Review Article

Arthroscopic Releases for Arthrofibrosis of the Knee

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Abstract

Intra-articular inflammation or fibrosis may lead to decreased soft-tissue and capsular compliance, which may result in pain or loss of motion within the knee. Etiology of intra-articular fibrosis may include isolated anterior interval scarring and posterior capsular contracture, as well as fibrosis that involves the suprapatellar pouch or arthrofibrosis that involves the entire synovial space. Initial nonsurgical management, including compression, elevation, and physical therapy, can decrease knee pain and inflammation and maintain range of motion. Surgical management is indicated in the patient who fails conservative treatment. Surgical options include arthroscopic releases of the anterior interval, posterior capsule, and peripatellar and suprapatellar regions. Recent advances in arthroscopic technique have led to improved outcomes in patients with intra-articular fibrosis of the knee.

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Knee stiffness is a common complication associated with trauma or surgery and has been extensively studied.[1-3] Risk factors include injury severity, timing of surgery, delayed postoperative rehabilitation, prolonged immobilization, infection, complex regional pain syndrome, and technical errors during intra-articular and extra-articular reconstructive procedures. Extra-articular stiffness may be caused by muscular fibrosis and contracture, heterotopic ossification, or myositis ossificans.

The inflammatory response to injury or surgery can cause fibrosis, resulting in restricted knee motion. Anterior interval scarring, contracture of the posterior capsule or suprapatellar pouch, and diffuse arthrofibrosis may contribute to knee stiffness, lead to alterations in the biomechanics of the joint, and cause pain.[4-6] Specific releases can be performed for each fibrotic region. Familiarity with the diagnosis and arthroscopic management of these disorders may lead to improved outcomes in this patient population.

Pathophysiology of Arthrofibrosis

The exact etiology of intra-articular tissue fibrosis is unknown, but several theories exist. Platelet-derived growth factor and transforming growth factor-beta 1 are inflammatory cytokines produced by the inflamed synovium that promote the proliferation of fibroblasts and extracellular matrix proteins, the inhibition of proteolytic enzymes, and the production of collagen. These cytokines are present in intra-articular scar tissue and in the synovial fluid of patients with joint trauma, as well as in fibrosis in the kidney, liver, and lung.[7-9] Additionally, vascular endothelial growth factor is present in the infrapatellar fat pad.[8] This factor is released after injury to the fat pad

and may lead to vascular ingrowth and scarring.[4] Another theory posits that injury, whether induced by trauma or surgery, produces hemorrhage and subsequent fibrosis due to the maturation of localized clotting and induction of progenitor cells.

Nonsurgical Management

Prevention is the most effective means of avoiding motion loss following knee injury or surgery. Initially, modalities such as ice, compression, elevation, aspiration of effusion, electrical stimulation, physical therapy, nonsteroidal anti-inflammatory drugs, and a short-term course of oral corticosteroids can be used to decrease knee pain and inflammation and maintain motion.[10] Flexion is more easily obtained than extension, thus, efforts should be directed toward maintaining extension. Isometric strengthening of the quadriceps helps to restore extension and prevents atrophy. Early patellar mobilization prevents adhesion formation and contracture of the patellar tendon. Surgery for an acute injury is best performed after inflammation, edema, and pain have decreased and range of motion (ROM) has normalized. Preoperative and postoperative immobilization should be kept to a minimum; early knee mobilization following surgery is recommended.

Additional intervention is indicated in patients who fail initial nonsurgical treatment. Several authors have recommended isolated manipulation of the knee under anesthesia within 6 to 12 weeks postoperatively in patients who have not regained full ROM following surgery.[10,11] However, this modality has recently fallen out of favor due to the risk of intra-articular hemorrhage and subsequent postoperative scarring, as well as complications such as excessive tibiofemoral and patellofemoral compression with the risk of chondral damage or fracture, rupture of the patellar tendon, distal femoral fracture, and complex regional pain syndrome.[12,13]

Surgical Management

Anterior Interval Release

The anterior interval is the space between the infrapatellar fat pad and patellar tendon anteriorly, and the anterior border of the tibia and transverse meniscal ligament posteriorly.[4] Trauma or previous surgery may cause hemorrhage or inflammation of the fat pad (ie, Hoffa syndrome), which may result in fibrosis. Fibrosis that occurs between the fat pad and the transverse meniscal ligament or the anterior tibia leads to dysfunction of anterior knee structures (eg, decreased excursion of the patellar tendon) and results in stretching of the surrounding synovial tissue, which may cause pain or loss of knee extension.[4] Fibrosis within the anterior interval has a spectrum of severity. Paulos et al[1] described infrapatellar contracture syndrome, which is a severe form of fibrosis of the fat pad and patellar tendon that severely limits ROM.

History and Physical Examination

Patients with anterior interval scarring report anterior knee pain and frequently describe a sense of fullness within the knee, especially with extension. Physical examination may demonstrate a small flexion contracture, decreased proximal excursion of the patella, and a positive Hoffa test.[4] This test is performed with the knee in 30° of flexion; the thumbs are placed at the medial and lateral margins of the infrapatellar fat pad and patellar tendon (Figure 1). Pressure is applied with the thumb, and the knee is fully extended. Increased pain in the fat pad with knee extension indicates a positive result. Patients may also have pain in this area with forceful hyperextension of the knee. The patellar tendon and patella should be carefully examined to rule out other causes of anterior knee pain.

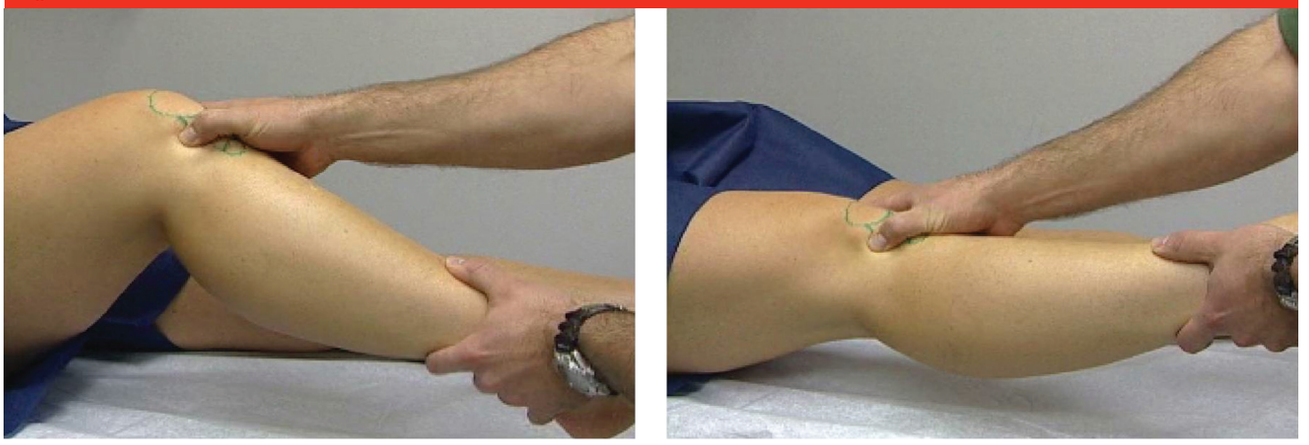
Scarring in the fat pad can be visualized on standard T1- and T2-weighted magnetic resonance images. On sagittal T1- and T2-weighted magnetic resonance images, anterior interval scarring is indicated by a low signal coursing from the posterior portion of the fat pad to the anterior surface of the tibia and/or transverse meniscal ligament.

Surgical Technique

Arthroscopic management of anterior interval scarring begins by establishing a modified anterolateral viewing portal. The portal is created slightly more lateral and proximal than standard arthroscopic portal placement to allow better visualization of the anterior interval structures (Figure 2). The anterior interval can be viewed with a 30° arthroscope; scarring is indicated by decreased opening of the interval with knee extension as well as fibrosis of the infrapatellar fat pad.

Fibrosis can be released using a 70° electrothermal probe inserted via a modified anteromedial portal (Figure 2). Systematic release begins anterior to the transverse ligament, starting just anterior to the anterior horn of the medial meniscus and proceeding laterally and anterior to the anterior horn of the lateral meniscus (Figure 3). The release continues until the anterior tibial cortex is encountered or until normal fat pad tissue is seen. Adequate release is confirmed by visualization of interval widening with knee extension and closing with flexion. Care is taken to avoid disrupting the anterior meniscal attachments or

Figure 1



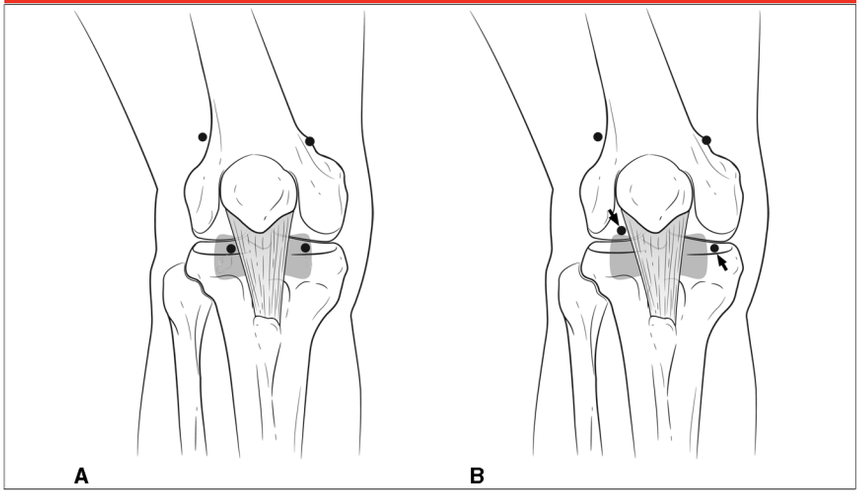
A B

Clinical photographs demonstrating the Hoffa test of the knee. **A,** The thumb is placed at the lateral margin of the infrapatellar fat pad and patellar tendon with the knee in 30° of flexion. **B,** Pressure is applied with the thumb as the knee is brought into full extension. (Reproduced with permission from Steadman JR, Dragoo JL, Hines SL, Briggs KK: Arthroscopic release for symptomatic scarring of the anterior interval of the knee. *Am J Sports Med* 2008;36[9]:1763-1769.)

the transverse meniscal ligament. Meticulous hemostasis must be obtained to prevent postoperative bleeding and recurrent scarring.[4]

Postoperatively, the goal of rehabilitation is to prevent scar reformation while preserving joint mobility. Initially, rehabilitation focuses on establishing full ROM and patellar and patellar tendon mobility. Patients are limited to touch-down weight bearing for 2 weeks to limit inflammation and to maximize interval excursion.[14] Typically, patients are prescribed a 4- to 6-week course of anti-inflammatory medication following surgery. After 6 weeks, the goal is the return of functional strength; sports-specific exercise is begun to facilitate gradual return to sport.

Figure 2



A B

Illustration demonstrating modified placement of arthroscopic portals for anterior interval release. **A,** Standard placement of arthroscopic portals. **B,** The modified anterolateral portal (arrow) is established slightly more lateral and proximal than the standard portal to improve visualization of the anterior interval. The modified anteromedial portal (arrow) is created more medial than the standard portal to allow exploration of the anterior interval. The shaded areas denote the infrapatellar fat pad.

Results

Steadman et al[4] described the results of isolated anterior interval release in a series of 25 consecutive patients with scarring of the anterior interval. Patients failed a minimum of 6 months of physical therapy and nonsteroidal anti-inflammatory drugs. Following arthroscopic release, the average Lysholm score significantly improved from 59 preoperatively to 81 postoperatively, and the average International Knee Documentation Committee score improved from 49 to 70 ($P < 0.0001$ and $P < 0.001$, respectively). Four patients with failed results required a second surgical release. Ogilvie-Harris and Giddens[15] described arthroscopic resection of

Figure 3

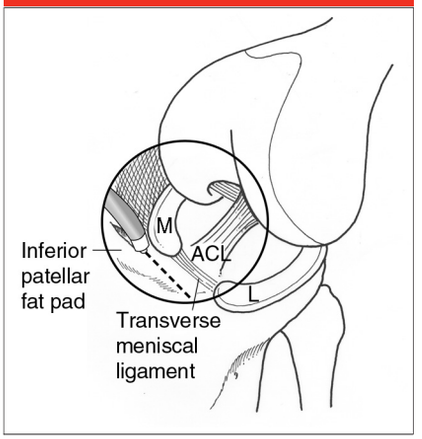


Illustration demonstrating anterior interval release. The release is made anterior to the transverse meniscal ligament and proceeds laterally and anterior to the anterior horn of the lateral (L) meniscus. ACL = anterior cruciate ligament, M = medial meniscus. (Reproduced with permission from Steadman JR, Dragoo JL, Hines SL, Briggs KK: Arthroscopic release for symptomatic scarring of the anterior interval of the knee. *Am J Sports Med* 2008;36[9]:1763-1769.)

the infrapatellar fat pad in patients with Hoffa syndrome. Patients had marked improvement in symptoms and function after surgery at an average follow-up of 76 months. Conversely, patients with severe scarring or infrapatellar contracture syndrome had symptoms of patellofemoral arthritis and tibiofemoral arthritis and could not return to a preinjury level of sport or work despite improvement in ROM after arthroscopic and open treatment.[1]

Posterior Capsular Release

Flexion contractures are one of the main factors that adversely affect patient outcome and knee function following surgery.[1,2,16] A 5° loss of extension can cause a noticeable limp during ambulation as well as patellofemoral irritability, and a deficit of 10° is poorly tolerated.[6] Extension deficit >20° results in substantial limb-length discrepancy.[2] Contracture of the posterior capsule is the primary cause of extension loss; however, anterior interval scarring, patellar entrapment, anterior cruciate ligament graft malposition, and hamstring tightness can also contribute to loss of extension.[1,2,16,17]

History and Physical Examination

Patients with an extension deficit should be systematically evaluated for the causes of flexion contracture. A thorough history should be obtained, and any trauma and/or surgical procedures should be noted. Knee ROM should be carefully measured, and the quality of the end point should be recorded. Flexion contractures exhibiting a firm end point tend to involve the posterior capsule, whereas a spongy end point typically indicates involvement of the patellofemoral mechanism or anterior interval.

MRI is the radiographic imaging modality of choice. Thickening or scarring of the posterior capsule, which is indicated by a low signal on T1- and T2-weighted magnetic resonance images, may sometimes be observed.

Surgical Technique

Surgical intervention is indicated after failed nonsurgical treatment in the patient with a flexion contracture of 10° to 15° and an unyielding end point.[18] However, even smaller degrees of contracture may not be tolerated in the elite athletic population. Open[17-19] and arthroscopic[20,21] posterior capsular releases have been described, but arthroscopic releases are more technically demanding.

The patient is positioned for standard arthroscopy with the contralateral leg placed in a well-leg holder and the foot of the bed dropped. A tourniquet should be carefully placed high on the thigh to allow adequate draping for the creation of a posteromedial and/or posterolateral portal (Figure 4). Use of an arthroscopic pump is recommended to maintain constant intra-articular pressure and ensure distension of the posterior capsule. Anterolateral and anteromedial arthroscopic portals are created near the edge of the patellar tendon to allow instrumentation to be used in the posterior compartment.

The posteromedial compartment is visualized by placing a 30° arthroscope between the medial femoral condyle and posterior cruciate ligament via the anterolateral portal.[20] Often, a blunt arthroscopic obturator must first be used to break through scar tissue or adhesions before inserting the arthroscope.[20] Under direct visualization, a spinal needle is inserted into the skin through the posteromedial capsule to localize the posteromedial arthroscopic portal (Figure 4). The portal is then created under direct visualization by making a small incision and advancing an arthroscopic cannula through the incision into the posteromedial compartment. Similarly, the arthroscope may be placed between the anterior cruciate ligament and lateral femoral condyle to visualize the posterolateral compartment. A posterolateral portal can be created in a similar manner; however, care must be taken to avoid the peroneal nerve, which lies on the posteromedial border of the biceps femoris tendon. The incision must be made anterior to this tendon, and blunt dissection must be performed during portal placement.

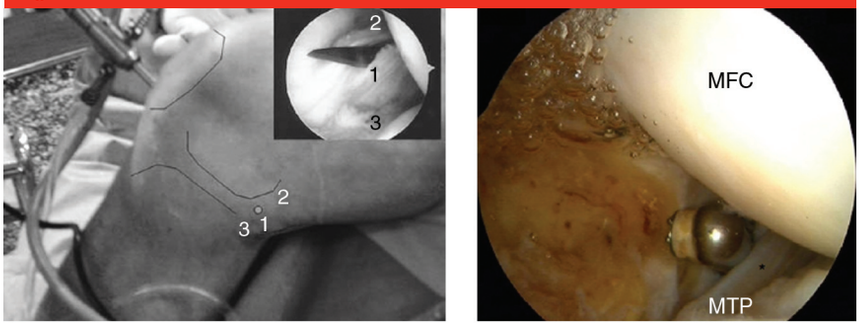
Two methods of arthroscopic capsular release have been described in the literature. LaPrade et al[20] described an isolated posteromedial release for flexion contractures. They recommended separating the posteromedial capsule from the posteromedial structures, including the medial gastrocnemius tendon and

muscle, with a blunt arthroscopic obturator or a small periosteal elevator. The posteromedial capsule is then released using an arthroscopic basket punch and shaver, with the shaver blade facing anteriorly. The procedure starts medially and proceeds laterally to the midline in line with the posterior cruciate ligament at the mid level of the capsule. The gastrocnemius muscle and tendon become visible as the capsule is released.

Mariani[21] described posteromedial and posterolateral arthroscopic capsular releases in which the arthroscope can be placed in either the posteromedial or posterolateral portal to visualize the contralateral compartment. Often, the posterior septum must be released before the capsular release can be performed. A blunt trocar can be used to perforate the septum, and a shaver or radiofrequency probe can then be used to expand the perforation. Posterior adhesions are removed until the femoral condyles become visible. A punch or radiofrequency probe is directed toward the superior capsular attachments at the condyle, and the capsule is then progressively released. The gastrocnemius tendon can be visualized and released to allow for a greater posterior release.

Postoperatively, patients may be admitted to the hospital for pain management and initial physical therapy. Placement of an indwelling epidural catheter, in addition to oral and intravenous analgesics, is often beneficial for pain management. Early, aggressive physical therapy is begun on the first postoperative day. A continuous passive motion machine is used and is alternated in cycles with extension splinting. Patients are advanced to weight bearing as tolerated and weaned from crutches when they are able to ambulate without pain. Patients are also prescribed a 2-week course of prophylaxis to prevent deep vein thrombosis. After discharge, patients continue with outpatient physical therapy and nighttime extension splinting for at least 6 weeks.

Figure 4



A B

A, Clinical photograph of the knee demonstrating the location of a posteromedial arthroscopic portal used for posterior capsular release. Inset, Arthroscopic image demonstrating the position of the posteromedial portal. The entry site (1) is located between the posterior medial femoral condyle (2) and the posterior medial tibial plateau. (3) and is created under direct visualization. **B,** Arthroscopic view from the posterolateral portal toward the posteromedial aspect of the knee during capsular release. MFC = medial femoral condyle, MTP = medial tibial plateau. (Panel A reproduced with permission from Louisia S, Charrois O, Beaufils P: Posterior "back and forth" approach in arthroscopic surgery on the posterior knee compartment. *Arthroscopy* 2003;19[3]:321-325. Panel B reproduced with permission from Pace JL, Wahl CJ: Arthroscopy of the posterior knee compartments: Neurovascular anatomic relationships during arthroscopic transverse capsulotomy. *Arthroscopy* 2010;26[5]:637-642.)

Results

LaPrade et al[20] reported the results of 15 patients who underwent isolated arthroscopic posteromedial release. Preoperative knee extension averaged 15° and significantly improved to 0.07° at final follow-up (average, 24 months). Mariani[21] reported the results of 18 patients with extension deficits that averaged 34° (range, 16° to 44°) who were treated with posterior capsular release. Extension deficits averaged 3° (range, 0° to 5°) at final 1-year follow-up. Patients with more severe preoperative flexion contracture require more aggressive releases of both the posteromedial and posterolateral capsule and, if results are inadequate, may require release of the gastrocnemius tendon.

Peripatellar and Suprapatellar Releases

In general, arthrofibrosis in the suprapatellar pouch of the knee causes loss of flexion, whereas scarring of the posterior structures can cause loss of extension. Scarring and adhesions lead to loss of capsular compliance and pain.[22]

History and Physical Examination

Physical examination begins with inspection of patellar glide or excursion, which should be examined in all directions.[23] Typically, the patella exhibits decreased excursion in all directions in patients with arthrofibrosis. Patellar tilt should be carefully assessed.[23] The inability to elevate the lateral aspect of the patella to neutral with the knee in full extension and with the patella centered in the trochlea indicates a tight lateral retinaculum and possible overconstraint of the patellar mechanism

Figure 5

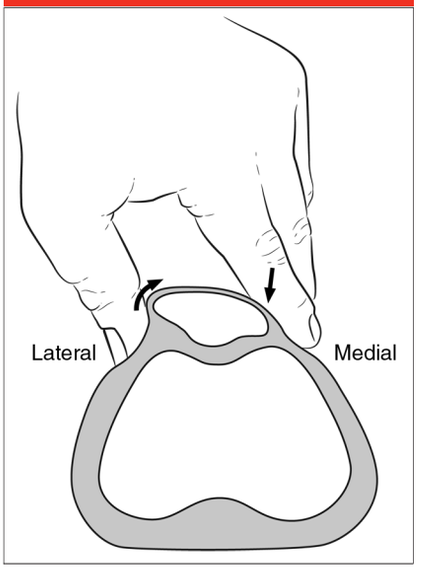
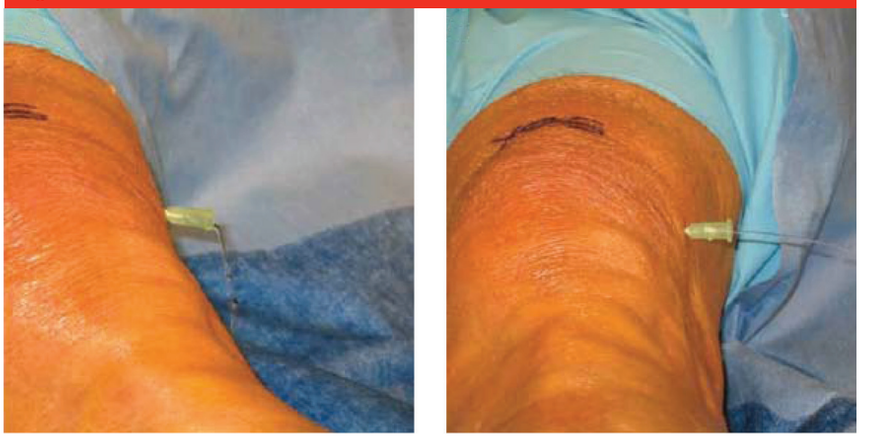


Illustration of the patellar tilt test. The patella is centered within the femoral trochlea with the knee in full extension. The medial and lateral aspects of the patella are stabilized with the thumb and forefinger, and the lateral aspect is elevated with the thumb. Inability to elevate the lateral aspect of the patella to neutral indicates a tight lateral retinaculum. (Reproduced with permission from Dixit S, DiFiori JP, Burton M, Mines B: Management of patellofemoral pain syndrome. *Am Fam Physician* 2007;75[2]:194-202.)

Figure 6



A **B**

Clinical photographs demonstrating assessment of intra-articular volume. Preoperatively, the knee is injected with 60 mL of sterile saline. After injection, the syringe is removed from the needle to assess the outflow of saline. **A,** Slow egress (drip) indicates normal volume. **B,** Rapid outflow suggests insufficient intra-articular volume. (Reproduced with permission from Dragoo JL, Miller MD, Vaughn ZD, Schmidt JD, Handley E: Restoration of knee volume using selected arthroscopic releases. *Am J Sports Med* 2010;38[11]:2288-2293.)

(Figure 5). Tenderness in the region of the suprapatellar pouch and/or infrapatellar fat pad is common, in addition to loss of ROM. A systematic evaluation, such as the one described by Kim et al,[3] allows for assessment and management of intra-articular sources of motion loss.

Surgical Technique

Performing capsular distension before arthroscopy is useful because it reestablishes effective joint space, allows easier and safer insertion of instruments, enhances visualization, and may disrupt intra-articular adhesions.[24] Sterile saline should be slowly injected into the capsule to allow for stretching and to avoid rupturing the capsule; this will prevent extravasation of fluid during arthroscopy.[22,24]

Intra-articular volume capacity can be assessed by injecting the knee with 60 mL of sterile saline.[22,24] After injection, the syringe is disconnected from the 18-gauge needle. A slow release of saline indicates that the articular volume is normal and the capsule is under little tension (Figure 6, A). However, if the saline is expressed from the joint in a stream, the capsule is under significant pressure, which indicates insufficient capsular volume. The knee should then be evaluated for structures known to reduce intra-articular volume (eg, anterior interval scarring, complete suprapatellar plica)[22] (Figure 6, B).

Using an electrothermal probe, adhesions are lysed and scarring is released to reestablish the suprapatellar pouch. Adhesions between the capsule and the femoral condyles are often observed and require release. The anterior interval is then reestablished, if necessary.[4]

Medial and lateral retinacular release may be indicated in patients with persistent decreased patellar excursion after release of the suprapatellar pouch. The patellar tilt test can be used to identify an excessively tight lateral retinaculum (Figure 5).[25] If the medial and lateral patellar retinaculum are scarred, they may be partially released to improve patellar mobility and capsular compliance. Often, the anterolateral portal is used as the working portal, and the anteromedial portal is used for viewing. Placement of the electrothermal probe through a superior portal is rarely necessary. The retinacular releases are performed approximately 1 cm posterior to the border of the patella to avoid devascularization. The procedure is performed in layers to prevent an excessive amount of release. The intercondylar notch can also be assessed for fibrosis. After

the anterior and suprapatellar pouch releases are completed, knee ROM is tested. If persistent extension deficit remains, then the posterior compartment is assessed and released as described previously.

Postoperatively, an indwelling epidural catheter can help to provide adequate pain management, which allows for immediate intensive physical therapy. Patients are placed in a continuous passive motion machine immediately, and patellar mobilization and ROM exercises are emphasized. In general, weight bearing is limited for several days to weeks to decrease the incidence of hemorrhage and inflammation.

Results

Numerous authors have reported substantial improvement in knee ROM (range, 35° to 68°) following lysis of adhesions.[14,26-28] The most common adverse outcome of this procedure is the inability to restore complete ROM.[14,26,28] Several authors have also noted marked postoperative tenderness in the region of the infrapatellar fat pad, which resolved with nonsurgical measures.[26,27] Complications of retinacular releases are common, especially with excessive release that continues beyond the fat and muscle layers or disrupts the vastus tendon insertions. Excessive release can result in wound complications or patellar instability. Hemarthrosis is the most common complication; meticulous hemostasis is required due to the proximity of the geniculate arteries.[29]

Summary

Intra-articular fibrosis can cause significant morbidity within the knee. Arthroscopic techniques provide minimally invasive, efficacious alternatives to open procedures. Anterior interval release is a simple procedure for management of anterior interval scarring. Posterior capsular release, although technically demanding, is effective for managing flexion contracture secondary to contracture of the posterior capsule. Lysis of adhesions and retinacular release of the suprapatellar pouch and peripatellar region offer controlled, focused management of the intra-articular causes of motion loss, with decreased risk of complications.

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