Current Concepts

Arthroscopic Labral Repair in the Hip: Surgical Technique and Review of the Literature

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Abstract: Hip pain can be caused by multiple pathologies. Injuries to the acetabular labrum are the most common pathologic findings identified at the time of hip arthroscopy. Five causes of labral tears have been identified; these include trauma, femoroacetabular impingement, capsular laxity, dysplasia, and degeneration. Studies have shown the function and the importance of the labrum. To restore function of the labrum, new surgical techniques, such as suture anchor repair, have been described. The goal of arthroscopic treatment of a torn labrum is to relieve pain by eliminating the unstable flap tear that causes hip discomfort. The goals of these treatments are to maintain the function of the hip joint and decrease the development of premature arthrosis. **Key Words:** Acetabular labrum—Labral repair—Hip arthroscopy.

In our experience, injuries to the acetabular labrum are the most consistent pathologic findings identified at the time of hip arthroscopy. In the review of our last 300 cases, labral tears were present in 90% (Fig 1).[1] Dynamic forces acting across the injured hip will result in hip pain, decreased athletic performance, and limitations in activities of daily living. The diagnosis of a labral tear remains largely clinical and is analogous to those patients who present with meniscal pathology. These patients often have mechanical symptoms (catching and painful clicking) as well as restricted range-of-motion. Sometimes their presentation is more subtle, with symptoms of dull, activity-induced, positional pain that fails to improve with rest.[2,3] Patients who have persistent hip pain for more than 4 weeks, clinical signs, and magnetic resonance imaging findings consistent with a labral tear are candidates for hip arthroscopy. Current treatment strategies such as arthroscopic excision of the acetabular labrum might result in immediate pain relief, but will likely compromise the physiologic function of the labrum, such as enhancing joint stability, preserving joint congruity, and disrupting the sealing mechanism, resulting in increased cartilage consolidation and joint compressive forces.[4-8] Ferguson et al.[4-6] have shown that the load-bearing role of the labrum should not be underestimated, and a review of the recent literature in this area suggests that excision or removal of the acetabular labrum may alter important physiologic functions such as enhancing joint stability, maintaining the sealing mechanism, and decreasing cartilage consolidation. With increasing knowledge about the function and the importance of the labrum, new surgical strategies such as suture anchor repair must be encouraged to maintain the function of the hip joint and decrease the development of premature arthrosis.

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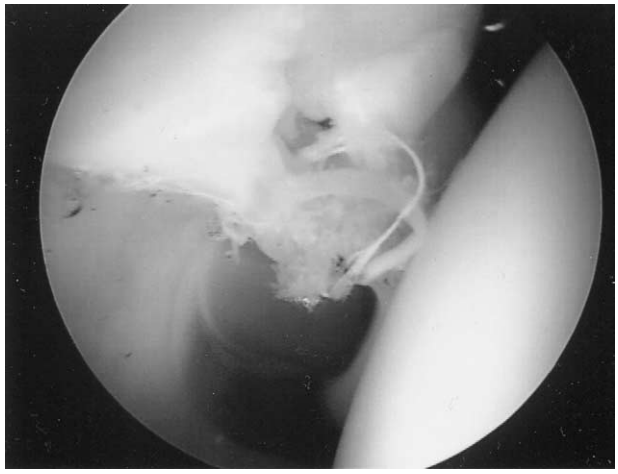

FIGURE 1. Typical appearance of a labral tear in the anterior superior weight-bearing zone.

In 2002, the senior author (M.J.P.) developed a labral repair technique for the hip and we are reporting on the technique and clinical experience with the management of hip labral tears using this arthroscopic repair technique used by a single surgeon by now in over 400 patients. The purpose of this article is to present the surgical techniques for arthroscopic labral repair in the hip, and to review the current literature related to this topic.

DIAGNOSIS

To effectively treat patients with labral tears, the underlying cause of the labral injury must be identified by careful clinical and radiologic examination. Based on our clinical experience and comprehensive review, we have identified at least 5 causes of labral tears: (1) trauma, (2) femoroacetabular impingement, (3) capsular laxity/hip hypermobility, (4) dysplasia, and (5) degeneration.[9] Magnetic resonance arthrography is currently the best method of imaging labral tears (Fig 2). However, if magnetic resonance arthrography is positive for a tear, a full examination is required to permit appropriate treatment of the underlying cause of the labral tear.

Although unusual, isolated traumatic tears of the labrum do occur. These are often a result of significant trauma to the hip joint during contact sports or trauma resulting in either subluxation or dislocation of the femoral head. These traumatic labral tears are often associated with chondral injuries to the femoral head (analogous to the Hill-Sachs lesion in the shoulder) and/or acetabular rim injury (analogous to the bony Bankart lesion in the shoulder).

Femoroacetabular impingement results in compression of the anterior superior labrum between the rim of the acetabulum and the anterior femoral neck. Bony impingement can result from decreased femoral head neck junction offset (the CAM effect), overhang of the anterior superior acetabular rim (pincer lesion), a retroverted acetabulum, or a combination of these bony deformities.[10-14] If clinical and radiographic examinations show labral pathology after no or minimal trauma, then careful radiographic evaluation should be performed to search for underlying impingement as the cause for the labral pathology.

Capsular laxity or hypermobility of the hip can result in injury to the labrum as well. Underlying collagen disorders or hormonal influences on capsular tissue may predispose patients to labral injury resulting from capsular laxity. Repetitive rotational sporting activities like golf place increased stress on the capsular tissue, resulting in attenuation of the iliofemoral ligament. This ultimately leads to rotational instability of the hip, which results in increased pressure on the anterior superior labrum as the head rides anterior in the joint.[15-17] In addition to fixation of the torn labrum, the underlying capsular laxity must be addressed with suture plication to ensure an optimal outcome.

It has been shown that labral tears are associated with acetabular dysplasia.[18,19] In our practice, this

FIGURE 2. Magnetic resonance arthrogram of the hip showing an intrasubstance labral tear (arrow).

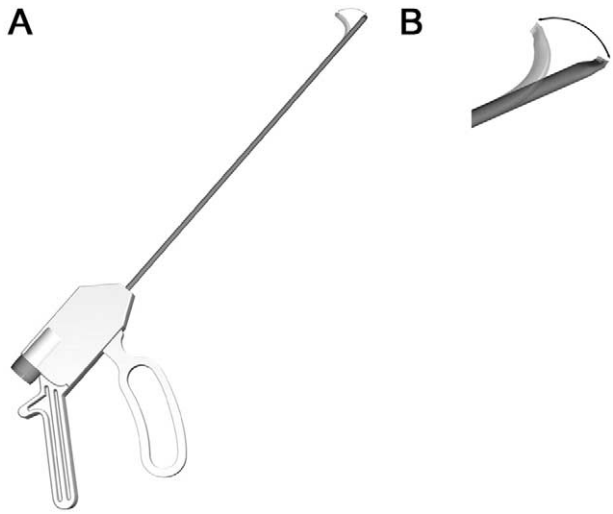

FIGURE 3. Flexible instruments allow for significantly improved access to most structures within the hip joint during routine arthroscopy. (A) TAC-S probe and (B) ligament chisel. (Reprinted with permission.[3])

subgroup of patients represented 5% of the labral tears seen at the time of arthroscopy. Although Byrd and Jones[19] reported that the results of hip arthroscopy in the presence of dysplasia compare favorably with those reported for the general population, we believe that extreme dysplasia (center edge angle $<17°$) should be approached with a concomitant bony procedure such as periacetabular osteotomy in certain cases. The final factor commonly associated with the presence of a labral tear is global hip joint degeneration. Degenerative labral tears were present in 11% of the patients in our series. Isolated treatment of labral tears without addressing the underlying causative factor will likely result in poor outcomes. These associated causative factors must be identified preoperatively and treated appropriately at the time of surgery.

Differential diagnosis of the classic mechanical symptoms (painful catching or clicking) of labral tears includes snapping iliotibial tendon or a hypermobile psoas tendon.[3] Careful physical and radiologic examination are necessary to differentiate the pathologies.

SURGICAL TECHNIQUE

Patient Positioning

Hip arthroscopy may be performed in either the supine or lateral position depending on surgeon preference. In either case, distraction of the femoral head from the acetabulum must be performed to fully visualize the articular surfaces. Either general or spinal anesthesia may be used, but it is necessary to maintain complete skeletal muscle relaxation at all times to minimize the amount of traction force required for distraction. A thorough understanding of the anatomic relationships around the hip joint with special attention to neurovascular structures and tissue planes is of paramount importance. Specialized instruments including flexible probes, extra long cannulas, and extra long shavers, burrs, drills, and loose body retrievers, all have improved accessibility of the joint and increased the versatility of procedures available to the surgeon (Fig 3).

We perform hip arthroscopy using a standard fracture table with the patient in the modified supine position in which the hip is placed in a position of 10° flexion, 15° internal rotation, 10° lateral tilt, and neutral abduction (Fig 4). Using an extra wide peroneal post, the leg is first placed in abduction, traction is applied to break the vacuum seal, and then the leg is placed in slight adduction over the post, which forces the femoral head laterally. This helps in venting the capsule before more in-line traction is applied. The extra wide peroneal post also helps minimize pressure on the pudendal nerve. A minimum of 8 to 10 mm of distraction is recommended to avoid any iatrogenic injury to the chondral surfaces or labrum. Adequate traction typically requires between 25 and 50 lb of force.[20] Gentle countertraction is also applied to the contralateral limb. All of the intra-articular structures in the hip joint can be seen through the combined use of 70° and 30° arthroscopes as well as the interchange of portals.[3]

FIGURE 4. The modified supine position: the hip is in 10° flexion, 15° internal rotation, 10° lateral tilt, and neutral abduction.

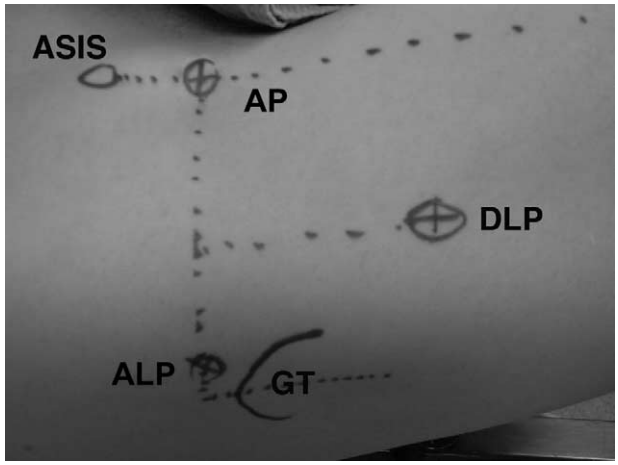

FIGURE 5. Three portals are recommended for labral repairs (anterolateral, anterior, and distal lateral accessory). The anterior portal (AP) coincides with the intersection of a sagittal line drawn distally from the anterior superior iliac spine (ASIS) and a transverse line across the superior margin of the greater trochanter (GT). The anterolateral portal (ALP) lies anterior to the superior tip of the greater trochanter. The distal lateral accessory portal (DLP) lies approximately 4 cm from the midpoint between the ALP and AP. Careful attention to proper portal placement is essential to avoid the nearby neurovascular structures.

Portal Placement

Accurate portal placement is essential for optimal visualization of all intra-articular structures and safe access to the hip joint. Three portals are required for arthroscopic labral repair, the anterolateral, anterior, and distal lateral accessory portals (Fig 5). The anterolateral portal is referenced off of the greater trochanter. This portal is placed approximately 1 to 2 cm superior to the tip of the greater trochanter and 1 to 2 cm anterior from this proximal point. The needle is placed at an angle of approximately 15° to 20° in relation to the floor. This portal allows for optimal visualization of the iliofemoral ligament, femoral head, anterior superior labrum, ligamentum teres, transverse ligament, and most of the acetabulum. Typically a 70° arthroscope is used through this portal for greatest visualization. The anterior portal is usually the second portal to be established and allows for visualization of the posterior-superior capsule, posterior-superior labrum, the posterior recess, the femoral head, and the ligamentum teres. This portal is also the optimal location for viewing the head-neck junction, the anterior femoral neck, the zona orbicularis, and the distal insertion of the capsular ligaments on the intertrochanteric line. Again, use of the 70° arthroscope will allow for optimal visualization. The portal is established by identifying the intersection of the vertical line drawn from the anterior superior iliac spine distally and the horizontal line drawn from the site of the anterolateral portal. After the skin is incised, this portal should be established using blunt dissection because it presents a risk to the lateral femoral cutaneous nerve, which lies within a few millimeters of the cannula. In addition, care must be taken in placing the portals to avoid the pathways of the ascending branch of the lateral femoral circumflex artery and femoral neurovascular bundles.[21] If the anterior portal is placed too anterior or deep, the femoral neurovascular bundle is at risk.[22] The localization of the femoral pulse distal to the inguinal ligament helps prevent inadvertent injury to these structures. Also, the relationship of the ascending branch of the lateral femoral circumflex artery has been shown to be variable in location relative to the anterior portal. Care should be taken to not place the anterior portal too inferior to minimize this risk.[22]

Once the traction is applied, the anterolateral portal is established under fluoroscopic guidance using the landmarks described above. Immediate visualization of the anterior triangle is established through this portal (Fig 6). The anterior triangle represents the capsule, the labrum, and the femoral head chondral surface. The anterior portal is established under direct visualization as the spinal needle is directed in the center of the triangle. As soon as both portals are established, the camera should be switched to the anterior portal to verify that the anterolateral portal is adjacent to and not through the acetabular labrum.

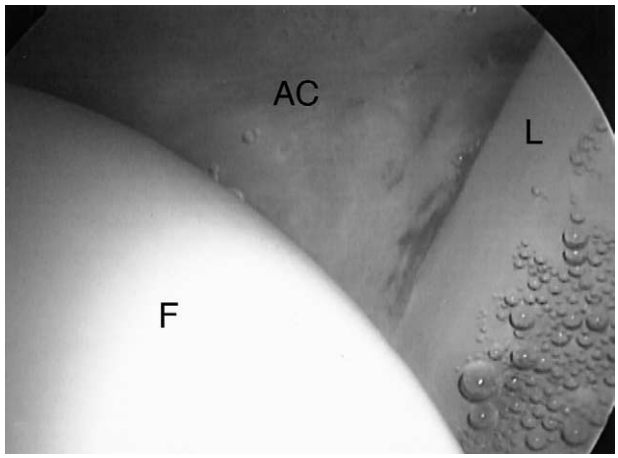

FIGURE 6. Visualization of the anterior triangle is achieved on entry into the joint through the anterolateral portal (AC, anterior capsule; L, labrum; F, femoral head).

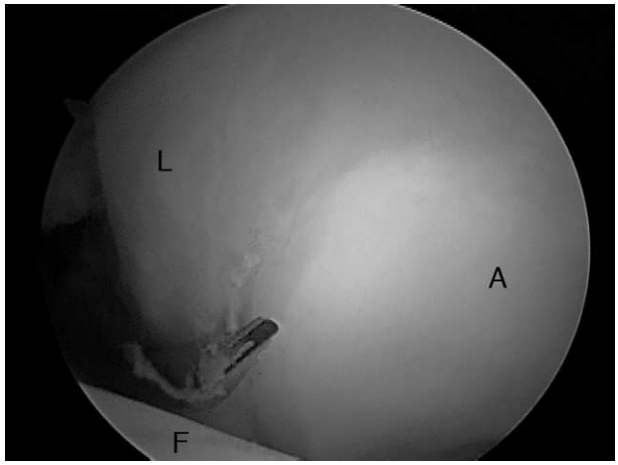

Figure 7. Debridement of labral tears should remove all frayed tissue and leave as much viable tissue as possible (F, femoral head; A, acetabulum; L, labrum).

For labral repair in the peripheral compartment and for decompression of the femoral head-neck junction in impingement, we have developed a distal lateral accessory portal. This portal is placed after traction has been slowly released and the operative knee is flexed to 45°. The arthroscope is then placed in the anterior portal and a skin incision is made approximately 4 cm distal to the midpoint between the anterior and anterolateral portals.

Arthroscopic Management of Labral Tears

The goal of arthroscopic debridement of a torn labrum is to relieve pain by eliminating the unstable flap tear that causes the observed hip discomfort. However, the surgeon seeks to debride all torn tissue and leave as much healthy labrum intact as possible (Fig 7). The majority of the vascular supply to the labrum comes from the capsular contribution while the articular surface of the labrum has decreased vascularity and limited synovial covering.[23] The labrum is thinner in its anterior inferior portion and thicker and slightly rounded in appearance posteriorly. A recess between the acetabular labrum and the hip extends circumferentially around the labrum. Once a labral tear is well identified, the margins need to be defined with a flexible probe. Controlled use of monopolar radiofrequency energy through the same flexible probe can contract the torn portion of the labrum and better define the edges. A flexible ligament chisel is then used to detach the torn part of the labrum from the intact labrum, leaving only a small portion attached. A motorized shaver is then used to complete the debridement and remove the torn portion of the labrum.[24,25]

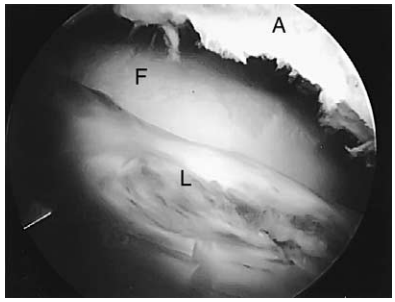

Figure 8. A type I labral tear with full-thickness detachment off of the rim of the acetabulum. These tears require suture anchor repairs (L, labrum; A, acetabulum; F, femoral head).

We now have significant experience with over 400 labral repairs performed by a single surgeon, and 2 techniques have been used depending on the characteristics of the torn labrum. Seldes et al.[26] reported 2 distinct types of tears of the acetabular labrum through histologic evaluation of cadaveric specimens. The first consisted of a detachment of the fibrocartilaginous labrum from the articular hyaline cartilage at the transition zone (Fig 8). The second consisted of 1 or more cleavage planes of variable depth within the substance of the labrum (Fig 9). They noted increased microvessel formation within both types of tear patterns. Based on their investigations, they concluded that tears of the acetabular labrum are acquired conditions that are highly prevalent in aging adult hips and likely occur

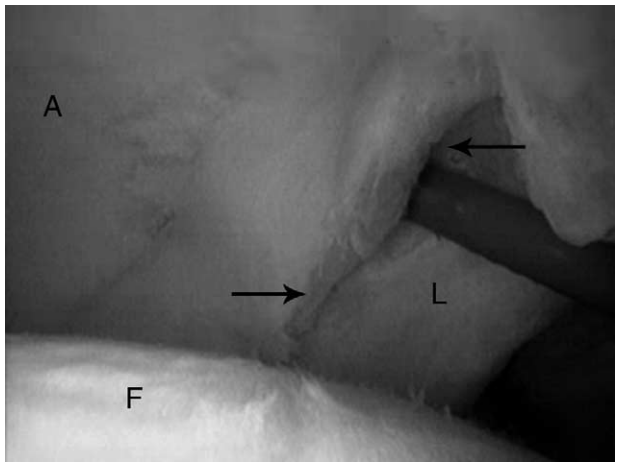

Figure 9. A type II labral tear with an intra-substance split in the tissue. The tear is running longitudinally between the 2 arrows and the probe is placed directly in the tear (L, labrum; A, acetabulum; F, femoral head).

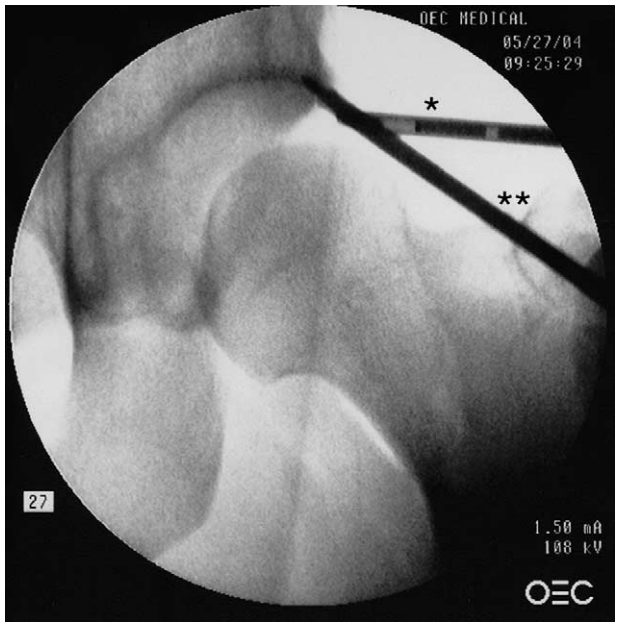

Figure 10. Placement of the suture anchor on the anterior-superior acetabulum with fluoroscopic assistance (* arthroscope, ** tap).

early in the arthritic process of the hip, representing one of the contributing causes of degenerative hip disease.

If the labrum is detached from the bone, a bioabsorbable suture anchor is needed to stabilize the fibrocartilaginous tissue back to the rim of the acetabulum. Typically, placement of the anchor needs to be on the acetabular rim, more on the capsular side than the articular side of the labrum in order to achieve an appropriate angle that will not result in penetration of the anchor into the joint. Fluoroscopy may be used during this portion of the procedure to ensure appropriate placement (Fig 10). After the sleeve for the anchor is placed in the appropriate position, we recommend tapping the anchor while visualizing the articular surface of the acetabulum to avoid iatrogenic chondral injury (Fig 11A). Once the anchor is placed, a suture passer is used to deliver a limb of suture through a small portion of the substance of the labrum (Fig 11B). The suture is retrieved and passed through the labrum a second time, thus resulting in a vertical mattress suture. The cannula must be pulled back slightly to an extra-articular position and the suture is tied down using standard arthroscopic knot-tying techniques (Fig 11C). This must be performed blindly using tactile sensation, and an automatic suture cutter is needed to cut above the knot. Recently, labral repair has been performed under direct visualization through the peripheral joint compartment and the lateral portal. This technique has been performed in approximately 12 patients and the senior author prefers this approach at this time.

An intrasubstance split in the labrum is considered to be repairable if it is well fixed to the acetabulum and has a stable outer rim. The cleavage plane in the labrum should be fully defined and debrided of frayed, nonviable tissue. A spectrum is used to deliver a looped monofilament suture between the junction of the articular cartilage and the fibrocartilage labrum (Fig 12A). The working cannula is then pulled back to the capsule, and a bird beak is then delivered through the outer edge of the labrum peripheral to the tear; the loop suture is then grasped and brought out the working cannula (Fig 12B). A bioabsorbable suture is passed around the labral split using the looped monofilament as a suture lasso. Using tactile sensation, the knot is tied in an extra-articular position and an automatic suture cutter is used to cut the remaining suture above the knot (Fig 12C).

After the labral repair, the capsule and the femoral head-neck junction are also assessed by dynamic examination to determine if other pathologies are present that would require capsular plication, thermal capsulorrhaphy, and/or osteoplasty for femoral-acetabular impingement. The patient is then transported to the recovery room strapped in specialized boots designed to limit hip motion, particularly internal and external rotation and abduction. After discharge, the boots are worn only at night for 2 to 4 weeks. In the recovery room, the patient is immediately placed in a continuous passive motion machine, flexing the hip from 30° to 70°. For 4 weeks, the patient will use the continuous passive motion machine for 4 hours each day. Within 4 postoperative hours, the patient will walk, ascend and descend stairs with crutches, and ride a stationary bicycle under the supervision of a physical therapist. It is imperative to begin these early range-of-motion exercises to prevent tissue adhesions and promote early recovery. For 4 weeks, weight bearing is restricted to 20 lb of flat-foot pressure. A brace is worn only during the day for 10 days to 2 weeks to limit hip motion, particularly to give flexion control and abduction position. The postoperative protocol for a labral repair may differ if other procedures (e.g., osteoplasty of the femoral head-neck junction or microfracture) are performed during the hip arthroscopy.

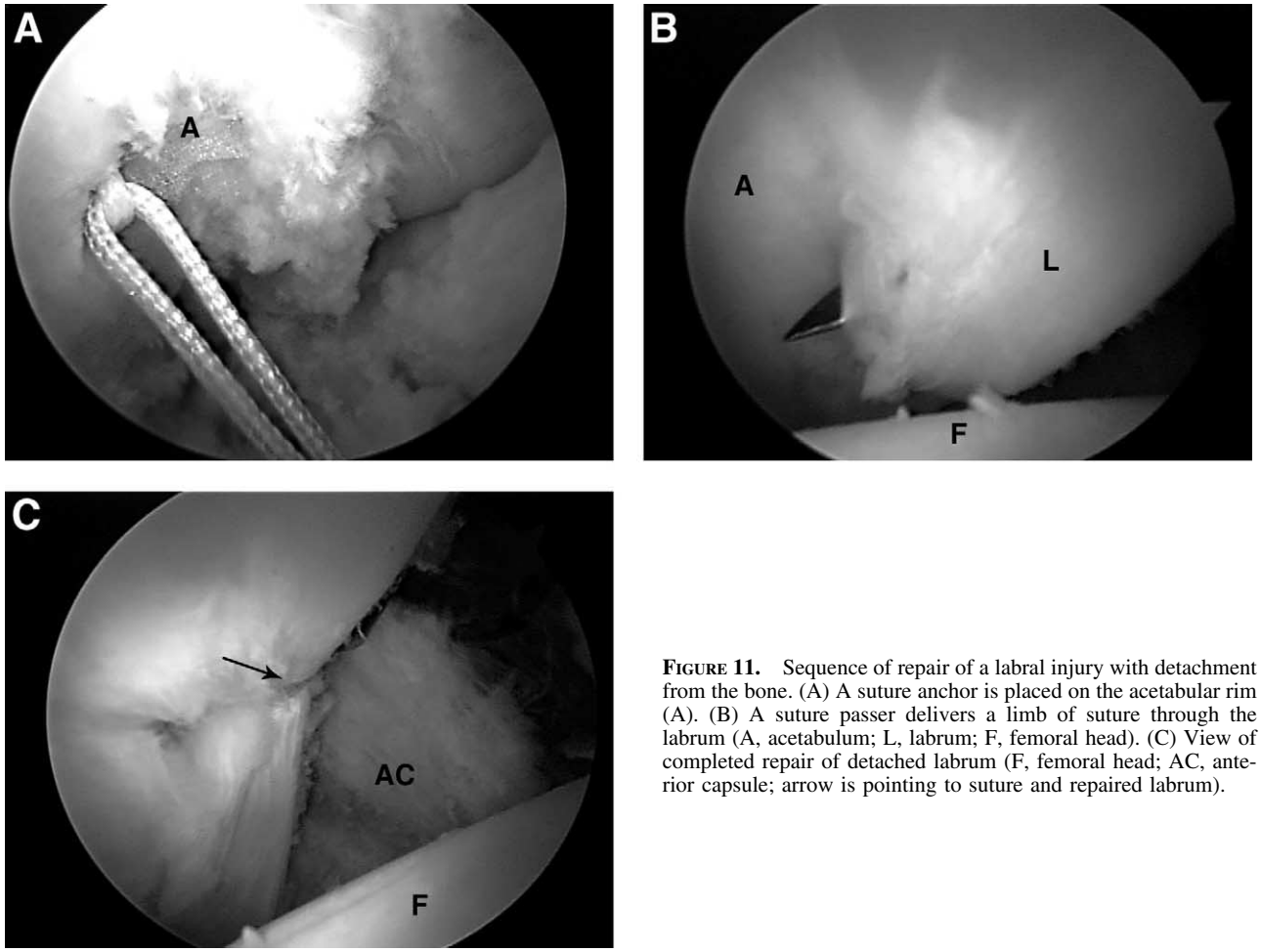

FIGURE 11. Sequence of repair of a labral injury with detachment from the bone. (A) A suture anchor is placed on the acetabular rim (A). (B) A suture passer delivers a limb of suture through the labrum (A, acetabulum; L, labrum; F, femoral head). (C) View of completed repair of detached labrum (F, femoral head; AC, anterior capsule; arrow is pointing to suture and repaired labrum).

DISCUSSION

Over the past several years, the role of hip arthroscopy in the management of intra-articular lesions has evolved as a result of significant improvements in surgical technique and instrumentation. Basic science as well as clinical research has begun to better elucidate the functional role of the acetabular labrum, as well as underlying causes contributing to its injury.[4-7,12,23,26-30]

Work by Konrath et al.[30] has suggested that removal of the acetabular labrum does not significantly increase the pressure or load in the acetabulum. These investigators concluded that excision of the acetabular labrum may not predispose the hip to premature osteoarthrosis.[30] With this underlying belief, many arthroscopic hip surgeons feel that excision of the torn acetabular labrum is the appropriate treatment for patients with symptomatic labral tears. Although these patients may experience prompt pain relief,[31] in our opinion, contrary to the work of Konrath, excision of the labrum likely compromises its physiologic functions.[4-6] Evaluation of the load-bearing role of the acetabular labrum has shown that it may enhance stability by maintaining negative intra-articular pressure in the hip joint[32] as well as acting as a tension band to limit expansion during motion between the anterior and posterior columns during loading in the gait cycle.[16] Recent studies using poroelastic finite element models have found that the intact labrum appears to have an important sealing function in the hip joint by limiting fluid expression from the joint space and protecting the cartilage layers of the hip.[4,6] In the absence of this sealing, strains within the matrix of the cartilage are significantly higher, resulting in significantly increased cartilage surface consolidation as well as contact pressure of the femoral head against the acetabulum.[4-6] Ferguson et al.[5,6] have further explained using a poroelastic finite element model that the labrum provides some structural resistance to lateral and vertical motion of the

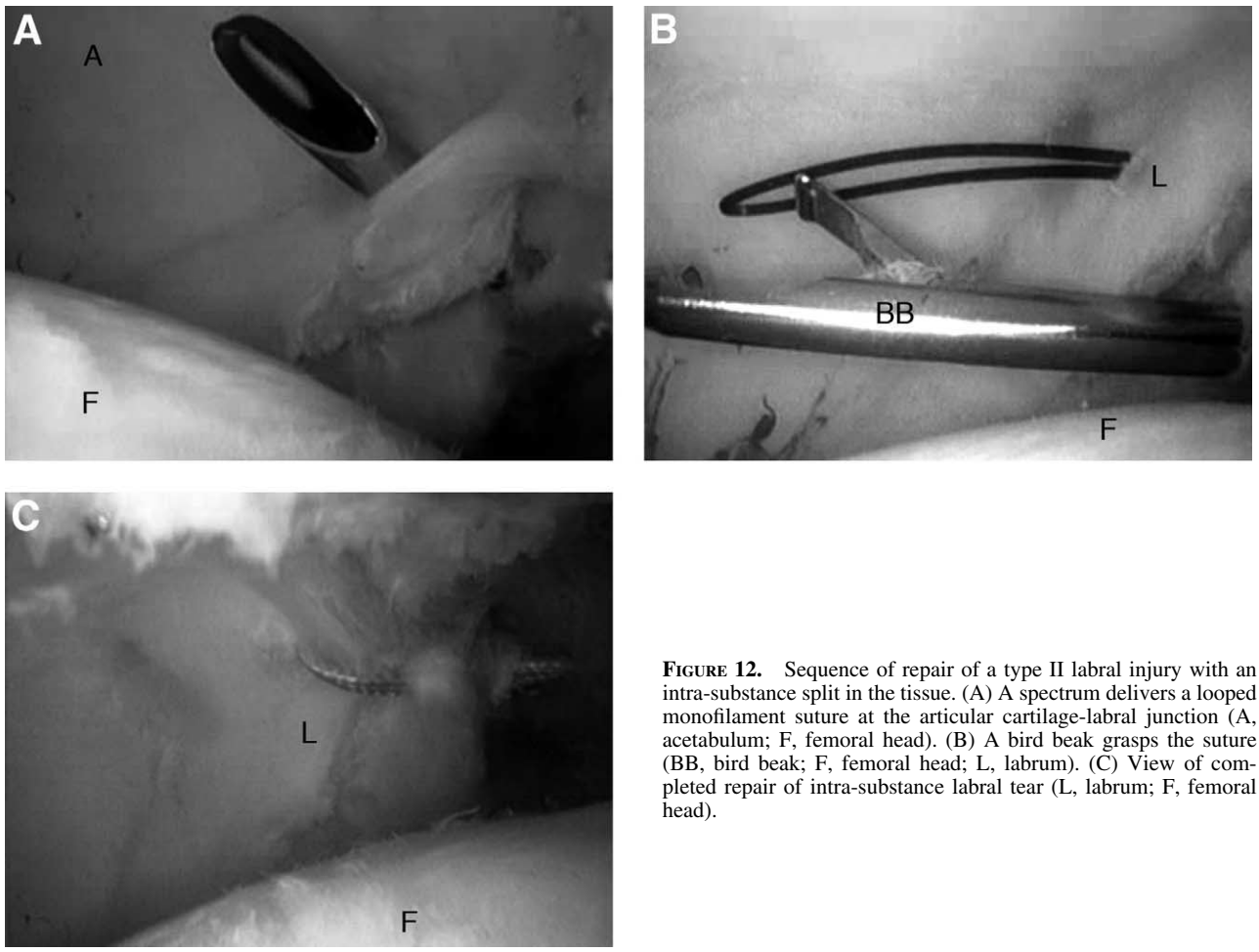

Figure 12. Sequence of repair of a type II labral injury with an intra-substance split in the tissue. (A) A spectrum delivers a looped monofilament suture at the articular cartilage-labral junction (A, acetabulum; F, femoral head). (B) A bird beak grasps the suture (BB, bird beak; F, femoral head; L, labrum). (C) View of completed repair of intra-substance labral tear (L, labrum; F, femoral head).

femoral head within the acetabulum. Because the labrum appears to enhance joint stability and preserve joint congruity, there is a significant concern about the potential for rotational instability or hypermobility secondary to labral deficiency. This instability may result in redundant capsular tissue, which potentially creates abnormal load distributions due to subtle subluxation.[16] Additionally, the labrum may also participate in nociception and proprioception because free nerve endings and sensory end organs have been identified in its superficial layers.[33]

The healing capacity of intra-articular structures such as menisci and joint labrum is highly associated with their vascular pattern.[7,23,26,34] Much like the meniscus, the labrum has its greatest healing potential at the peripheral capsular junction. Kelly et al.[23] have shown that vascular penetration of the labrum is greatest at the peripheral-most layer on the capsular surface while the central articular margin is less vascular. Petersen et al.[7] have confirmed that blood vessels enter the labrum from the adjacent joint capsule and are greatest at the peripheral one third, which supports the concept that peripheral tears have the biological potential to heal. Furthermore, intrasubstance tears that occur in the peripheral one third of the labrum should also be reconstructed. The vascular pattern reported by both Petersen et al.[7] and Kelly et al.[23] should encourage surgeons to master repair strategies of peripheral labral tears to maintain their function and preserve the overall integrity of the joint.

With increasing knowledge about the function and the importance of the labrum, new surgical strategies such as those described here must be learned and encouraged by surgeons who treat labral injury using hip arthroscopy. Although technically demanding, these arthroscopic skills should improve patient outcomes and ultimately help to maintain the function of the hip joint.

EARLY OUTCOME STUDIES

Early follow-up (2 years) in patients with labral repair showed outcomes in professional athletes equivalent to those after labral debridement (Bharam S, et al., presented at the Meeting of the American Orthopaedic Society for Sports Medicine, Orlando, FL, 2002; and Bharam S, et al., unpublished data, Meeting of the American Academy of Orthopaedic Surgeons, New Orleans, LA, 2003). Leunig also has reported better outcomes in patients after repair versus the open debridement technique. (Leunig M, presented at the Third Symposium on Joint Preserving and Minimally Invasive Surgery of the Hip, Montreal, Canada, 2004). Most recently, the senior author has observed excellent outcomes in over 400 patients with labral repairs. Nearly all of the patients have experienced marked improvement in symptoms, and both recreational and professional athletes have largely returned to play.

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