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Arthroscopic Management of Labral Tears in the Hip

By Michael K. Shindle, MD, James E. Voos, MD, Shane J. Nho, MD, Benton E. Heyworth, MD, and Bryan T. Kelly, MD

Introduction

Over the last decade, the diagnosis and arthroscopic management of labral tears of the hip in the young athletic population has evolved substantially due to improvements in clinical examination, diagnostic tools, surgical techniques, and flexible instrumentation in hip arthroscopy. Arthroscopic management of labral injuries in the hip has become an accepted therapeutic modality in appropriately selected patients. The treatment of labral tears and their associated disorders is crucial for hip preservation in young and active patients because several studies have demonstrated an association between labral tears and the early onset of osteoarthritis[1-3].

Educational Objectives

This paper will review the main causes of labral tears in the hip, including labral tears secondary to trauma, femoroacetabular impingement, instability, psoas impingement, dysplasia, and degenerative arthritis. We will discuss relevant anatomy and history, typical findings on physical examination, types of imaging studies performed, and treatment options, with a focus on the arthroscopic management of labral injuries, including labral repair. The outcomes associated with open surgical dislocation as compared with arthroscopic treatment of femoroacetabular impingement will also be reviewed.

Overview of the Anatomy and Function of the Labrum

The acetabular labrum is a fibrocartilaginous structure that is located circumferentially around the acetabular perimeter and becomes attached to the transverse acetabular ligament posteriorly and anteriorly. Neuroreceptors have been identified within the labrum, and these structures may provide proprioception to the hip joint[4]. The articular surface of the labrum has decreased vascularity and a limited synovial covering in comparison with the portion of the labrum at the peripheral capsulolabral junction[5] (Figs. 1-A and 1-B). Thus, similar to the healing potential of the menisci in the knee, which is greatest at the periphery, the healing potential of the labrum is greatest at the peripheral capsulolabral junction[5-8].

The labrum has an important sealing function in the hip. It plays a role in limiting the expression of fluid from the joint space and also helps contain the femoral head at extreme ranges of motion, particularly hip flexion[9-11]. In the absence of the labrum, increased contact pressures are transmitted across the hip joint.

Seldes et al. demonstrated two distinct histologic types of tears on the basis of evaluation of cadaver specimens[8]. A type-1 tear is a detachment of the fibrocartilaginous labrum at the zone of transition from the articular cartilage[8] (Fig. 2). This type of tear is likely the result of a cam impingement lesion, in which the primary injury is at the zone of attachment of the labrum to the cartilage, thus leaving the labrum relatively spared. Type-2 tears are within the substance of the labrum and consist of one or more cleavage planes of variable depth[8] (Figs. 3-A and 3-B). These tears are most consistent with pincer impingement lesions that lead to primary injury of the labral tissue itself as it is crushed between the overhanging pincer lesion and the neck of the femur.

Clinical Presentation

A complete history and physical examination are necessary in order to determine the source and cause of hip pain. The benefit of understanding the osseous, ligamentous, and musculotendinous contribution to the underlying disorder cannot be overestimated[12]. It is important to differentiate between intra-articular and extra-articular hip disorders so that the treatment strategies can be accurately focused. Other causes of referred hip pain, such as conditions of the lumbar spine, sacroiliac joint, or intrapelvic structures, must be included in the differential diagnosis. Diagnosing hip pain in an athlete can be complicated further by the presence of concomitant injuries to the surrounding soft tissues.

The history should focus on the exact location of pain,

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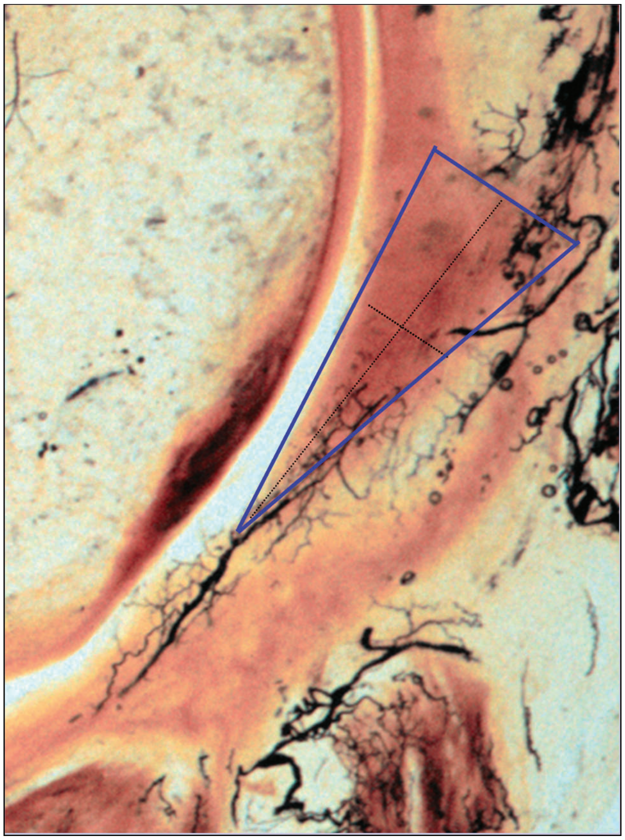

Fig. 1-A

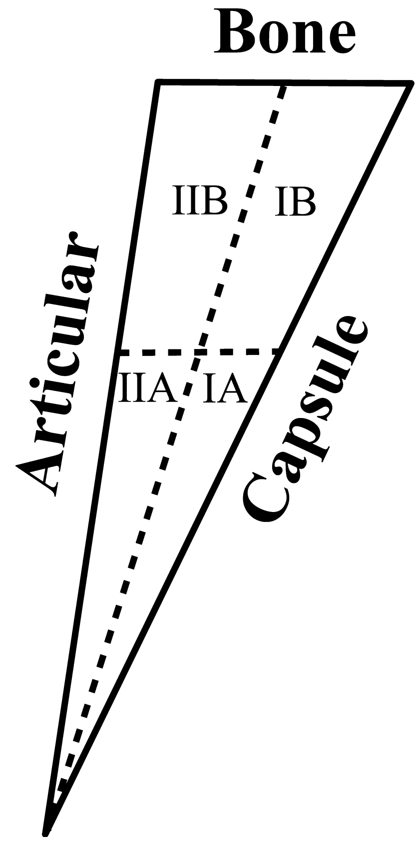

Fig. 1-B

Fig. 1-A High-power photograph showing the anterosuperior portion of the labrum in a coronal Spalteholz section[5,6] of a left hip. **Fig. 1-B** Corresponding diagram depicting the articular and capsular sides of the labrum as shown on the Spalteholz section. (Figs. 1-A and 1-B reprinted from: Kelly BT, Shapiro GS, Digiovanni CW, Buly RL, Potter HG, Hannafin JA. Vascularity of the hip labrum: a cadaveric investigation. Arthroscopy. 2005;21:6; with permission from Elsevier.)

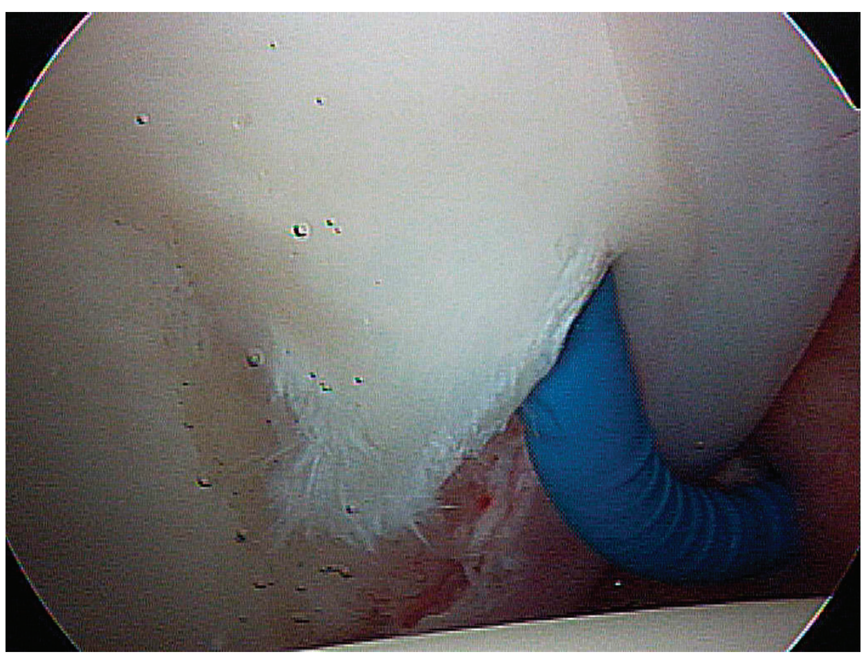

Fig. 2

Arthroscopic view of a Seldes type-I labral tear, demonstrating detachment of the fibrocartilaginous labrum at the zone of transition from the articular cartilage.

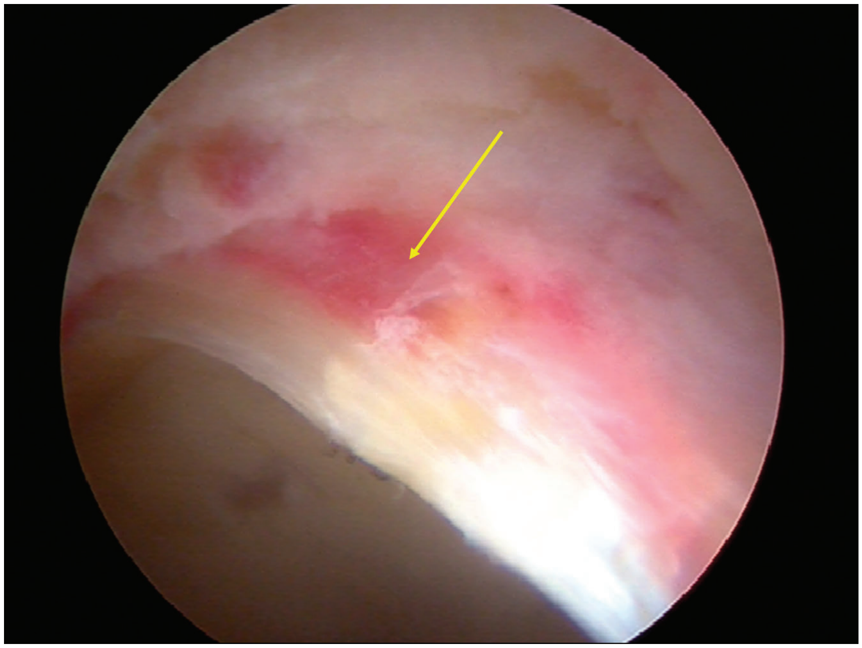

Fig. 3-A

Arthroscopic view of a Seldes type-II intrasubstance tear (yellow arrow).

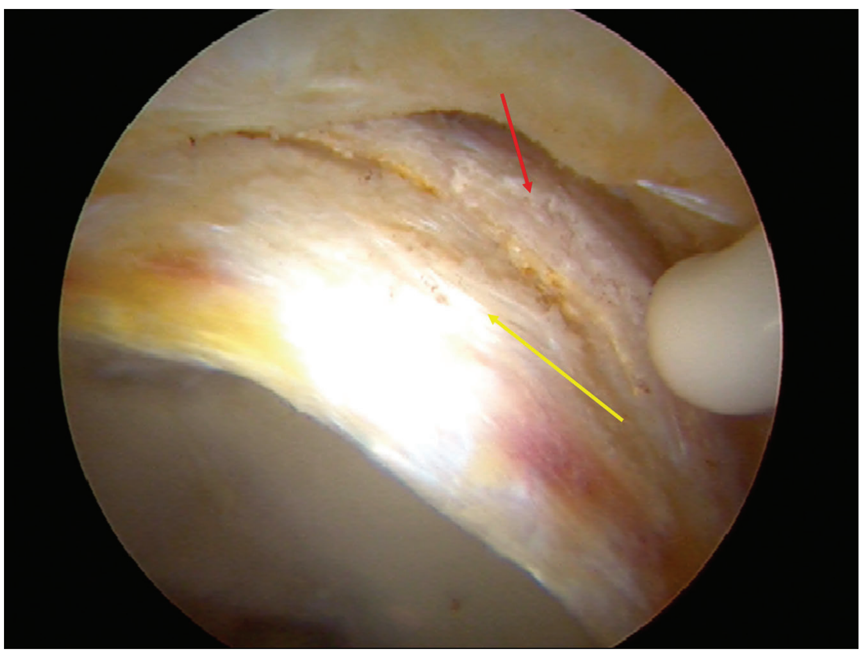

Fig. 3-B

After labral débridement (yellow arrow), a pincer lesion is evident (red arrow).

the qualitative nature of the discomfort (such as catching, clicking, instability, stiffness, weakness, or decreased performance), the timing of the onset of symptoms, and the precipitating cause of the symptoms[13]. Patients with labral tears typically point to the groin as the area of pain.

Optimally, a clinical examination should be performed in a systematic and reproducible fashion so that an accurate diagnosis and effective treatment recommendations can be made. A complete examination of the surrounding structures is necessary to fully evaluate patients presenting with hip pain. The general examination should carefully assess gait, the abdomen (with an emphasis on pubic pain), lumbar spine abnormalities (including a neurologic evaluation), the sacroiliac joint, the knee, and lower-limb lengths. Although

TABLE I Physical Examination Technique Incorporating Five Different Positions

Patient Position				
Standing	Seated	Supine	Lateral	Prone
General (laxity, body habitus, posture)	Neurologic	Passive range of motion	Palpation	Craig test[12] (rotate limb until the greater trochanter is parallel to floor)
Gait (swing, stance, foot progression, pelvis)	Circulation	Impingement test (flexion, adduction, internal rotation) (FADIR[12])	Ober test[12] (knee and hip extended, hip abducted)	Ely test[12] (flex knee and draw lower leg into thigh)
Spine (lateral, posterior, scoliosis, lordosis)	Skin	Thomas test[79] (flex hips and lower affected leg)	Passive/active range of motion	Hyperextension
Pelvis (shoulder height, iliac crests)	Lymphatic	FABER test[12] (flexion, abduction, external rotation)	FADIR test (flexion, adduction, internal rotation)	Palpation
Trendelenburg test[80]	Internal and external hip rotation	McCarthy hip extension sign[81] (with both hips flexed, pain is reproduced by extending the affected hip, first in external rotation and then in internal rotation)	Lateral rim impingement (flexion→extension in abduction)	Strength

there is no universally accepted "correct" comprehensive hip examination, a positionally based examination, as described by Martin et al., helps to limit missed diagnoses[12,14]. With this method, the patient is examined in five different positions, including standing, seated, supine, lateral, and prone. Within each position, five specific tests are administered (Table I).

Specific provocative maneuvers can elicit pain consistent with a labral tear or an impingement lesion. The hip flexion, adduction, and internal rotation (FADIR) test[1] may recreate groin pain or mechanical symptoms. Mechanical symptoms attributable to intra-articular abnormalities can also be elicited by loading the hip joint with both a resisted leg raise in the supine position as well as forced internal rotation while applying an axial load. Both of these maneuvers can load the hip joint anterolaterally, which is the most common location for labral tears.

Radiographic Workup

Plain radiographs are the initial mainstay for evaluating hip pain. An anteroposterior radiograph of the pelvis, an elongated-neck lateral view with the hip in 90° of flex-

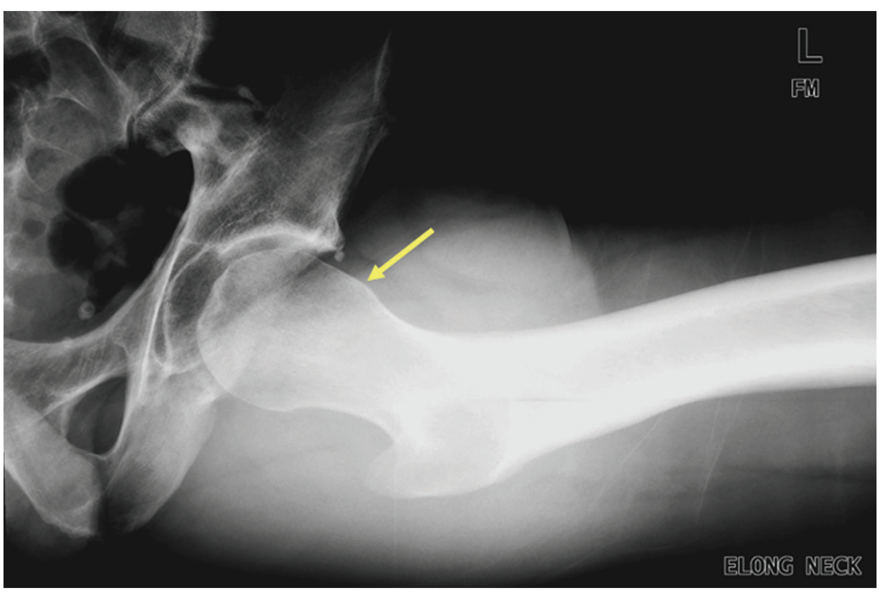

Fig. 4

Dunn lateral radiograph (elongated-neck lateral view) of the hip, demonstrating an osseous offset (yellow arrow) at the femoral head-neck junction, indicating a cam lesion.

Fig. 5

A false-profile view of the hip. This is a true lateral radiograph of the acetabulum, which allows measurement of coverage of the anterior portion of the femoral head (anterior center-edge angle). A value of ≥25° is normal, while a value of ≤20° is consistent with acetabular dysplasia[77,78].

ion and 20° of abduction (Dunn lateral radiograph), and a false-profile radiograph are included in the initial evaluation[15]. Our anteroposterior radiographs of the pelvis are performed according to the method of Siebenrock et al., who recommended taking radiographs of the pelvis in 15° of internal rotation and in a standardized position of pelvic inclination, which is indicated by the distance between the symphysis and the sacrococcygeal joint (approximately 32 mm in men and 47 mm in women)[16]. An elongated-neck lateral view (Dunn lateral radiograph) is useful for identifying a cam lesion (Fig. 4) associated with femoroacetabular impingement, and a false-profile view is useful to evaluate coverage of the anterior portion of the femoral head (Fig. 5)[15].

Radiographs should be carefully scrutinized for abnormalities of osseous anatomy. Wenger et al. demonstrated that 87% of patients with labral tears had at least one abnormal finding on plain radiographs[17]. Radiographic assessment includes the femoral neck-shaft angle, the Tönnis angle, the center-edge angle of Wiberg (normally >25°), the femoral head-neck offset, and the acetabular version (the so-called crossover sign represents a retroverted acetabulum)[18].

Fluoroscopically Guided Injection

Fluoroscopically guided hip-joint injection of an anesthetic medication is an adjuvant to a thorough history and physical examination and will help delineate intra-articular from extra-articular conditions. Response to an intra-articular injection has been shown to be 90% reliable as an indicator of an intra-articular abnormality[19]. Selective ultrasound-guided injections to the iliopsoas and trochanteric bursae can further distinguish between extra-articular and intra-articular sources.

Three-Dimensional Computed Tomography

In patients diagnosed with symptomatic femoroacetabular impingement, a three-dimensional computed tomography scan may be ordered preoperatively to assess femoral version and the extent of osseous abnormalities and to evaluate the amount of resection to be addressed during hip arthroscopy[15].

Magnetic Resonance Imaging

Magnetic resonance imaging provides the most detailed information regarding the soft tissues surrounding the hip. Our institution utilizes noncontrast magnetic resonance

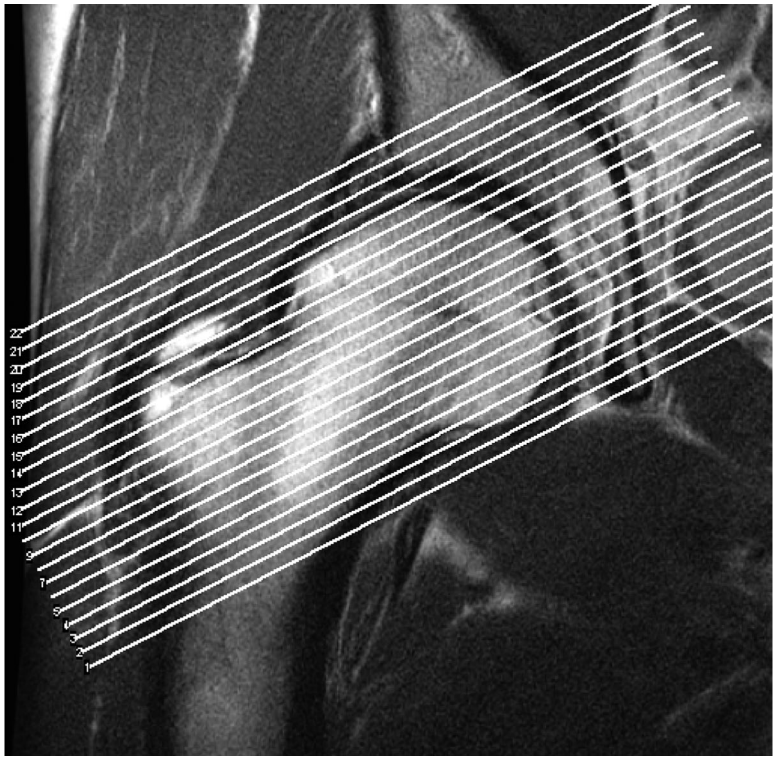

Fig. 6

Slice prescription for an oblique axial view on a magnetic resonance imaging scan, which accentuates the osseous offset. (Reprinted from: Shindle MK, Foo LF, Kelly BT, Khanna AJ, Domb BG, Farber A, Wanich T, Potter HG. Magnetic resonance imaging of cartilage in the athlete: current techniques and spectrum of disease. J Bone Joint Surg Am. 2006;88 Suppl 4:36.)

imaging to evaluate the hip joint[20]. The magnetic resonance imaging study includes a screening examination of the whole pelvis, acquired with use of coronal inversion recovery and axial proton-density sequences. Detailed hip imaging is obtained with use of a surface coil over the hip joint, with high-resolution cartilage-sensitive images acquired in three planes (sagittal, coronal, and oblique axial) with use of a fast-spin-echo pulse sequence and an intermediate echo time[21]. Other authors have advocated the use of magnetic resonance arthrography of the hip to evaluate hip disorders[22-24].

As part of the multiplanar assessment of femoroacetabular impingement, the axial oblique magnetic resonance imaging sequences can be helpful in defining the abnormal osseous neck-shaft offset. In these images, the slice prescription is parallel to the neck-shaft angle seen on a coronal image, passing directly through the center of the femoral head (Fig. 6). The alpha angle, measured according to the method of Nötzli et al. and normally being <50°, can help define the anterior margin of the waist of the femoral neck (Fig. 7)[25].

Nonoperative Management

All patients should undergo an initial trial of conservative treatment, including physical therapy, anti-inflammatory medication, and activity modification. Intra-articular injury of the hip is oftentimes associated with extra-articular muscular dysfunction[13], and the initial rehabilitation should focus on normalization of any associated muscular imbalances and weakness as well as range of motion.

Etiology

In order to effectively treat patients with labral tears, the underlying etiology of the tear must be identified. The main causes of labral tears include: (1) femoroacetabular impingement, (2) trauma, (3) dysplasia, (4) degeneration, (5) psoas impingement, and (6) hypermobility[26]. Patients are candidates for hip arthroscopy if they have persistent hip pain for more than one month, positive clinical signs, magnetic resonance imaging findings consistent with a labral tear, and correctable mechanical overload[26]. Contraindications to hip arthroscopy are labral disorders and underlying mechanical abnormalities that are not correctable by arthroscopic means.

Femoroacetabular Impingement

Ganz et al. and Lavigne et al. have identified femoroacetabular impingement as the predominant cause of labral tears in the nondysplastic hip[1,27]. Abnormal hip morphology can limit motion and result in repetitive impact of the proximal portion of the femoral neck against the acetabular labrum and its adja-

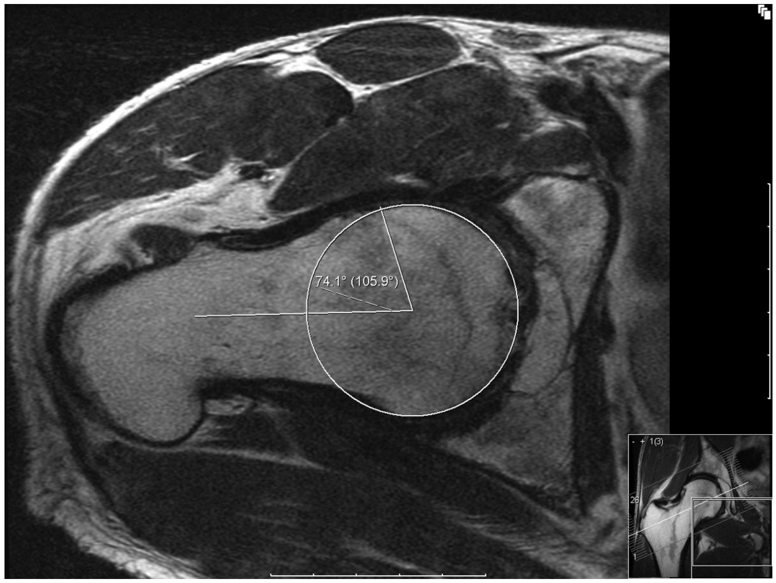

Fig. 7

In a patient with a positive impingement test, decreased internal rotation of the hip, and groin pain, an abnormal alpha angle of 74.1°, as described by Nötzli et al.[25], is measured on an axial oblique fast-spin-echo magnetic resonance imaging scan. In the lower right, a coronal view of the hip is shown, demonstrating the axial oblique cut through the femoral neck. (Reprinted from: Shindle MK, Voos JE, Heyworth BE, Mintz DN, Moya LE, Buly RL, Kelly BT. Hip arthroscopy in the athletic patient: current techniques and spectrum of disease. J Bone Joint Surg Am. 2007;89 Suppl 3:34.)

cent cartilage. Two distinct types of femoroacetabular impingement have been described: pincer and cam. Pincer-type impingement involves abnormal morphology of the acetabulum due to retroversion or acetabular profunda. This causes impingement of the labrum between the femoral neck and the acetabulum, which can result in crushing, degeneration, and eventual ossification of the labrum[1,28]. Pincer-type impingement can also lead to a characteristic posteroinferior "contre-coup" pattern of cartilage loss from the femoral head and corresponding portion of the acetabulum[21].

Cam impingement is the result of the contact between an abnormally shaped femoral head and a normal spherical acetabulum during hip flexion and internal rotation[29]. This abnormal contact displaces the labrum toward the capsule and applies a disproportionate load to the transition zone between the labrum and the articular cartilage. This leads to a characteristic pattern of cartilage loss over the anterosuperior weight-bearing portion of the dome and can lead to avulsion of the labrum. Chondral injuries resulting from cam-type impingement are usually more severe than those resulting from pincer-type impingement.

Although the two types of femoroacetabular impingement can occur as separate entities, it has recently been shown that combined impingement occurs in the majority of cases (86%) (Fig. 8)[30]. Philippon and Schenker demonstrated that femoroacetabular impingement is a major cause of hip pain, decreased athletic performance, and reduced range of motion in the athletic population[31]. Impingement may occur in a broad range of sports, including ice hockey, soccer, football, and ballet[32].

Fig. 8

Coronal fast-spin-echo magnetic resonance image of a patient with combined femoroacetabular impingement with a cam lesion (arrow) and ossification of a torn superior portion of the labrum (arrowhead) consistent with pincer-type impingement. (Reproduced, with modification, from: Shindle MK, Foo LF, Kelly BT, Khanna AJ, Domb BG, Farber A, Wanich T, Potter HG. Magnetic resonance imaging of cartilage in the athlete: current techniques and spectrum of disease. J Bone Joint Surg Am. 2006;88 Suppl 4:36.)

Traumatic Instability

The spectrum of traumatic hip instability ranges from gross instability associated with a high-energy dislocation to a more subtle hip subluxation. While hip dislocations most commonly result from motor-vehicle crashes, they have also been reported in athletic competition, secondary to a forward fall on the knee while the hip is flexed or to a blow from behind while the player is down on all four limbs[33]. The immediate management of a hip dislocation involves rapid reduction in order to minimize long-term complications, such as osteonecrosis of the femoral head. The secondary phase of treatment focuses on the definitive care of injured structures. Due to the low-energy mechanism, most hip dislocations sustained during athletic competition are a pure dislocation without any associated acetabular rim fractures[34-36]. Thus, open reduction and internal fixation is often not warranted, and active and passive range of motion can begin as soon as tolerated by the patient.

Hip arthroscopy is playing an increasing role in the treatment of loose bodies, abnormalities of the femoral head, chondral injuries, and labral disorders associated with hip dislocations[37]. There is debate concerning the optimum timing for arthroscopy because of the concern over fluid extravasation secondary to capsular disruption and the effects of traction during the acute phase of injury. At our institution, if a loose body is not present, hip arthroscopy is delayed for at least six weeks so that a repeat magnetic resonance imaging scan can be performed to rule out the presence of early osteonecrosis before placing the hip in traction. However, if a large loose body is present, early intervention with hip arthroscopy is a reasonable option to decrease the prevalence of posttraumatic arthritis.

Posterior subluxation of the hip is more subtle in presentation because it involves less energy and may be misdiagnosed as a simple hip sprain or strain. Thus, even following minor trauma, the physician should have a high index of suspicion for an intra-articular injury. The mechanism of subluxation is often similar to that of hip dislocation: a fall on a flexed knee and hip with a posteriorly directed force. Conventional radiographs should be performed, including anteroposterior pelvic and Judet 45° oblique radiographs[38], in order to exclude a fracture of the posterior portion of the acetabular rim. The evaluation should also include a magnetic resonance imaging scan, which has the capability of demonstrating the characteristic triad of iliofemoral ligament disruption, fracture of the posterior portion of the acetabular rim, and hemarthrosis, as described by Moorman et al.[39]. In order to decrease intracapsular pressure, emergent aspiration of a large hemarthrosis may be warranted[39]. A magnetic resonance imaging scan is also useful to detect osteonecrosis and help determine when patients may safely return to athletic competition.

Chronic pain after subluxation or dislocation of the hip is a common problem. Chondral injury, ligamentum teres rupture, and loose bodies have all been implicated in the literature as sources of chronic pain[37,40,41]. However, labral changes associated with these injuries are poorly described. A posterior labral tear is usually associated with a hip dislocation; to our knowledge, there are no reports in the literature of anterior abnormalities following posterior dislocation except in two cases presented by Paterson[42]. In those hips, the entire labrum was pulled off in a ring-type avulsion[42]. As a result of advances in imaging and hip arthroscopy, labral abnormalities following these injuries are being more accurately described. In our experience, anterior labral tears have occurred in all patients presenting with a posterior hip subluxation or dislocation. This may be a crush injury secondary to underlying femoroacetabular impingement, or it may be similar to the circle concept for the shoulder, which states that a complete dislocation requires capsular deformation and/or disruption on both the same side and the opposite side of the joint (Fig. 9)[43].

Dysplasia

Labral tears can also occur in association with hip dysplasia. Byrd and Jones demonstrated that arthroscopic débridement may provide symptomatic relief, but we believe that extreme dysplasia is a contraindication to isolated arthroscopic procedures[44] due to the continued mechanical overload to which the joint is subjected after treatment. In this patient population, an open acetabular osteotomy is a well-described surgical alternative[45,46].

Degenerative Joint Disease

Osteoarthritis of the hip may affect the cartilage as well as the health of the labrum. Hip arthroscopy performed to débride osteophytes or a frayed or loose labrum can relieve mechanical

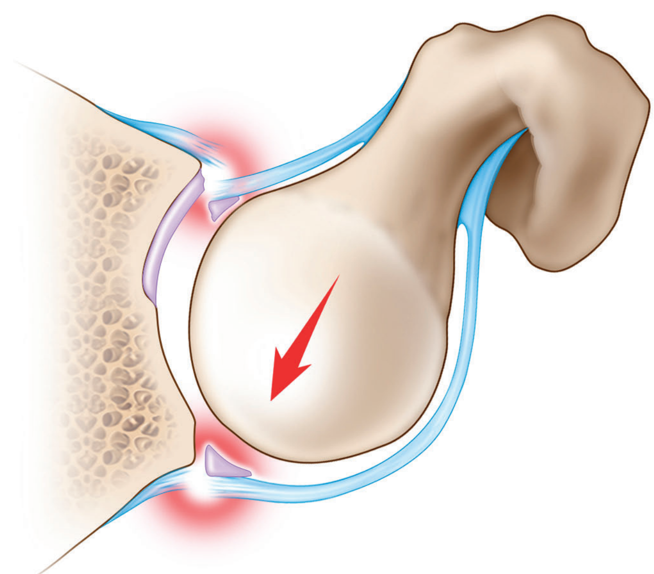

Fig. 9

Artist's depiction of an axial image of a hip with a posteriorly directed force (red arrow), demonstrating a crushed anterior labrum secondary to the anterior head-neck junction impinging on the acetabulum as the femoral head levers out of the socket posteriorly.

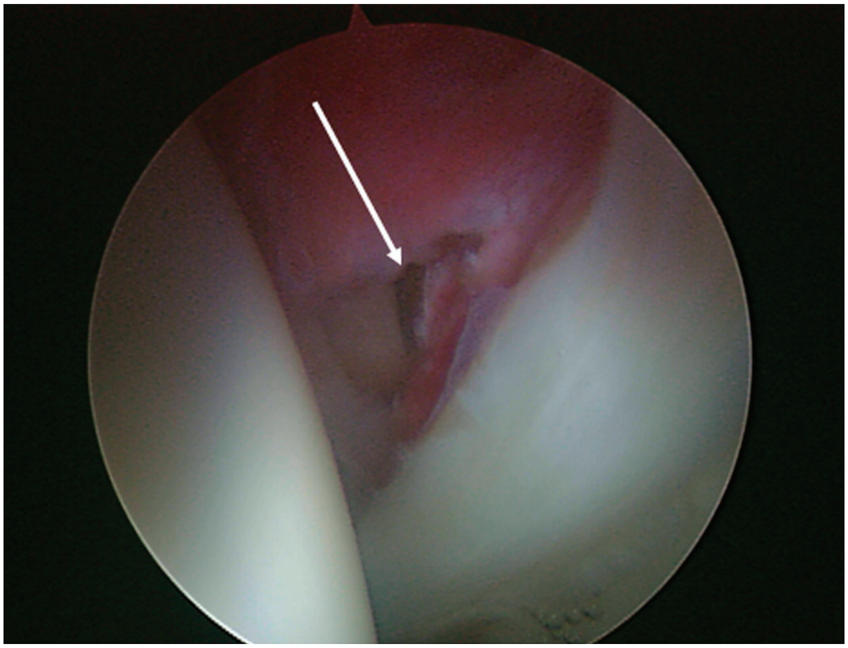

Fig. 10
Arthroscopic view of an anterior labral lesion (arrow) associated with overlying psoas tendon impingement.

symptoms in some patients[47]. However, this procedure should be considered with caution because, in comparison with nonosteoarthritic hips, osteoarthritic hips (even hips in the early stages of degenerative joint disease) have been reported to have a significantly worse outcome ($p < 0.0001$) following hip arthroscopy[48]. In our experience, the presence of full-thickness cartilage loss on the femoral head leads to a much more unpredictable response to arthroscopic procedures.

Psoas Impingement

Labral tears typically occur anterosuperiorly in association with femoroacetabular impingement or dysplasia. Less commonly, labral disorders may occur atypically in a directly anterior location adjacent to the iliopsoas tendon and without any associated osseous abnormalities (Fig. 10). The consistent directly anterior location adjacent to the iliopsoas tendon suggests that this entity may be related to compression or traction on the anterior capsule-labral complex by the iliopsoas tendon (Fig. 11). In our experience, labral débridement or repair combined with partial tenotomy or fractional lengthening of the iliopsoas tendon has yielded good early results for these patients. Further study will be required to evaluate the long-term outcomes of the treatment options for this injury.

Hypermobility and/or Ligamentous Laxity

Atraumatic hip instability may arise from overuse injuries leading to microinstability or from generalized ligamentous laxity. Overuse injuries are common in athletes who participate in sports that involve repetitive axial hip-loading and rotation, such as figure skating, golf, martial arts, gymnastics, and ballet[49,50]. The greatest clue to the diagnosis is in the history because athletes can usually describe the motion that reproduces the pain. The iliofemoral ligament or the labrum may be damaged or stretched by these repetitive forces, which can lead to painful labral injury, capsular redundancy, and subsequent microinstability. When the static stabilizers of the hip (capsule, iliofemoral ligament, labrum) are compromised, dynamic stabilizers play a larger role, which can result in a cascade of disorders. For example, the hip must rely more on the psoas major muscle, which can result in a chronically contracted muscle that can in turn cause low back pain, coxa saltans (snapping hip syndrome), and a crushing injury to the anterior portion of the labrum[18,51].

Atraumatic instability may also be found in patients with hip pain secondary to generalized ligamentous laxity or in association with connective-tissue disorders, such as Marfan syndrome or Ehlers-Danlos syndrome[50]. The treatment of atraumatic instability is still controversial. In an attempt to break the cycle of painful capsule-labral irritation, the initial treatment should consist of a nonoperative approach that includes anti-inflammatory medication and physical therapy. Hip arthroscopy should be considered if the pain is persistent and an intra-articular anesthetic injection provides relief. The goal of hip arthroscopy is to reduce capsular laxity and restore the labral anatomy. Capsular laxity may be addressed by capsular plication, and the labrum may require repair or débridement.

Management of Labral Tears

Hip arthroscopy can be performed with the patient in either the supine or the lateral position. The positioning of the patient is based on surgeon preference, as there are benefits and drawbacks to each approach. The most important factor is consistency and complete familiarity with the

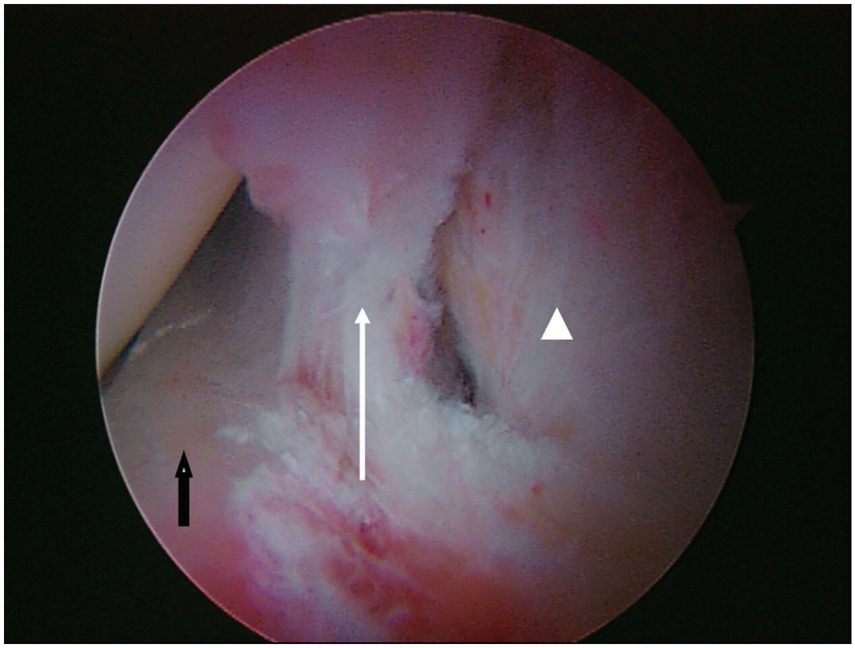

Fig. 11

Arthroscopic image demonstrating an intimate association between the labrum (black arrow), capsule (white arrow), and iliopsoas tendon (white arrowhead).

positioning procedure on the part of the surgeon and the ancillary staff, as the majority of complications associated with hip arthroscopy are associated with patient positioning and traction[52,53].

Accurate portal placement is essential for optimal visualization and safe access to the hip joint. The standard portals that are used are the anterolateral peritrochanteric, posterolateral peritrochanteric, and anterior portals. Anatomical studies have demonstrated that the anterior portal is associated with the greatest risk for nerve injury due to its close proximity to the lateral femoral cutaneous nerve[54]. Many other portals (mid-anterior, distal anterolateral accessory, proximal

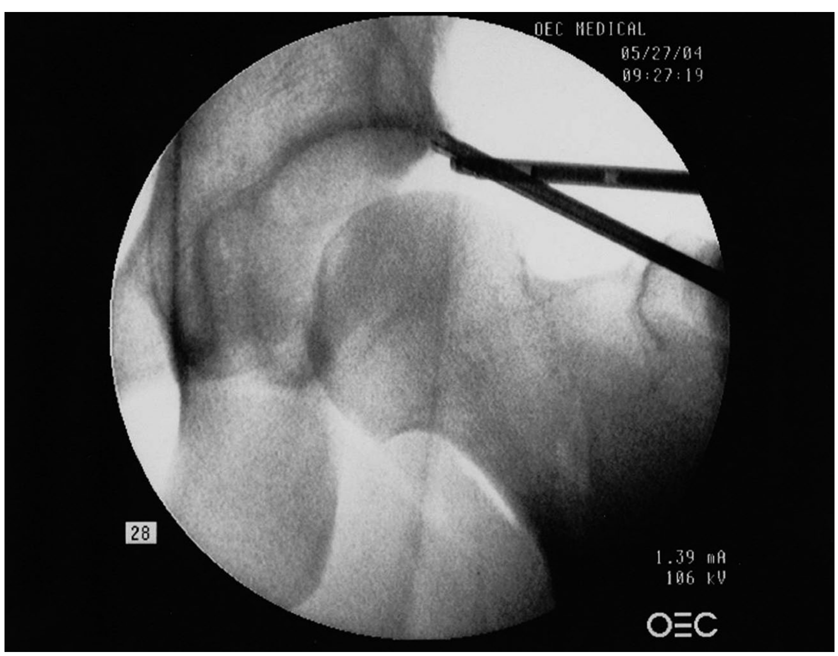

Fig. 12

Fluoroscopic imaging aids in the placement of a suture anchor on the edge of the acetabulum.

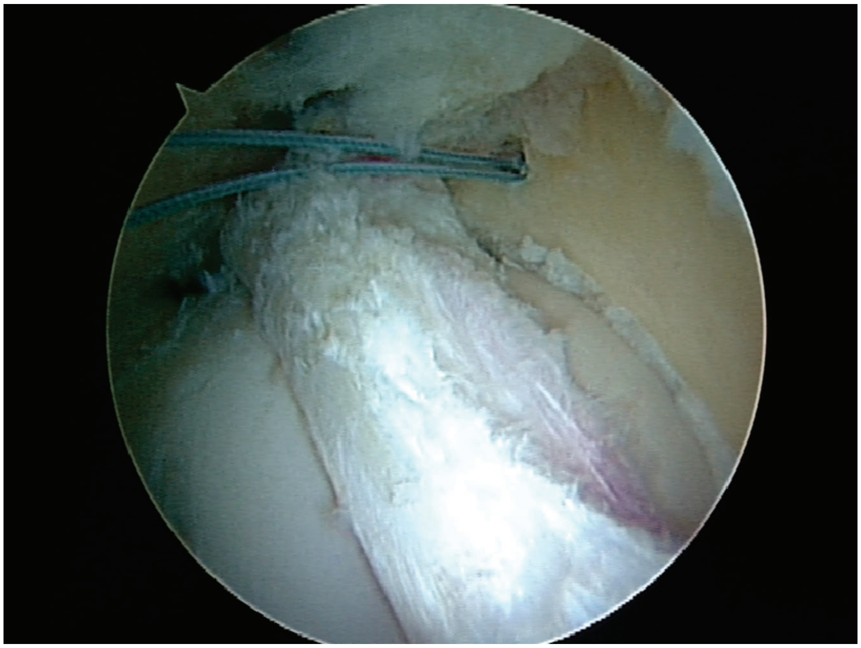

Fig. 13-A
Arthroscopic image demonstrating suture anchor placement.

Fig. 13-B
A penetrator device was used to place sutures through the labrum in a vertical mattress configuration.

anterolateral accessory, and peritrochanteric space portals) have been described and are useful for more advanced technical procedures.

Injuries to the acetabular labrum are the most consistent pathologic findings identified during hip arthroscopy in athletes. Treatment strategies for labral injury include both labral débridement for irreparable tears and labral repair for healthy tissue with good healing potential. Vascularity studies have demonstrated that there is a good vascular supply to the labrum arising from the capsular side; however, the articular portion of the labrum remains largely avascular[5]. With an increased understanding of the function of the labrum and its

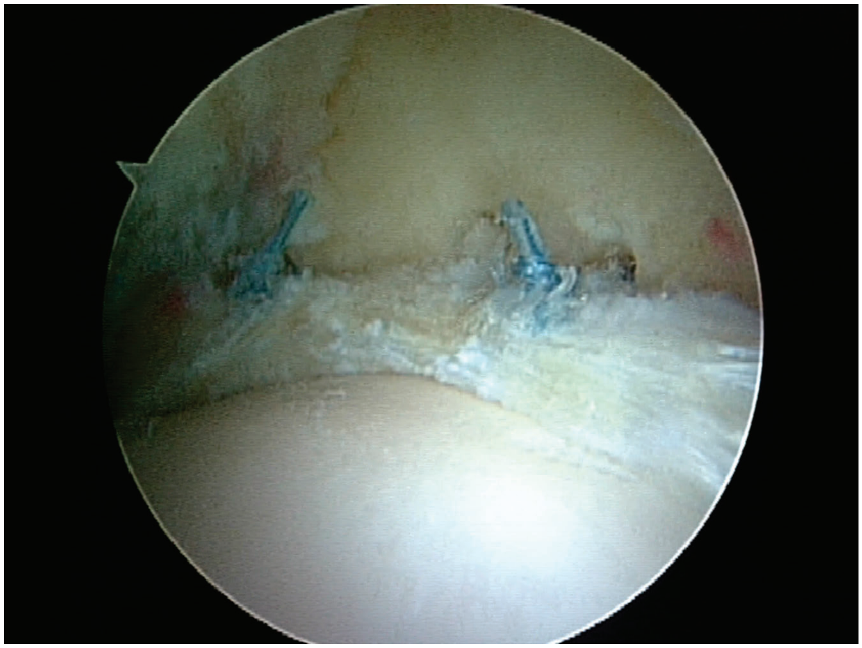

Fig. 13-C
Arthroscopic view from the central compartment, permitting evaluation of the labral repair.

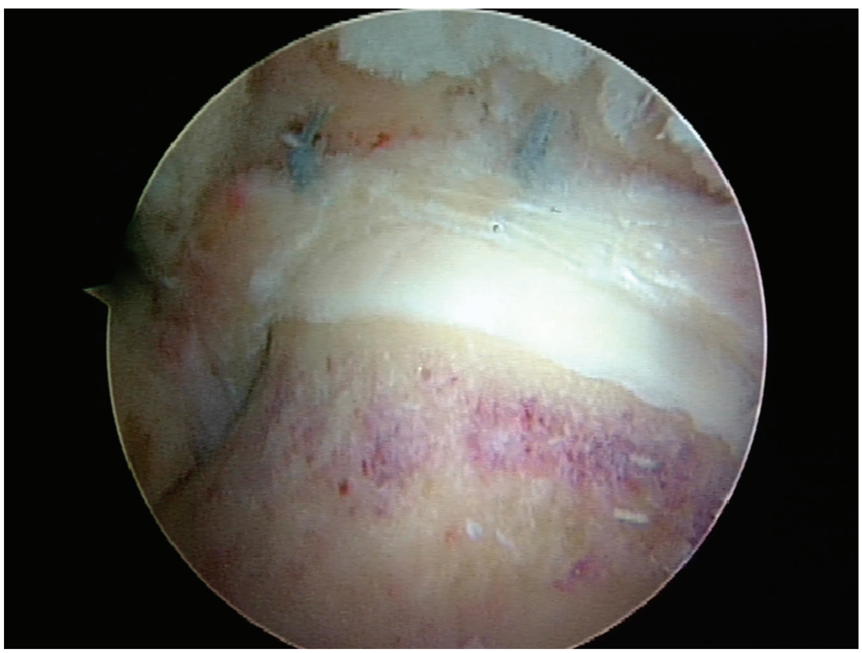

Fig. 13-D
Arthroscopic view of the peripheral compartment.

potential chondroprotective role, newer repair strategies have been described to improve the chances of labral preservation. It has become clear, however, that treatment of labral injuries in isolation, without addressing the underlying osseous disorder, has a greater chance of failure[55,56].

Once the labrum has been débrided of all nonviable tissue, the remaining labral tissue should be probed to determine if there is sufficient volume and quality to warrant refixation. The acetabular rim can be directly visualized and should be prepared to a bleeding bone bed with a motorized burr. Labral tears in a more lateral position (Zone 3)[57] are most easily addressed with the 70° arthroscope placed through the anterior or mid-anterior portal. The working portal then becomes the anterolateral or posterolateral por-

TABLE II Summary of Studies Evaluating the Open Treatment of Labral Tears and Femoroacetabular Impingement*

Study	No. of Hips	Mean Age *(yr)*	Mean Duration of Follow-up *(mo)*	Procedure	Return to Play	Outcomes Data	Failures
Beck et al.[67]	19	36	57	Surgical dislocation, osteoplasty, labral débridement		70% good-to-excellent results	5 of 19 hips failed and underwent conversion to THA
Bizzini et al.[61]	5	22	32	Surgical dislocation, osteoplasty, labral débridement	3 of 5 returned to professional level, 2 of 5 returned to minor league		
Murphy et al.[69]	23	35	60	Surgical dislocation, osteoplasty, and débridement; 3 with associated intertrochanteric osteotomy, 3 with associated periacetabular osteotomy		65% had good-to-excellent results	7 of 23 hips failed and underwent conversion to THA
Peters and Erickson[70]	30	31	32	Surgical dislocation, osteoplasty, labral débridement		85% had good-to-excellent results	4 of 8 hips with radiographic osteoarthritis underwent conversion to THA
Beaulé et al.[66]	37	41	36	Surgical dislocation, osteoplasty, labral débridement	28 of 37 returned to preoperative level of activity	82% had good-to-excellent results	6 were dissatisfied with operative procedure
Espinosa et al.[68]	25 in Group I;						
	35 in Group II	30	24	Group I: dislocation and labral débridement; Group II: dislocation and labral refixation	Group I: 76% had good-to- excellent results; Group II: 94% had good-to-excellent results	Group I: 4% had a poor result Group II: 6% had a moderate result	

*THA = total hip arthroplasty.

tal. More medial tears (Zone 2) are most easily addressed with the 70° arthroscope in the anterolateral portal, with the working portal being the anterior or mid-anterior portal. Fluoroscopy can be used to assist suture anchor placement at the edge of the acetabulum (Fig. 12), with care taken to ensure that the anchor does not penetrate the joint. Once the anchor is placed, the suture is passed through the labrum with use of either suture penetrators or shuttle sutures (Fig. 13-A). Restoration of labral function and anatomy is probably best achieved by passing the suture through the tissue in a vertical mattress fashion (Fig. 13-B), so that the suture material does not deform the labrum and is not in direct contact with the weight-bearing acetabular cartilage (Figs. 13-C and 13-D). This method of suture-passing mimics the technique that is used for open labral refixation.

Management of femoroacetabular impingement lesions (both pincer and cam) is critical to the success of labral refixation techniques as well as to the clinical outcome of the arthroscopic procedure. Typically, the rim lesion is treated primarily. This can be done either in the central compartment, with traction, or in the peripheral compartment, without traction. The margins of the pincer lesion are initially defined by probing with a flexible instrument. Fluoroscopy can be used during this portion of the procedure to clearly visualize the relationship between the anterior and posterior walls of the acetabulum. Resection of the rim lesion oftentimes leads to destabilization or requires detachment of the labrum in order to fully visualize the abnormality. In order to preserve the labrum during the rim resection, two different techniques can be employed. In the first, the labrum is sharply dissected from the acetabular rim in the region of the rim impingement and then held in a

TABLE III Summary of Studies Evaluating the Arthroscopic Treatment of Labral Tears and Femoroacetabular Impingement*

Study	Number of Hips	Mean Age *(yr)*	Mean Duration of Follow-up *(mo)*	Procedure	Return to Play	Outcomes Data	Failures
Byrd and Jones[52]	44	29	26	Arthroscopy, labral débridement, loose-body removal		93% good-to-excellent results	1 case of meralgia paresthetica
Guanche and Sikka[72]	8	36	14	Arthroscopy, labral débridement	8/8 returned to pre-injury level of competition		
McCarthy et al.[63]	13	24	18	Arthroscopy, labral débridement		92% good-to-excellent results	1 failure with recurrent symptoms
Philippon et al.[32]	45	31	19	Arthroscopy, osteoplasty, labral débridement and/or repair, microfracture	42/45 returned to professional competition	78% still active in professional sports at time of 19-month follow-up	3 failures with progressive osteoarthritis
Saw and Villar[75]	6			Arthroscopy, labral débridement	5/6 returned to professional soccer		
Ilizaliturri et al.[73]	14	31	30	Arthroscopy, osteoplasty, labral débridement, microfracture		Mean WOMAC score improved from 77 to 87; improved range of motion in all patients with slipped capital femoral epiphysis or Legg-Calvé-Perthes disease	No osteonecrosis, infection, fractures
Santori and Villar[65]	58	37	42	Arthroscopy, labral débridement		67% good-to-excellent results	33% dissatisfied with procedure
Potter et al.[64]	33	35	26	Arthroscopy, labral débridement		68% good-to-excellent results in nondisability patients; 39% good-to-excellent results in disability patients	
Farjo et al.[71]	28	41	34	Arthroscopy, labral débridement		71% good-to-excellent results in patients with no preoperative osteoarthritis; 21% good-to-excellent results in patients with preoperative osteoarthritis	8 failures requiring conversion to THA
O'Leary et al.[74]	22	34		Arthroscopy, labral débridement		90% good-to-excellent results	1 conversion to THA 1 yr status post-arthroscopy

*WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index; THA = total hip arthroplasty.

protected position while the bone is resected. Once an adequate rim resection has been completed, the labrum is repaired to the rim with use of the previously described bone-anchoring technique. In the second method, the capsule overlying the rim lesion is cut in a longitudinal fashion and, with use of a radiofrequency tissue ablator, peeled back to fully expose the osseous overhang without frank detachment of the labrum. The rim is then resected over the labrum until the transition zone is reached, and the labrum is subsequently repaired in regions that have been destabilized.

Cam lesions should be addressed once the rim resection and labral repair are completed. This portion of the procedure is performed in the peripheral compartment. The surgical goal of decompression of the femoral head-neck junction (cam decompression) is restoration of the normal offset of the head-neck junction and clearance of the femoral head within the acetabulum during full flexion and rotation. There are numerous techniques to achieve this goal; however, adequate visualization of the cam lesion within the peripheral compartment is essential, and fluoroscopic assistance can be helpful. With visualization of the cam lesion (typically through the anterolateral portal), a 5.5-mm burr is introduced through a second portal. The boundaries of the cam impingement lesion are marked out, and sequential removal of the cam lesion is then performed to recreate a spherical femoral head. At the completion of the bone resection, all bone debris is removed from the peripheral compartment and dynamic arthroscopy is performed to confirm the absence of any residual impingement. A resection of <30% of the head-neck junction is recommended because this range has been shown to preserve the load-bearing capacity of the femoral neck[31].

Outcomes

Open surgical dislocation of the hip has played a key role in the recognition and treatment of femoroacetabular impingement. This procedure allows circumferential inspection of the acetabular rim, including the labrum, cartilage, and femoral head-neck junction, and it permits the simultaneous treatment of intracapsular disorders. During the last decade, due to advances in arthroscopic techniques and flexible instrumentation, hip arthroscopy has grown in popularity. Although the procedure was initially met with some skepticism, advances in arthroscopic techniques have led to an expanding list of surgical applications, including treatment of femoroacetabular impingement, labral tears, capsular laxity and instability, chondral lesions, ligamentum teres injuries, and the snapping hip syndrome[13,58-60]. The advantages of hip arthroscopy include the ability to have minimally invasive access to the hip joint, peripheral compartments, and associated soft tissues. In addition, hip arthroscopy allows for a dynamic intraoperative assessment and correction of femoroacetabular impingement and has been associated with favorable short-term outcomes[61-65].

A systematic review of the literature revealed that only a limited number of studies have evaluated the outcomes of either open or arthroscopic approaches. Of the sixteen articles with reported outcomes after either open or arthroscopic surgery (Tables II and III), none utilized a Level-I or II study design and only one met the criteria for a Level-III study. The available literature indicates that open surgical dislocation with labral débridement and osteoplasty is successful, with a good correlation occurring between patient satisfaction and favorable outcomes as defined by the Harris hip or Merle d'Aubigné scores[61,66-70]. At an average of forty months after open surgery, 65% to 85% of patients were satisfied with their outcome (Table II). A common finding in all series, however, was an increased prevalence of failure among patients with substantial pre-existing osteoarthritis.

Arthroscopic treatment of labral tears is also effective, with at least 67% and as many as 93% of patients being satisfied with their outcomes (Table III)[32,52,63-65,71-75]. Satisfied patients were able to return to their pre-injury level of athletic competition and achieved good clinical results. Patients treated arthroscopically for labral tears and associated femoroacetabular impingement also did well, with as many as 93% of the patients being able to return to sports and 78% being able to remain active at 1.5 years after surgery.

Recurrence of Labral Tears and Revision Hip Arthroscopy

Secondary labral tears or labral re-tears may occur through mechanisms similar to those through which primary labral tears occur: femoroacetabular impingement, trauma (hip subluxation or dislocation), degenerative hip disease, dysplasia, capsular laxity and/or hypermobility, and psoas impingement. Because hip arthroscopy cannot effectively correct or curb the pathophysiological progression of degenerative joint disease or hip dysplasia, arthroscopic surgery to address labral tears in the setting of these two underlying conditions is generally not recommended, as rates of labral re-tear are likely to be high whether débridement or repair is pursued. In contrast, for the treatment of labral tears associated with femoroacetabular impingement, capsular laxity, psoas impingement, or traumatic episodes, arthroscopic surgery likely represents the least invasive method to definitively address such lesions. However, be-

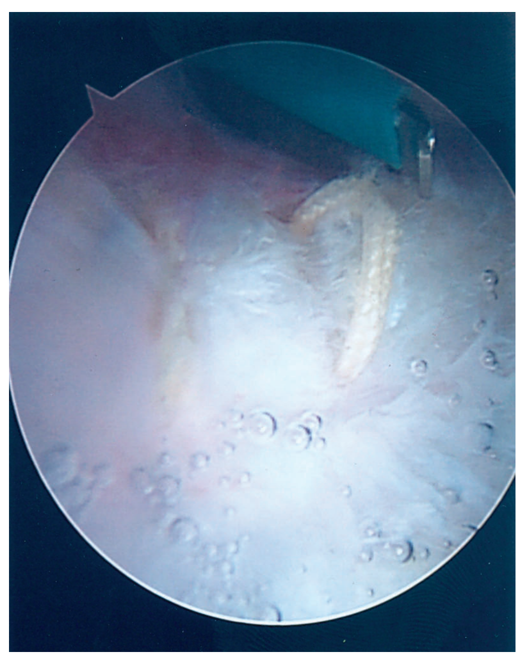

Fig. 14

Arthroscopic view of a failed labral repair with a loose suture. (Reprinted from: Heyworth BE, Shindle MK, Voos JE, Rudzki JR, Kelly BT. Radiologic and intraoperative findings in revision hip arthroscopy. Arthroscopy. 2007;23:1298; with permission from Elsevier.)

cause there is a paucity of literature regarding the outcome after revision arthroscopic hip surgery, the clinical effectiveness of such procedures (by themselves or in comparison with the effectiveness associated with the many open hip surgeries available for the treatment of labral tears) remains largely unknown.

Two studies have investigated findings associated with revision hip arthroscopy[55,56]. Heyworth et al. reported on the radiographic and intraoperative findings in twenty-four revision hip arthroscopy procedures performed in twenty-three patients at an average of approximately two years following the index procedure[56]. The authors, who identified labral tears in twenty-two of the twenty-four hips at the time of revision arthroscopy, hypothesized that patients who presented with persistent symptoms following primary arthroscopic labral débridement or repair had osseous impingement lesions that had not been adequately addressed. In nineteen (79%) of the hips, an underlying osseous hip disorder was detected with radiographs, computed tomography scans, and magnetic resonance imaging and was confirmed with diagnostic arthroscopy. In each of these nineteen hips, the osseous hip disorder was diagnosed as one form of femoroacetabular impingement (specifically, cam lesions at the femoral head-neck junction, anterosuperior acetabular pincer lesions, or both). Moreover, six of the patients had undergone either a cam resection at the time of the primary procedure, only to require treatment of a pincer lesion at the time of revision, or the reverse. The authors concluded that even when osseous lesions are fully recognized, there may be a tendency to insufficiently address them surgically. The series also included eight hips in which labral repair failed (Fig. 14), suggesting that there is a subset of labral tears that do not have good healing potential. Because some form of femoroacetabular impingement was detected in six of these eight hips, it may be that osseous impingement lesions, left unaddressed, may represent a contraindication to labral repair or reattachment. Finally, the authors identified seven cases of psoas impingement in which a labral lesion was associated with a tight psoas tendon and for which fractional release of the tendinous portion of the musculotendinous unit as it crosses the hip joint may be performed. Our unpublished data suggest that this procedure may provide appreciable pain relief in a subset of patients with persistent hip pain. The study was limited, however, by its small sample size, its retrospective and observational nature, and the lack of follow-up outcome measures.

Philippon et al. investigated thirty-seven revision hip arthroscopies that had been performed for the treatment of persistent hip pain, and those authors reported extremely similar findings to the study described above[55]. By far the most common disorder addressed in their series was femoroacetabular impingement, as 95% of the patients underwent some form of osseous débridement. Notably, 87% of patients had labral lesions as well, requiring surgical intervention, lending further support to the strong association between femoroacetabular impingement and labral disorders. Importantly, the authors noted improvement in the functional outcome measures, collected at an average of 12.7 months following revision surgery. Modified Harris hip scores improved from a preoperative average of 53 to 77 in the twenty-seven patients who were available for follow-up. This did not include the five hips in which revision surgery was deemed to be a failure and in which a total hip replacement procedure or a second revision hip arthroscopy procedure was performed.

In both studies, acute complication rates were relatively low, although Heyworth et al. did not report on postoperative follow-up. The complication rates after revision hip arthroscopy are likely to be similar to the complication rates after primary hip arthroscopy, which range from 1.4% to 5% in the literature, with transient neurapraxia being the most common[76]. In general, however, more research along with comparative analyses and longer-term follow-up is necessary to accurately assess the safety and efficacy of revision hip arthroscopy for recurrence of labral tears and other hip conditions. From the available evidence, however, it appears that failure to address osseous impingement lesions of the hip and a tight psoas tendon are key factors in unsuccessful hip arthroscopy and may necessitate revision surgery. Moreover, failure of labral repairs may often be the result of unrecognized osseous impingement at the time of the initial surgery.

Postoperative Rehabilitation

The results of hip arthroscopy are highly dependent on postoperative rehabilitation. Based on the extent of bone resection and the presence of labral repair, patients are restricted to foot-flat weight-bearing (maximum, 20 pounds [9.1 kg]) for a period of time between ten days and four weeks. Our protocol includes continuous passive motion for the first four weeks, for two to four hours per day. Patients are encouraged immediately postoperatively to ride a stationary bicycle with a high seat to avoid pinching. Over a three-to-four-month period, a slow progression to full strength and activity occurs. This gradual progression avoids overactivation or aggressive loading of the hip flexors, abductors, and adductors, as these muscle groups are highly susceptible to fatigue and tendinitis postoperatively. A full return to sporting activity is anticipated by five to six months, but patients may continue to see improvement in symptoms for up to one year postoperatively.

Discussion

Arthroscopic management of labral tears of the hip has been shown to provide pain relief and improve function in appropriately selected patients. Most outcome studies to date have looked only at surgery addressing labral tears in isolation. Improved results should be expected if the underlying disorder is concurrently addressed. Strict attention to the acquisition of a thorough history, the performance of a thorough physical examination, the use of appropriate imaging techniques such as magnetic resonance imaging, and the adherence to safe and reproducible surgical techniques as described in this paper are essential to the success of this procedure. ■

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