Arthroscopic Treatment of the Osteoarthritic Knee

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Introduction

The knee is the most commonly affected weight-bearing joint by osteoarthritis, accounting for approximately 1 million surgical procedures yearly and for the majority of nonsteroidal anti-inflammatory drugs purchased in the United States. More than 20 million people in the United States are afflicted with early osteoarthritis, and it is the leading cause of limitation of activities of daily living and second only to cardiac disease in causing loss of time from vocational activities and work disability [1, 2]. In addition, an increased life expectancy and increased awareness of the benefits of physical fitness and participation in sports activities has resulted in a larger population with chronic articular cartilage injuries and early degenerative disease and higher expectations with respect to activity levels and recreational activities [3].

These active individuals are frequently resistant to and dissatisfied with total knee arthroplasty as a long-term solution to their symptoms. In addition, survival rates for total knee arthroplasty in very active individuals under the age of 55 years have historically been unsatisfactory [4, 5]. Many of these patients may be candidates for osteotomy; however, frequently these patients are also candidates for arthroscopic debridement for symptomatic relief of pain and mechanical symptoms without the risks and recovery associated with osteotomy.

The etiology of osteoarthritis of the knee stems from a myriad of causes, including traumatic, genetic, iatrogenic, as well as idiopathic. Discerning the causative factors in any given case may contribute to the prognosis after arthroscopic debridement [6–8]. In general, exacerbation of pain and mechanical symptoms associated with injury to an osteoarthritic joint will be associated with a better prognosis after arthroscopic treatment than will other causes [9–11].

The pathology of osteoarthritis consists of a predictable sequence of loss of articular cartilage accompanied by changes in its cellular and acellular composition, ineffective repair processes, and remodeling of subchondral and juxtaarticular bone. In addition, there is also thickening of the joint capsule, inflammation in the synovium, and bone cyst formation. The pain and symptoms associated with these changes are frequently unpredictable as is the rate of progression, which can complicate the outcome of arthroscopic debridement for this disease [10, 12].

Numerous theories have been proposed to account for the pain generators in the osteoarthritic joint and how these might account for symptomatic improvement after direct treatment. Various contributing factors include electromechanical influences on chondrocyte activity, changes in humoral, synovial, and chemical factors within the joint, immune response to proteoglycan and collagen breakdown products within the synovium, altered joint mechanics and irritation of unprotected subchondral bone, meniscal pain, and the presence of inflammatory mediators and degradative enzymes within synovial fluid. Synovial fluid in the osteoarthritic knee contains disproportionate concentrations of catabolized matrix proteins, interleukins, collagenases, metalloproteinases, and numerous other enzymes [13]. The presence of this altered biochemical milieu has inspired many researchers to investigate the therapeutic effects of arthroscopic lavage and its potential for symptomatic improvement. However, the possibility of altering or delaying the natural history of the disease in this manner seems unlikely and remains controversial [6, 14].

History

Reports of arthroscopic treatment of the arthritic knee originate in the 1920s when Bircher reported on beneficial effects of diagnostic arthroscopy [15]. Burman et al. reported on the use of arthroscopic lavage of the knee in 10 patients with osteoarthritis in the 1930s, reporting significant improvement

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in all patients [16]. Watanabe et al. later championed the use of arthroscopic lavage in reducing symptoms of osteoarthritis in the 1950s [17].

Following on the experimentation of Magnusun and Pridie in open debridement of the knee, a number of investigators began exploring arthroscopic debridement and marrow stimulation techniques in the treatment of osteoarthritic knee in the 1970s after numerous technologic advancements in arthroscopic equipment. The use of arthroscopy as a diagnostic tool in the assessment of the extent of cartilage injury became widespread at this time, aiding in predicting one's candidacy for osteotomy or prosthetic replacement [11, 18, 19].

In the past decade, a growing body of research has been devoted to further defining the most appropriate indications for arthroscopic interventions for osteoarthritis in large part due to economic pressures and the fear that arthroscopy is overused with little real benefit to a large subset of this population [9, 12, 20, 21].

Indications

Although it continues to be mired in controversy, the arthroscope remains a useful tool in the surgeon's arsenal for the treatment of the degenerative knee. Diagnostic arthroscopy is frequently helpful in defining the extent of degenerative changes in the younger patient with precocious arthritis or when there is suspicion of multicompartment disease. Planning of subsequent treatment from cartilage grafting to unicompartmental or total joint arthroplasty is efficiently accomplished in this manner. Concomitant cartilage or synovial biopsy also can be performed for subsequent diagnostic and therapeutic interventions as well. Though frequently elusive and frequently requiring an associated arthrotomy, loose bodies associated with pain or mechanical symptoms may be removed arthroscopically.

A number of studies have demonstrated discrepancies between x-ray findings and arthroscopic evaluation in the diagnosis of osteoarthritis. A significant number of patients with debilitating knee pain (up to 33%) and preoperative x-rays demonstrating joint space narrowing have been demonstrated to have normal joint surfaces upon arthroscopic evaluation [22]. Lysholm et al., on the other hand, found that only patients with Outerbridge IV [23] changes at arthroscopy had preoperative radiographs consistent with osteoarthritis [18].

A number of retrospective studies have shown significant benefit after arthroscopic treatment of unicompartmental osteoarthritis associated with mild degenerative changes, normal alignment, and unstable meniscal tears [6–8, 24, 25]. Other studies have demonstrated poorer results in the setting of malalignment associated with osteoarthritis [9, 24, 26]. Varus malalignment may impart a worse prognosis than that of increased valgus [24]. Other risk factors associated with a poor prognosis include severe or tricompartmental disease and calcium pyrophosphate deposition [7, 13].

Critics of arthroscopic debridement would argue how many patients go on to further surgery and total knee arthroplasty after arthroscopy and that theoretically some patients might be made worse by removal of functional meniscal tissue and cartilage. Indeed, partial meniscectomy may increase the force transmitted across the articular surfaces of the tibiofemoral joint by as much as 45% [27]. However, other studies have failed to demonstrate a negative impact of arthroscopy over time. In a retrospective study, Pearse and Craig demonstrated that meniscal debridement did not hasten the progression of osteoarthritis to joint arthroplasty over lavage alone [28].

The simple presence of a meniscal tear in the osteoarthritic knee should not be used alone as an indication for arthroscopic intervention. Magnetic resonance imaging (MRI) studies have demonstrated a 91% prevalence of meniscal tears in knees with osteoarthritis compared with 76% in a population of asymptomatic subjects. Furthermore, it has been postulated that the torn meniscus is an infrequent source of pain in the osteoarthritic knee [29]. However, there is excellent evidence that traumatic tears in the osteoarthritic knee associated with mechanical symptoms and appropriate physical exam findings indicate a good candidate for arthroscopic treatment [9, 12, 26, 30].

Authors' Preferred Surgical Technique

After the induction of general or spinal anesthesia in the supine position, a tourniquet and leg holder are applied at approximately the middle of the thigh. If the leg holder is applied too distally, it may interfere with use of superior portals when necessary, and, if applied too proximally, it will prevent the appropriate counterforce when manipulating the leg into varus or valgus for visualization of the medial or lateral compartment. This is particularly important in a degenerative knee where stiffness, joint space narrowing, and capsular contraction may make visualization and instrumentation of the compartments more challenging, requiring a better mechanical advantage upon the extremity.

Prior to draping, the knee is sterile injected with 30 mL 0.5% Marcaine (Bupivacaine Hcl, AstraZeneca, London, UK) with epinephrine for hemostasis and anesthesia. Use of this technique has made the need for insufflation of the tourniquet uncommon. The anterolateral portal is established just lateral to the patella tendon in the soft-spot at approximately the inferior pole of the patella. A vertical or oblique incision is preferred, in the event that capsular

Table 1 Outerbridge grading of chondral surface lesions

Grade I: Softening and swelling of cartilage (Fig. 1)
Grade II: Fragmentation and fissuring, less than 0.5-inch-diameter lesion (Fig. 2)
Grade III: Fragmentation and fissuring, greater than 0.5-inch-diameter lesion (Fig. 3)
Grade IV: Erosion of cartilage down to exposed subchondral bone (Fig. 4)

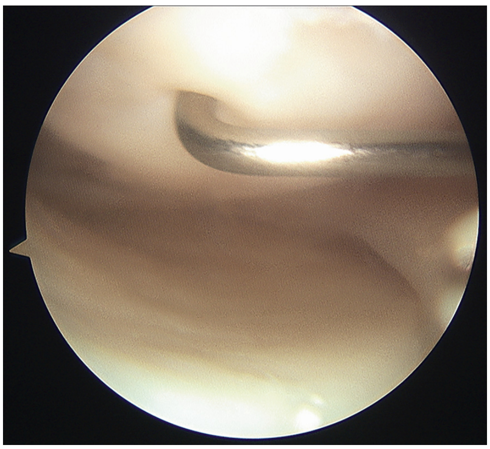

Fig. 1 Outerbridge grade I lesion

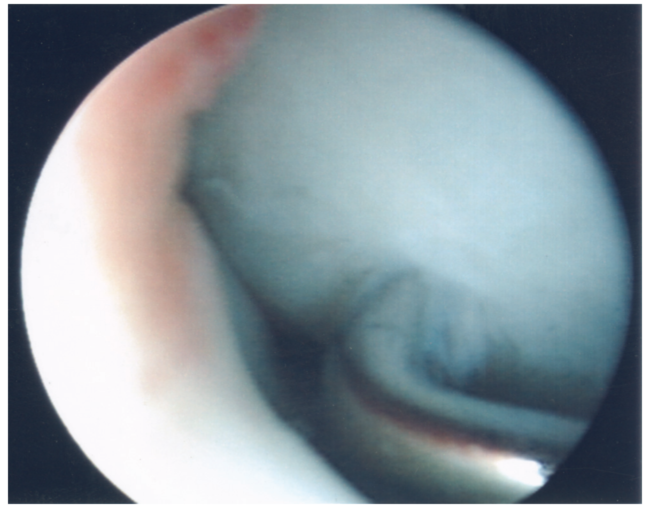

Fig. 2 Outerbridge grade II lesion of the lateral femoral condyle. Note probe used to estimate size of lesion

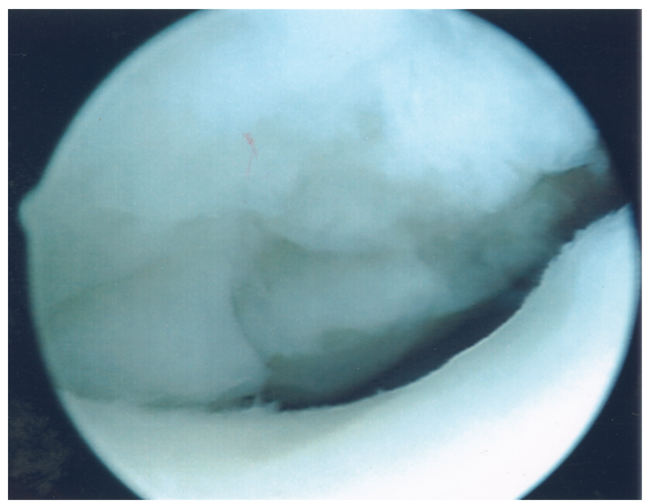

Fig. 3 Outerbridge grade III lesion of the patella

contracture or osteophytes in the intercondylar notch restrict the mobility of the arthroscope, such that it can be raised or lowered slightly to avoid these obstructions. The incision is carried through skin and capsule angled slightly into the intercondylar notch. The blunt arthroscopic cannula is inserted initially into the notch area with the knee flexed to avoid injury to articular cartilage and then redirected into the suprapatellar pouch as the knee is carried into full extension.

Routine diagnostic arthroscopy is then carried out. Visualization of the suprapatellar pouch may reveal synovitis common in degenerative conditions and cartilaginous loose bodies. Routine synovectomy in this area is not typically carried out. The facets of the patella and trochlea are visualized, and grading of cartilage injury is noted using the Outerbridge classification (Table 1; Figs. 1–4).

The arthroscope is then directed laterally over the trochlea ridge and to the lateral gutter. Care must be taken in translating the arthroscope over the lateral edge of the trochlea as a prominent osteophyte may be present in this area and the scope may have to be levered to prevent cartilage damage of fracture of osteophyte, potentially contributing to postoperative pain. The scope is directed down the lateral gutter while slightly retracting the arthroscope in order to avoid the lateral synovial fold and then advanced into the area of the popliteal hiatus, a common hiding place for degenerative loose bodies. While in the lateral gutter, femoral osteophytes may be visualized as well as the peripheral aspect of the mobile lateral meniscus (Fig. 5). Peripheral lateral meniscal tears or subluxated flaps of torn meniscus may be visualized in this area along with synovitis adjacent to painful tears.

If the trochlea cannot be gently negotiated, the scope should be redirected carefully down the middle of the trochlea while visualizing the articular cartilage into the medial compartment or intercondylar notch area.

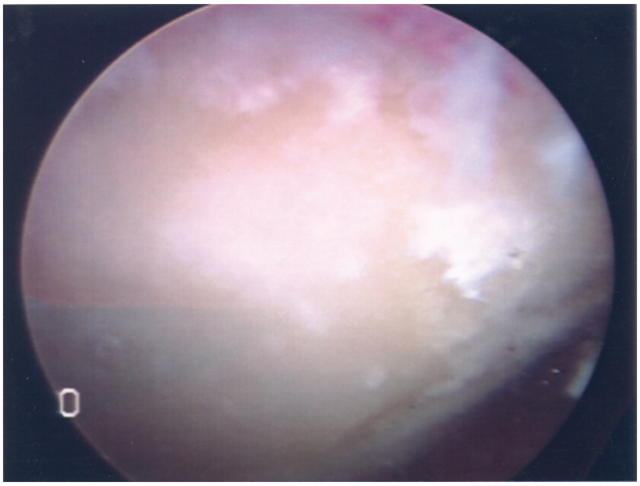

Fig. 4 Outerbridge grade IV lesion of the medial femoral condyle

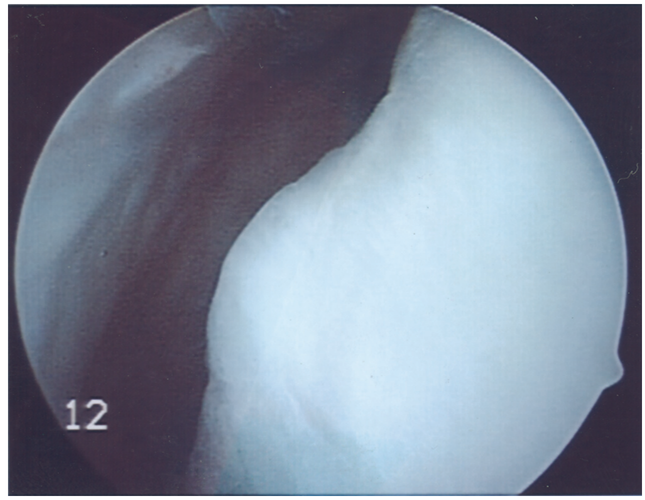

Fig. 6 Tracing the arthroscope down the medial femoral condyle demonstrates intact articular cartilage and medial osteophyte formation

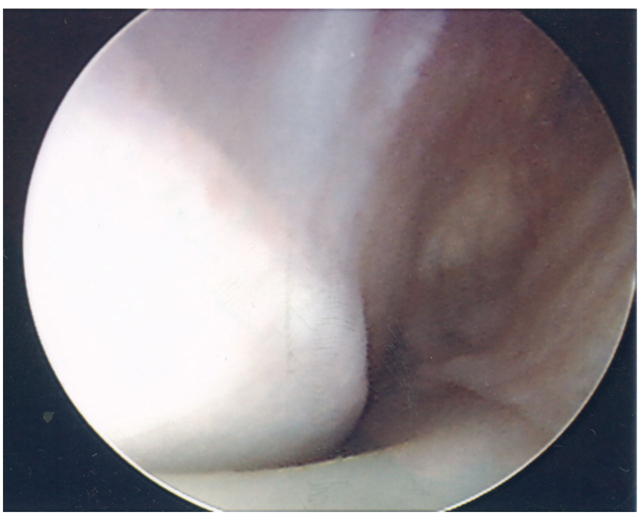

Fig. 5 Visualization of lateral gutter demonstrates intact peripheral rim of the lateral meniscus and popliteus hiatus in the background. Note early osteophyte formation on the lateral femoral condyle

The scope is then redirected into the suprapatellar pouch and across to the medial gutter. The articular cartilage of the medial femoral condyle is carefully traced and visualized as the scope is directed into the medial compartment (Fig. 6). A gentle valgus stress is applied to the knee in midflexion for visualization of the medial compartment. The anteromedial portal is then established for insertion of a probe.

The authors' technique for establishing the anteromedial portal allows for minimal violation of the joint capsule and minimizes the potential for iatrogenic articular cartilage injury. A 17-gauge spinal needle is placed through the skin anteromedially and into the medial compartment of the knee under direct vision. Advancing a small-bore hypodermic needle while instilling local anesthetic helps determine the proper orientation prior to inserting the spinal needle. A skin incision but no formal arthrotomy is made. The stylet from the spinal needle is removed, and a flexible wire is passed through the needle and into the joint. Once proper positioning of the needle and guide wire have been confirmed, the needle is removed and a cannulated switching stick is placed over the guide wire to provide gentle dilation of the needle arthrotomy (Fig. 7). The switching stick may then be removed and exchanged for a small cannula, which is passed over the guide wire. The guide wire can then be removed, and arthroscopic probe is introduced through the cannula (Fig. 8).

A shaver or arthroscopic punch also can be inserted atraumatically using this technique (Figs. 9 and 10). After removal of the switching stick, the inner shaving portion of an arthroscopic shaver is disengaged from its outer barrel. The outer barrel is then placed over the guide wire and the guide wire removed. The inner shaver is then reassembled with the barrel, and arthroscopic debridement is commenced. A similar technique of cannulation using the outer barrel of an arthroscopic shaver has been described by Shen and Meislin for use in hip arthroscopy [31].

The medial meniscus is probed on its superior and inferior surface, and tears are identified. Frequently adjacent chondral injury/degeneration is also present. Horizontal cleavage and complex tears are common in the degenerative knee.

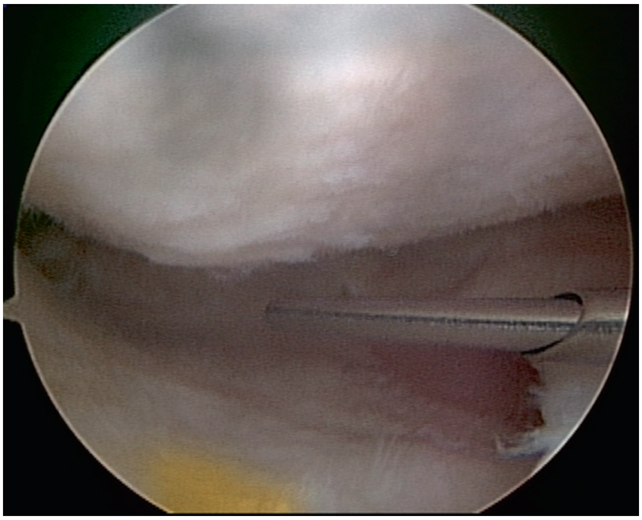

Fig. 7 Serial dilation of medial portal is initiated over a cannulated switching stick

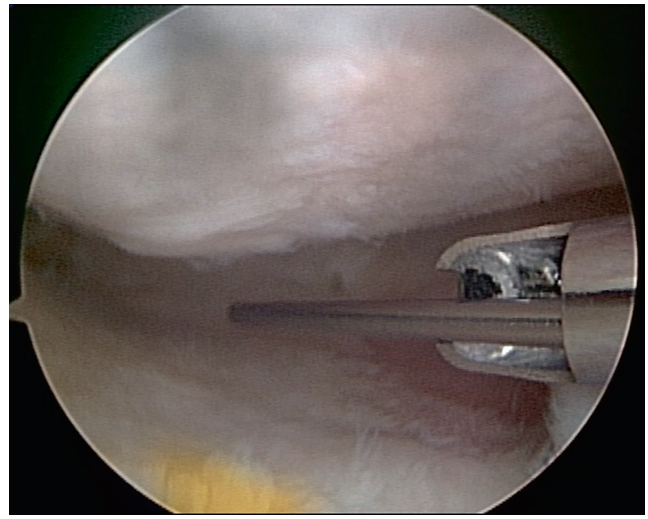

Fig. 9 Arthroscopic shaver is atraumatically introduced over switching stick

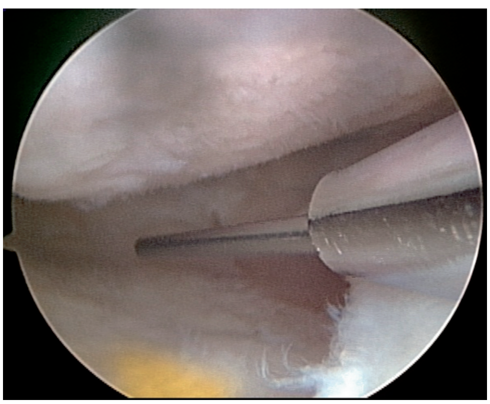

Fig. 8 Larger arthroscopic cannula is placed over switching stick

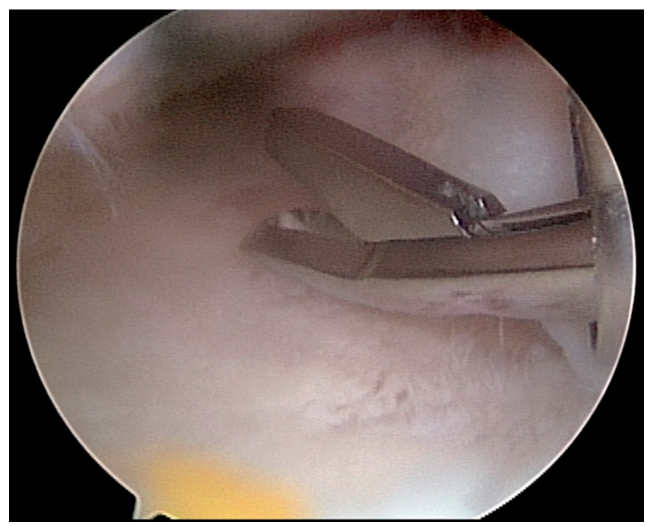

Fig. 10 Arthroscopic punch is inserted atraumatically through large medial cannula

The minimum resection of meniscus that results in a stable peripheral rim should be resected (Fig. 11A–C). The authors' preference is to use a 4.5mm full radius shaver, as the degenerative meniscus is often firm and rubbery and resistant to debridement with less aggressive instruments. Arthroscopic punches are useful for initiating the resection at the apex of the tear followed by the shaver. Horizontal tears are approached by debriding the more unstable flap of meniscus, frequently the inferior aspect, with preservation of the remaining tissue if stable (Fig. 12A–C). Occasionally, synovitis may be detected at the menisco-synovial junction associated with a tear (Fig. 13A, B). Gentle synovectomy may be performed (Fig. 13C); however, care should be taken, as overaggressive synovial debridement may lead to a painful postoperative hemarthrosis. Care is taken to pass a probe under the meniscus in the vicinity of the tear and over the edge of the tibia, as a flap of torn tissue may sublux medial to the joint, resulting in failure of the procedure if left undetected. Unstable flaps of articular cartilage may be the source of mechanical symptoms and should be debrided back to a stable rim to prevent further propagation. Only the minimum amount of articular cartilage is resected.

The intercondylar notch is then inspected, and the anterior cruciate ligament (ACL) is probed. If a loose body is suspected or if there is interest in decompression of an arthritic popliteal cyst, the arthroscope can be directed under the superior aspect of the posterior cruciate ligament (PCL) just

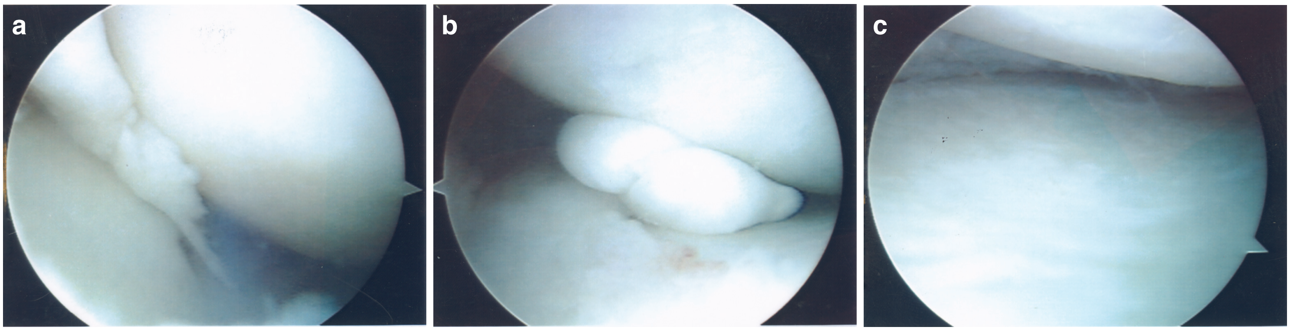

Fig. 11 (**A, B**) Unstable tear of the medial meniscus associated with Outerbridge grade II changes of the medial femoral condyle. (**C**) Image taken after debridement of unstable meniscal fragments to a stable rim of the medial meniscus

lateral to the medial femoral condyle and with modest force directed into the posterior aspect of the knee. Frequently, the arthroscope must be replaced with the tapered blunt stylus to pass into this area.

The arthroscope is then directed lateral to the lateral tibial spine, and the limb is taken into a figure-of-four position so that the lateral compartment may be visualized. Preservation of as much healthy lateral meniscus as possible is paramount to the maintenance of normal knee kinematics. Visualization of the anterior horn of the lateral meniscus may be challenging from the anterolateral portal, and, if a tear is suspected in this area, visualization may be improved from the medial portal.

Finally, attention is returned to the patellofemoral joint, where debridement of unstable flaps of cartilage may improve mechanical symptoms.

Rehabilitation

Patients are mobilized weight-bearing as tolerated immediately with crutches to wean as tolerated, and active range of motion exercises are begun upon discharge. Patients are instructed in quadriceps strengthening exercises to be performed daily. Deep venous thrombosis (DVT) prophylaxis includes aspirin daily, and T.E.D Covidien (Mansfield, Ma). stockings are encouraged for 1 month after the procedure. Patients are seen at 2–3 weeks postoperatively to review arthroscopy findings and discuss prognosis. Patients with extensor lag, quadriceps atrophy, or limited range of motion are referred for formal outpatient physical therapy. Patients should be counseled that maximal improvement in symptoms may not be experienced until 3–4 months postoperatively.

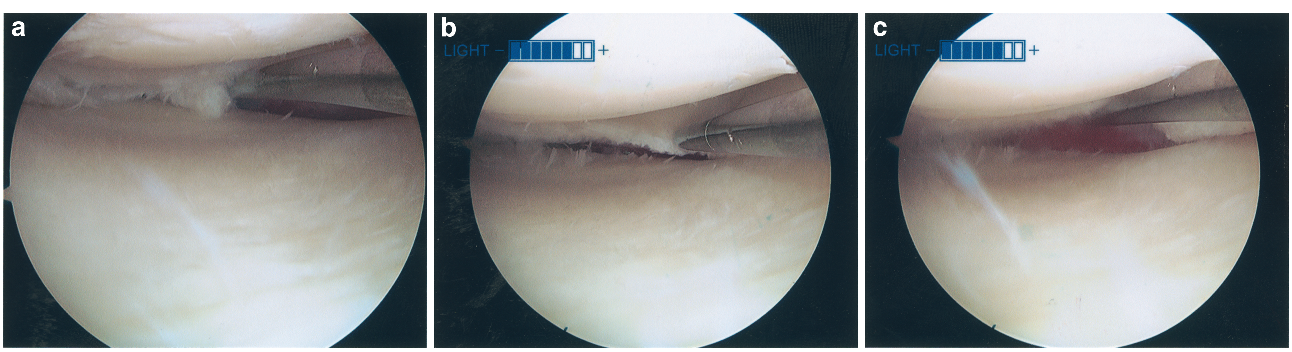

Fig. 12 (**A**) Degenerative horizontal cleavage tear of the posterior horn of the medial meniscus associated with Outerbridge grade II changes of the medial femoral condyle and grade III changes of the tibial plateau. After debridement of the unstable inferior flap of the tear, the (**B**) superior and (**C**) inferior surfaces of the meniscus are probed and inspected to ensure that debridement is complete

Complications

Complications after arthroscopic knee surgery are fortunately rare and include hemarthrosis, infection, thromboembolic disease, nerve injury, reflex sympathetic dystrophy, osteonecrosis, and ligament injury [32, 33]. The most common complication in the degenerative knee is that of recurrent pain and swelling secondary to underlying osteoarthritis with eventual progression to and the need for total knee replacement. Based on the available literature, this can be anticipated in at least 10% of this population by 2 years postoperatively [9, 12, 20, 21, 26, 30]. Though uncommon, spontaneous osteonecrosis can be a quite disturbing outcome after this procedure, with severe unrelenting pain and a decline in function that is frequently worse than the patient's preoperative symptoms. Because of the potential for this and other negative outcomes, it is important to counsel patients that, whereas the procedure is low risk, there is a small chance of worsening symptoms after the procedure. In addition, pain that does not improve in 6 weeks warrants repeat MRI scan to rule out post-arthroscopy osteonecrosis, which may benefit from a period of protected weight-bearing [33].

There is significant concern for thromboembolic disease in this frequently older population, many with concurrent underlying venous insufficiency. Fortunately, the incidence of symptomatic DVT and pulmonary embolism (PE) remains quite rare. Investigations into the rate of symptomatic DVT after arthroscopic procedures have demonstrated a rate of approximately 0.5%. Studies using ultrasonography or other imaging modalities at a set interval postoperatively indicate a rate of up to 17%, most of which are asymptomatic and localized to the calf [34].

Results

The results of arthroscopic debridement for internal derangements of the knee in the setting of osteoarthritis have been mixed but mostly favorable at short-term and intermediate-term follow-up in the literature. Harwin reviewed the results of arthroscopic debridement in 204 knees with osteoarthritis. At an average of 7.4 years follow-up, he found significantly better results in patients with a more normal mechanical alignment, including satisfactory results in 84% of patients with normal alignment. Older age and previous surgery were also risk factors for a poorer outcome [26]. In a retrospective review of 36 patients undergoing arthroscopic debridement, Fond et al. demonstrated improvements in pain and function (by hospital for special surgery (HSP), New York, N.Y. knee scores) in 88% at 2 years and in 69% at 5 years. Risk factors for failure of arthroscopic debridement included a greater preoperative flexion contracture and a lower preoperative HSS score [30]. Whereas a number of retrospective studies like these have demonstrated significant benefit for arthroscopic debridement of the osteoarthritic knee, most are lacking validated outcomes scores for pain and function.

Other intermediate-term studies have demonstrated poorer results for arthroscopic debridement in osteoarthritis. Dervin et al. prospectively evaluated 126 patients undergoing arthroscopic meniscal and chondral debridement using Western Ontario and McMaster Osteoarthritis Index (WOMAC), The SF-36 is a multi-purpose, short-form health survey with only 36 questions (SF-36) and SF-36: 44% were rated as having had a clinically important reduction in pain, by the WOMAC pain scale, at 2 years. Physicians were poor at predicting which patients would improve. Three variables were significantly associated with improvement after arthroscopic

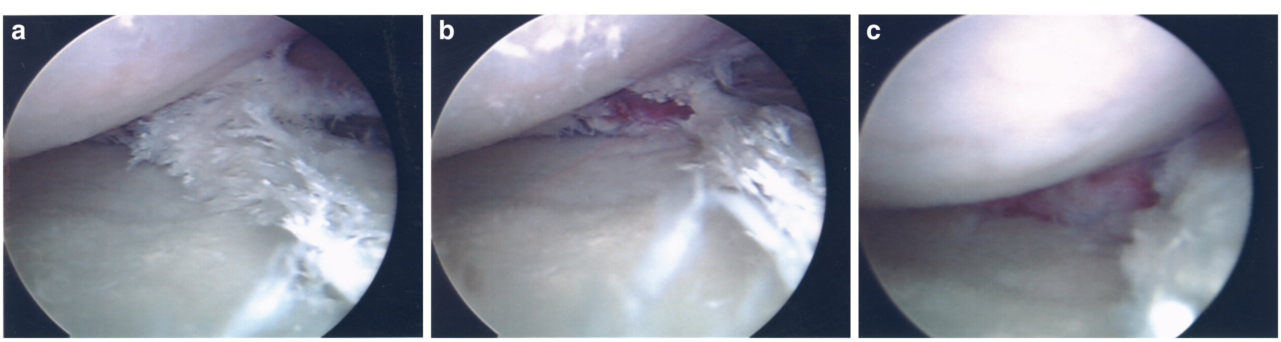

Fig. 13 (**A**) Degenerative tear of medial meniscus associated with chondrocalcinosis and Outerbridge grade III changes of the medial femoral condyle and medial plateau. (**B**) Note inflamed synovium at the posterior apex of the tear. (**C**) After debridement of meniscus and synovium, patient had improvement in pain and mechanical symptoms for more than a year postoperatively

debridement: the presence of medial joint-line tenderness, a positive Steinman test, and the presence of an unstable meniscal tear at arthroscopy [12]. Other longitudinal studies of administrative data sets have demonstrated that 18.4% of 6,212 Canadian patients undergoing arthroscopic debridement underwent total knee replacement (TKR) within 3 years [21]. In a prospective randomized study of arthroscopic debridement in a population of veterans with osteoarthritis, Moseley et al. demonstrated no benefit to debridement over placebo surgery [20]. These results have remained controversial as patients were not excluded based on previously known risk factors for poor outcome such as malalignment and significant joint contracture.

More recently, Aaron et al. reviewed the results of arthroscopic debridement in a consecutive group of 110 patients with osteoarthritis at a mean 34 months postoperatively. They found that 90% of patients with mild arthritis, normal alignment, and joint space >3 mm had significant improvement in Knee Society pain scores when compared with patients who had evidence of severe arthritis, malalignment, and a joint space <2 mm (25% improved). The severity of the articular lesion as graded intraoperatively was also predictive of outcome [9].

In the authors' experience, arthroscopic debridement and lavage provide short- to intermediate-term symptomatic improvement to the majority of patients with pain and mechanical symptoms associated with meniscal tear in the setting of mild osteoarthritis. The results are generally better in younger patients with normal alignment, a recent history of trauma or injury, and a shorter duration of symptoms. Absolute contraindications include severe or multicompartmental disease, malalignment of more than 3–5 degrees from the mechanical axis, the absence of mechanical symptoms or joint-line tenderness, and significant joint contracture or stiffness.

Clinical Pearls/Summary

Use of arthroscopy in the management of the osteoarthritic knee remains controversial. Careful patient selection is paramount to good results and improvement in patient satisfaction. In the appropriate patient with osteoarthritis, arthroscopy can result in sustained relief of pain and improvement in mechanical symptoms and activity levels. Risk factors for poor results include severe disease, contractures, malalignment, and the absence of mechanical symptoms, a history of injury, or joint-line tenderness.

Operative technique should emphasize avoiding any further injury to articular surfaces, which may hasten the progression of disease. Unstable meniscal tears and loose flaps of cartilage are debrided; however, aggressive chondroplasty and use of marrow stimulation techniques should be avoided in patients with significant osteoarthritis. Particular attention is paid to subluxated flaps of meniscal tissue, which can be a source of persistent pain if undetected. The role of joint lavage is unknown but seems unsupported by the current body of literature.

Case Report

Case 1

Chief Complaint and Patient History: A 55-year-old active woman with a history of mild osteoarthritis of both knees presented 8 weeks after a mild twisting injury to the left knee, complaining of progressive medial-sided knee pain associated with episodes of swelling, buckling, and occasional locking sensation.

Physical Exam: Physical exam demonstrated a trace effusion, medial joint-line tenderness, and pain with deep flexion. Lachman test and ligamentous examination was negative.

Imaging: Radiographs (Fig. 14A) reveal mild medial compartment narrowing on both knees, which was worse on the right than on the left. MRI scans (Fig. 14B, C) show degenerative changes and chondromalacia present in the medial compartment associated with degeneration and tear of the medial meniscus.

Surgery/Treatment: Arthroscopy was performed, initially demonstrating Outerbridge grade III changes in the medial compartment (Fig. 14D). Probing of the medial meniscus demonstrated subluxation of torn fragments of the medial meniscus, which were freed with the probe and debrided (Fig. 14E, F). Probing of the tibial surface and meniscus demon1strates Outerbridge grade IV lesion under the stable rim of the medial meniscus (Fig. 14G). After arthroscopy, the patient had complete relief of mechanical symptoms and dramatic improvement of her pain and remains satisfied 2 years after the procedure.

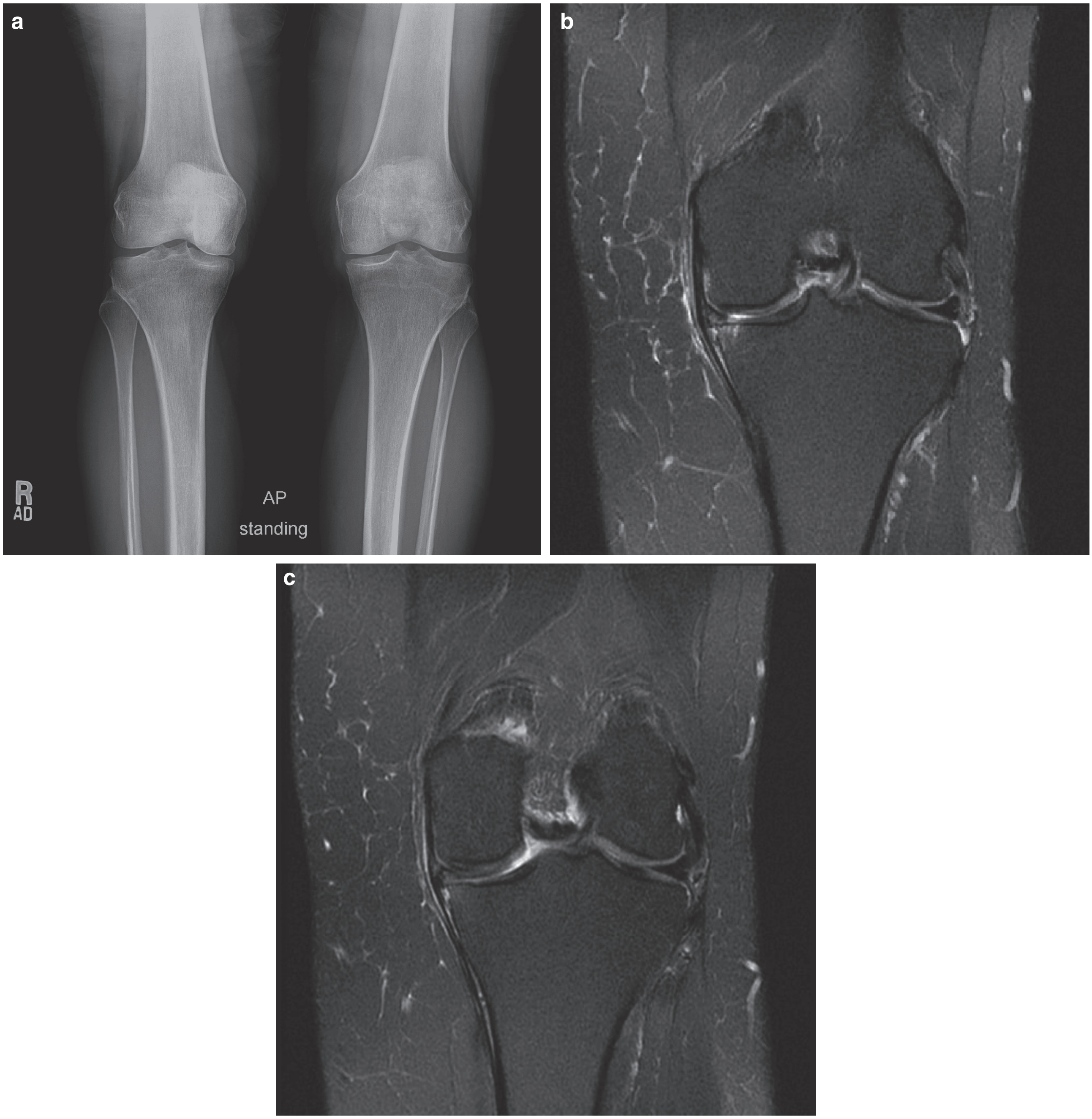

Fig. 14 Case 1. (**A**) Anteroposterior radiographs of the knees demonstrate mild medial compartment narrowing of both knees, with minimal degenerative changes. (**B, C**) MRI scans shows horizontal cleavage tear of the medial meniscus associated with articular cartilage degeneration and reactive bone edema. (**D**) Initial arthroscopic view of the medial compartment shows Outerbridge grade III fibrillation of articular cartilage of the femur and tibia. Torn meniscus is initially not apparent. (**E**) Probing of articular side of the medial meniscus reveals subluxated flap of torn meniscus. (**F, G**) Resection of unstable flaps of the medial meniscus back to stable rim reveals Outerbridge grade IV changes on the tibial plateau

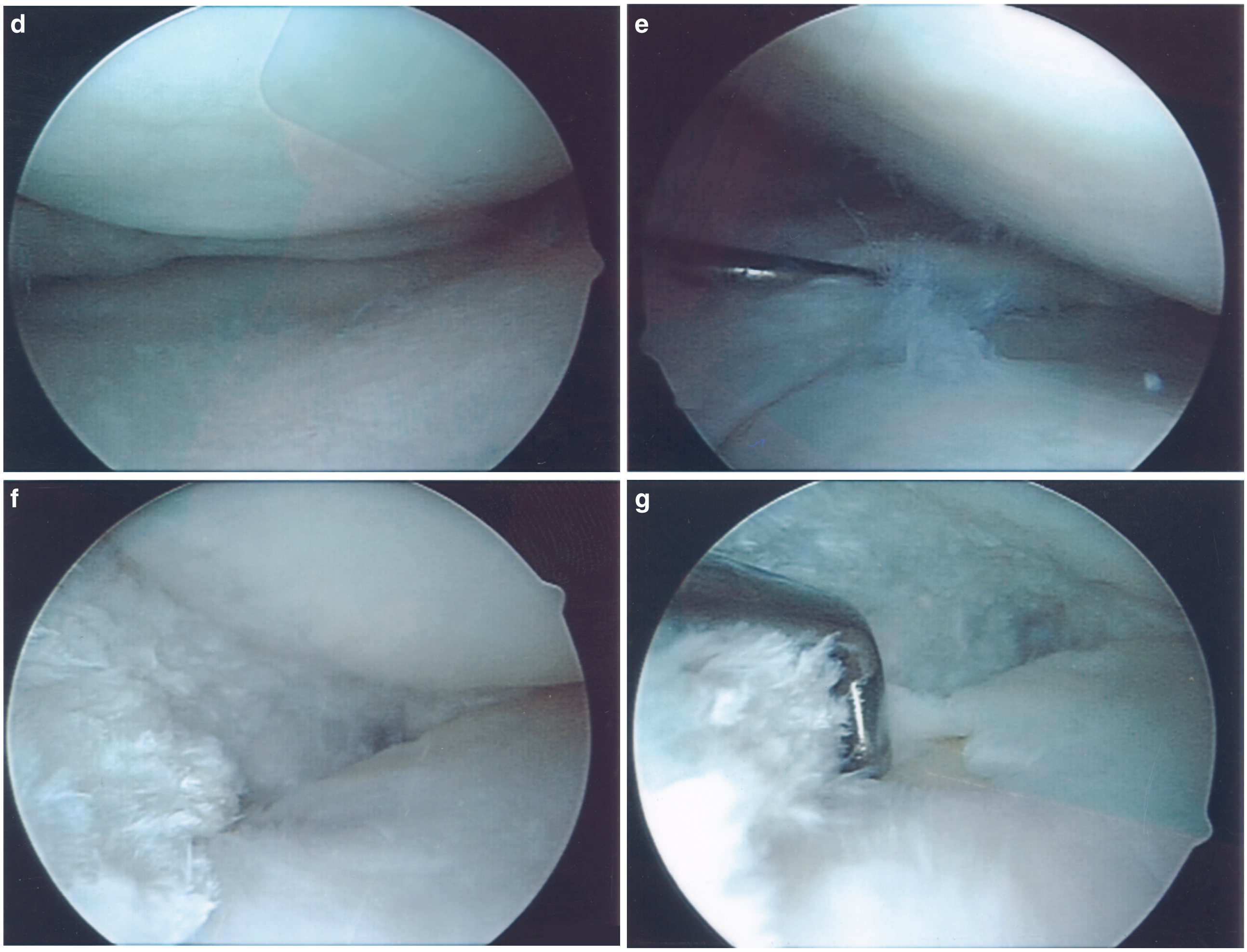

Fig. 14 (continued)

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