exclude infection whenever evaluating a painful total knee. Results of treatment will not be satisfactory if the mechanism of pain or knee failure is not understood. There is no role for exploratory revision surgery. A complete history, physical examination, and thoughtful differential diagnosis help make the diagnosis and develop an effective treatment paradigm.

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