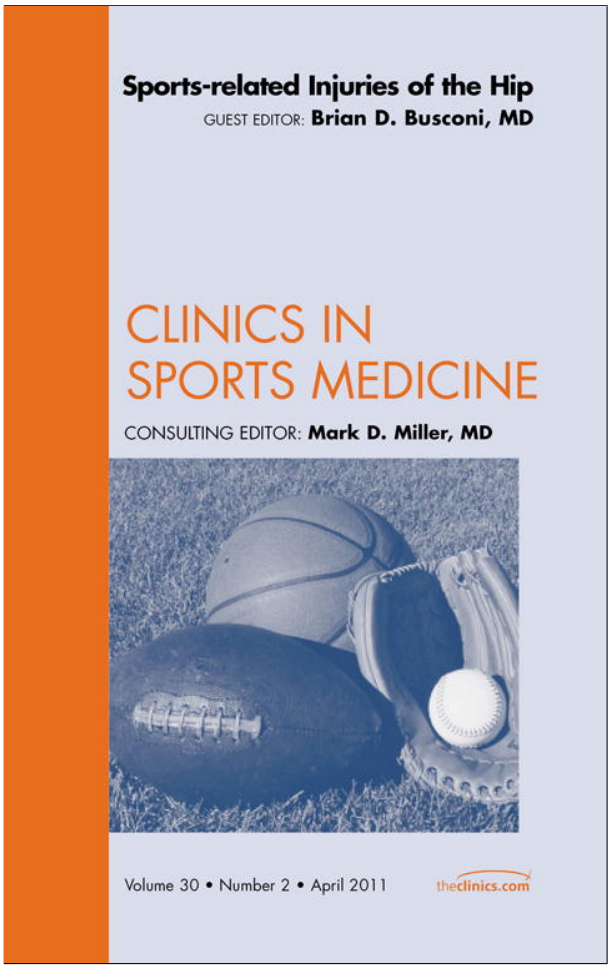

Acetabular Labral Tears: Diagnosis, Repair, and a Method for Labral Reconstruction

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KEYWORDS

• Labral tears • Labral reconstruction • Hip pain

Acetabular labral tears are a common cause of hip pain.[1–3] In athletes, hip injuries represent 3.1% to 8.4% of sports injuries in recent reports.[4,5] The prevalence of labral tears in patients with hip complaints has been reported from 22% to 55%.[6,7] The understanding of labral tears has greatly evolved in the past few years, and there now is better understanding of labral anatomy, function, disease and treatment. Hip arthroscopy has played an important role in the development of this knowledge, and has been established as a treatment option for the treatment of labral pathology. The goals of this article are to describe labral anatomy, to explain clinical presentation of labral pathology, and to provide guidelines in arthroscopic treatment.

ANATOMY

The acetabular labrum is a triangular fibrocartilaginous structure located circumferentially around the bony acetabulum, which becomes attached to the transverse

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acetabular ligament posteriorly and anteriorly.[8] There is no distinction between the labrum and the transverse acetabular ligament, and they appear to be a continuous structure.[9] Histologically, the labrum merges with the acetabular cartilage through a transition zone of 1 mm to 2 mm.[9] A recent study in human embryos showed that the chondrolabral junction is not uniform throughout the acetabulum and may have an anterior zone with weaker attachment to the bony acetabulum.[10] This zone was also described by McCarthy and colleagues[6] as the most frequent location of labral tears. Lower biomechanical properties in the anterosuperior region of the labrum compared with other regions may be a contributing factor of higher prevalence of labral tears at this area.[11]

The labrum plays a crucial role in normal hip mechanics. Crawford and colleagues,[12] using a three-dimensional motion analysis system, demonstrated labral tears lead to increased femoral head displacement in cadaveric hips. Fergunson and colleagues[13,14] demonstrated that the labrum provides a suction seal, keeping the synovial fluid inside the hip joint, which would help in pressure distribution and joint lubrication (**Fig. 1**).

Free nerve endings can be found in the acetabular labrum, and they may be involved in pain and proprioceptive sensation of the hip joint.[4] The labrum receives blood supply from branches of the obturator artery, superior gluteal artery and inferior gluteal artery. The articular side of the labrum is relatively avascular, compared with the capsular side, which is surrounded by highly vascularized synovium.[15] There are no specific areas of relative hypovascularity in the labrum. Labral tears seems to have a healing potential, as neovascularization occurs in labral tears studied histologically.[9] It also has been shown in an ovine model that labral repairs are capable of healing via fibrovascular repair tissue and/or direct reattachment via new bone formation.[16]

CLASSIFICATION OF LABRAL TEARS

Acetabular labral tears have been known for decades. Labral pathology has been described in trauma,[17] Perthes disease,[18] and acetabular dysplasia.[19] Labral tears also have been recognized as an early event in the development of hip osteoarthritis.[20]

Fig. 1. A longitudinal tear and partial detachment of the anterior to anterolateral labrum.

Seldes and colleagues[9] described two different histologic types of labral tears. Type 1 is a detachment of the labrum from the articular surface at the transition zone between the fibrocartilaginous labrum and the articular hyaline cartilage. Type 2 consists of one or more cleavage planes of variable depth within the substance of the labrum. Lage and colleagues[21] developed a classification based on the etiology of the labral tear and divided the tears into 4 categories: traumatic, degenerative, idiopathic, and congenital. Recently, femoroacetabular impingement (FAI) has been described as another cause of labral damage. This condition is an abnormal contact between the femoral head–neck junction and the acetabular rim caused by abnormal bony morphology.[22] In addition, capsular laxity and psoas impingement can result in labral tears. Therefore, the authors have included all of these conditions in a classification of labral tears summarized in **Table 1**.

The bony abnormalities in Cam and Pincer FAI, cause different patterns of labral tears.[20] Most commonly they are combined; if not combined, cam is more common. Cam impingement is characterized by abnormal femoral head–neck offset. This produces shear forces that create a primary lesion at the chondrolabral junction separating the labrum from the articular cartilage. Pincer impingement results from overcoverage of the acetabulum. In this type of impingement, the labrum is crushed between the acetabular rim and the femoral neck, causing degeneration of the labrum with intrasubstance ganglion formation.

Capsular laxity can be caused by congenital disorders and acquired conditions. Elher-Danlos syndrome, Marfan syndrome, and Down syndrome are common congenital causes of capsular laxity. Repetitive rotational sporting activities stress the capsule, resulting in attenuation of the iliofemoral ligament.[2] This capsular laxity leads to rotational instability, which results in increased pressure on the anterior superior labrum as the head rides anterior in the joint.[23]

A tight psoas tendon can compress the anterior capsulolabral complex and cause atypical anterior labral tears. Patients with labral tears require thorough evaluation for all possible causes that must be treated concurrently with arthroscopic labral treatment. This is crucial for good clinical outcomes, protection of labral healing, and prevention of labral reinjuries.

CLINICAL PRESENTATION

A detailed history and physical examination are essential to correctly diagnose labral tears, its causes, and concomitant disorders. Many remote conditions can present with referred pain to hip and groin areas,[8] such as the lumbar spine, sacroiliac joint,

Table 1
Labral tear classification

Type	Base Condition
1. Morphologic alterations	A) Femoroacetabular impingement Cam Pincer Mixed-type B) Dysplasia
2. Functional alterations	A) Instability B) Iliopsoas impingement
3. Trauma	Traumatic
4. Degeneration	Hip degenerative disease

or intrapelvic structures. Examination of the pubic region is important especially in athletes, since athletic pubalgia is an important differential diagnosis that can exist alone or in conjunction with labral tears. The term sports hip triad has been coined by Feeley and colleagues[4] to describe athletes presenting with a labral tear, adductor strain, and a rectus strain.

Patients with labral tears typically complain of anterior groin pain, but pain also can be referred to the buttock, greater trochanter, thigh, and medial knee. Other symptoms include clicking, locking, catching, instability, giving way, and stiffness.[24] The duration of symptoms must be evaluated and are extremely variable. A recent publication has shown as many as 45% of patients presenting with a sudden onset of symptoms.[25] Sports practiced by the patients and specific positions must be interrogated, as some types of sports are more prone to labral injuries, such as golf and ice hockey.[26]

Physical examination must be thorough; attention must be given to the patient gait, lower abdomen, lumbar spine, sacroiliac joints, and knees. Martin and colleagues[27] analyzed physical examinations of the hip performed by 6 hip specialists and found enough commonality to form the basis of recommended examination maneuvers in the evaluation of hip pain. Physical examination for labral tears superimposes with FAI examination, as these pathologies have a strong association. Hip examination must address motor strength, range of motion, points of tenderness, presence of limping, and Trendelenburg test. Hip motion is decreased in FAI, especially in cam impingement.[24,28,29] The most reliable specific test is the impingement test, which is done by flexion-adduction-internal rotation of the hip. This test is positive when it elicits anterior hip pain.[24] Forced external rotation with extension also can trigger hip pain related to acetabular labral tears.[9] The flexion-abduction-external rotation (FABER) test is a useful provocative maneuver. The affected leg is placed in a figure of four position so that the ipsilateral ankle is positioned proximal to the contralateral knee. The clinician should evaluate the presence of anterior hip pain, as well as the vertical distance between the lateral genicular line and the examination table, which is typically increased compared with the contralateral side in FAI patients.[24] A resisted leg raise in the supine position is another test used to elicit mechanical symptoms attributable to intra-articular abnormalities,[11] as well as an assessment of hip flexor strength.[27]

IMAGING

Plain radiographs remain the mainstay in evaluating hip pain. Many radiographic views can be used in the hip pain workup including an anteroposterior (AP) view of the pelvis, a cross-table lateral view, 45° and 90° Dunn view, a frog leg lateral view, and a false profile view.[30] The senior author (MJP) routinely uses an AP view of the pelvis, a cross-table lateral view, and a false profile view. It is crucial to assess proper patient positioning during radiographs to correctly determine osseous anatomy, especially acetabular rim morphology. Wenger and colleagues[31] reviewed hip radiographs of patients with labral tears and found that 87% of these patients had at least one bony abnormality.

Pincer impingement is characterized by acetabular overcoverage that can be either global or focal. Acetabular global overcoverage can happen in cases of coxa profunda or protusio acetabuli.[22] Focal overcoverage happens in a retroverted acetabulum, represented by the crossover sign,[24] the posterior wall sign, and a prominent ischial spine.[32] The amount of acetabular coverage of the femoral head can be measured by the center edge (CE) angle of Wiberg.[33] Increased angles are related to pincer impingement, while decreased angles are related to acetabular dysplasia. In some patients, paralabral cysts can be observed associated with labral tears. The femoral head–neck offset can be evaluated by measuring the alpha angle in the cross-table lateral view.

Other radiographic modalities are usually required to further delineate intra-articular hip pathology. Three-dimensional computed tomography can be employed to assess the extent of osseous resection that should be done during a hip arthroscopy. Magnetic resonance imaging (MRI) provides the most detailed images of intra-articular hip pathology, showing with great details labral anatomy and femoral and acetabular cartilage. The alpha angle is measured in the axial oblique sequences to evaluate the femoral head–neck junction.[24]

TREATMENT OF LABRAL TEARS

The initial treatment for labral tears should be conservative, consisting of physical therapy, anti-inflammatory medication, and activity modification. If patients have persistent pain after 4 weeks of treatment, they are candidates for hip arthroscopy.[2] Recent data suggest that early intervention in labral pathology leads to better results. Philippon and colleagues[26] showed that hockey players with labral tears who underwent arthroscopic treatment within 1 year from the time of injury returned to sports earlier than patients who had surgery more than 1 year after injury.

SURGICAL TECHNIQUE: LABRAL REPAIR

Hip arthroscopy may be performed in either the supine or lateral position depending on surgeon preference. The senior author (MJP) performs hip arthroscopy with patients in the modified supine position.[2] After placement of an extra wide post to protect the perineum, the hip is placed in a position of 10° flexion, 15° internal rotation, 10° lateral tilt, and neutral abduction. Traction is applied in the operative limb between 10 to 25 kg of force, with gentle countertraction applied to the contralateral limb. After traction, the leg is placed in slight adduction over the post, which forces the femoral head laterally. The leg is internally rotated to bring the femoral neck parallel to the floor. Traction is controlled with fluoroscopy, with the goal of a minimum of 8 mm to 10 mm of distraction.

Adequate portal placement is of paramount importance to hip arthroscopy, as a wrong portal placement can lead to neurovascular injury and inadequate joint visibility. The anterolateral portal is established 1 cm proximal and 1 cm anterior to the tip of the greater trochanter. The midanterior portal is made 6 cm to 7 cm from the anterolateral portal, at a 45° to 60° angle with respect to the longitudinal line passing through the anterolateral portal. This location should be half way between the longitudinal lines passing through the anterior superior iliac spine and the anterolateral portal. The latter portal is established with direct visualization from the anterolateral portal, with the 70° arthroscope.

After portal placements, a small capsulotomy is performed to facilitate mobility of the arthroscopic instruments and visualization of the joint. The labral tear is then assessed by location and size (**Fig. 2**). The labral tissue quality is evaluated, as well as the labral size. Labral tear treatment can be done either by débridement or repair. In the light of current understanding of the labral function and importance, it is important to make an effort to preserve as much labral tissue as possible. Clinical outcomes comparing débridement versus refixation have shown better results with labral repair.[25,34,35] Moreover, an experiment using ovine model showed the capacity of labral tears to heal after arthroscopic repair.[16] Therefore, the authors' approach is to preserve the labrum whenever possible. Labral débridement is limited to patients with a small peripheral tear that after resection retains enough tissue to maintain normal labral function.

To perform labral repair, the labral tear is first débrided of fraying and unhealthy tissue, with the goal of leaving only viable tissue with good healing capacity. Then, the acetabular rim is trimmed to a bleeding bed with a motorized burr. The labrum

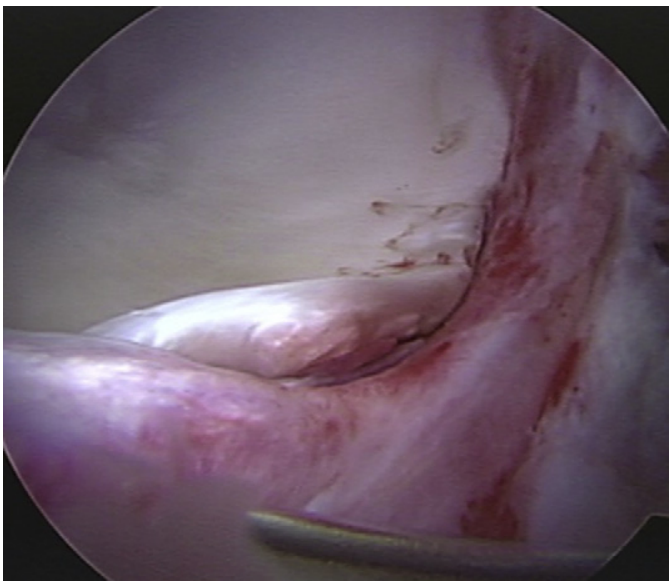

Fig. 2. Arthroscopic view of labral tear.

is repaired to the acetabular bone with the use of suture anchors (**Fig. 3**). They are drilled approximately 2 mm to 3 mm below the cartilage surface. Special care is taken not to penetrate the articular surface with the anchor. Typically, the most anterior part of the labral tear will be addressed first, with the anchors being delivered through the midanterior portal. Then, sequential anchors are placed along the labral tear to achieve adequate stability. More posterior anchors are placed through the anterolateral portal. The knots must be placed at the capsular side of the labrum, as failure to do so may cause an iatrogenic injury to the adjacent cartilage by the knot (**Fig. 4**).

The anchor suture can be looped around the labrum or passed through it. This decision is based on tissue quality and the position desired for the labrum. A hypotrophic labrum is not a good candidate for sutures to be passed through, as the tissue may be ripped as an arthroscopic penetrator is used to pass the suture through the labrum. Sutures looped around the labrum usually tend to evert it, while sutures passed through the labrum tend to invert it. This characteristic can be used to better restore the labral suction seal, as the labrum needs to sit correctly on the femoral head to act as a gasket for the joint. To make sure the suction seal has been restored, traction is released after anchor placement, and a dynamic examination is then performed

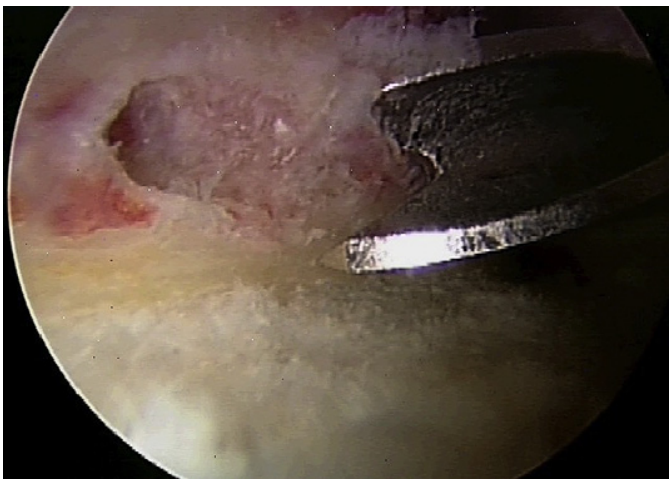

Fig. 3. Suture anchor placement in the acetabular rim close to the surface.

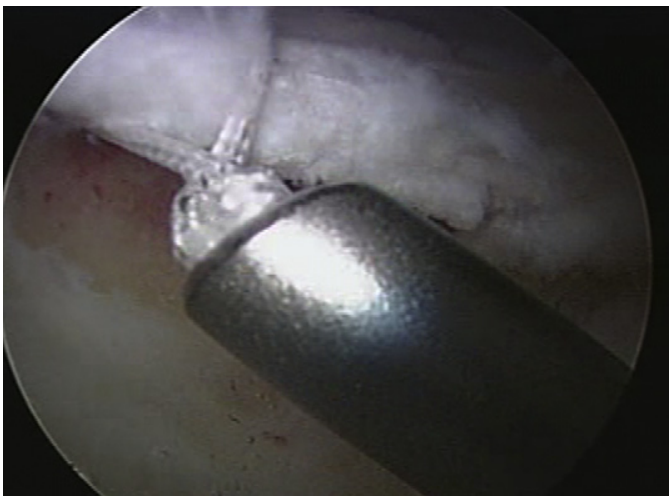

Fig. 4. The suture knots are on the capsular side of the labrum to avoid the knots rubbing on the cartilage surface.

(**Fig. 5**). The hip is brought through a complete range of motion to ensure adequate sealing by the labrum. If any labral area seems unstable, additional anchors can be placed. It is very important to make sure the labrum is stable at the time zero, so that there is no risk of labral retear during early postoperative rehabilitation.

Addressing associated conditions is essential for good surgical outcomes. Bony abnormality such as femoroacetabular impingement must be corrected to protect the labrum from new injuries. One study of revision hip arthroscopy showed that the most common reason patients returned for revision hip arthroscopy was persistent impingement.[36] To correctly address the pincer impingement, sometimes it is necessary to detach the labrum from the acetabular rim using an arthroscopic knife (**Fig. 6**). Then, the detached labrum is treated as a regular labral tear and is repaired to the trimmed rim as the technique described using suture anchors.

The pincer lesion also can be evaluated without labral detachment. In this situation, the bony overhang is trimmed over the labrum until the chondro–labral junction is reached. This method can create zones of labral instability, and these unstable areas

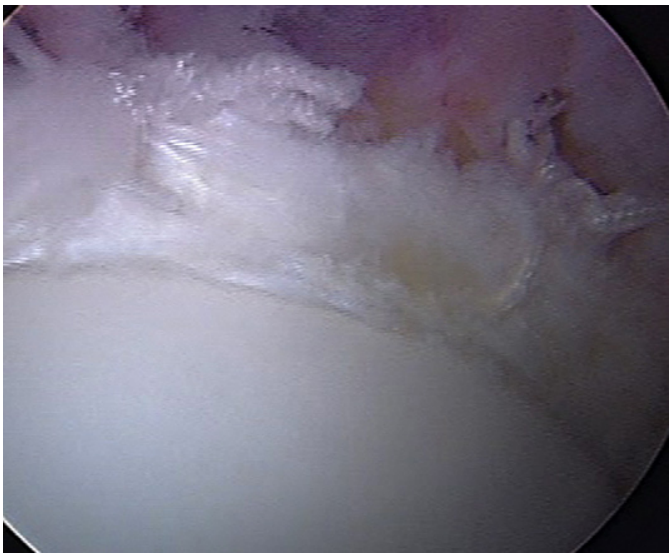

Fig. 5. The labrum is tightly sealed to the femoral head when the hip is moved through normal range of motion.

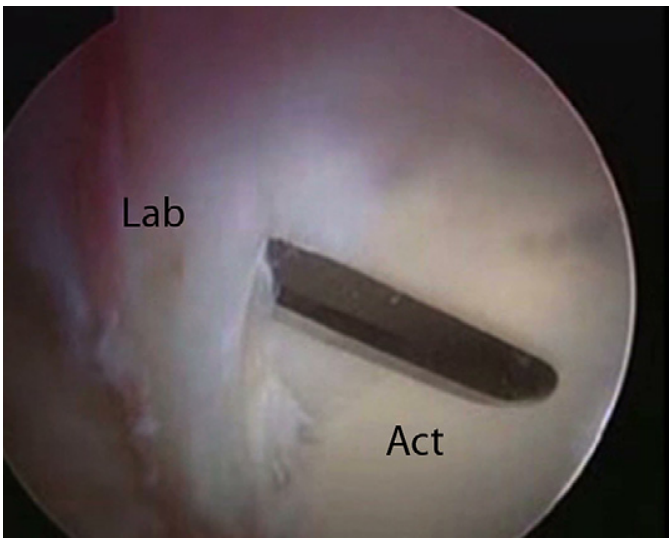

Fig. 6. Detachment of the labrum (Lab) before rim trimming. This allows for refixation of the labrum (Lab) on the new acetabular (Act) rim following trimming.

should be treated with anchor placement. It is important to evaluate the CE angle before performing the acetabular trimming to avoid situations of hip dysplasia and instability. It is estimated that 1 mm of bony resection at the acetabular rim decreases 2.4° of the CE angle, while 5 mm of rim resection cause a 5° change of the CE angle.[37] Cam impingement can be evaluated and treated in the peripheral compartment.

Tight psoas tendon that causes psoas impingement of the labrum can be released using a transcapsular approach. A small capsulotomy is made at the anterior part of the capsule, corresponding to the psoas valley of the acetabular rim (**Fig. 7**). The tendinous part of the iliopsoas muscle can be identified and then released using an arthroscopic knife. Psoas tendon release should be performed as the last step of the surgery, so that the risk of intra-abdominal fluid extravasation is diminished. In the end of the procedure, the capsule is closed with a number 2 Vicryl suture, (Ethicon,

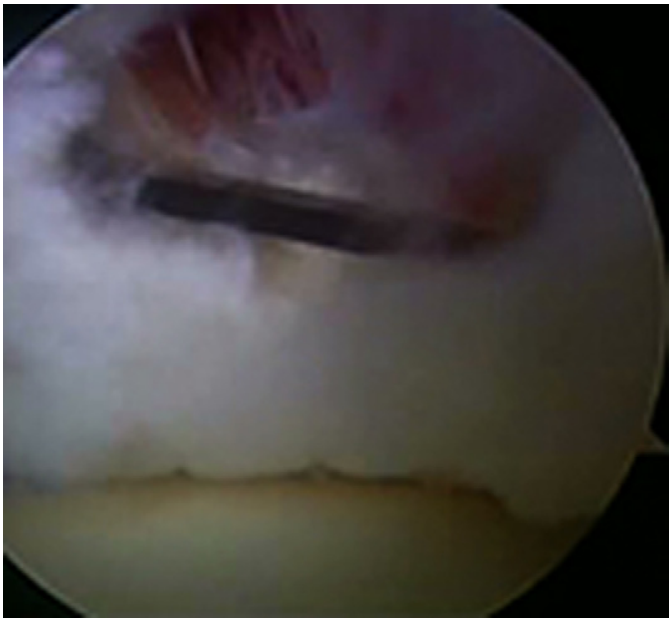

Fig. 7. A small capuslotomy showing the psoas tendon release.

Somerville, NJ, USA) and platelet-rich plasma is injected into the joint. For patients with capsular laxity, the capsule should be plicated to restrain the capsule and restore stability.

LABRAL RECONSTRUCTION

When treating labral tears, the authors' main objective is to preserve the labrum. This is not always possible, however. For cases that the labrum is deemed not amenable to repair, the senior author (MJP) has developed a method for labral reconstruction with the iliotibial band autograft.[38] Indications for labral reconstruction are hypotrophic labrum and complex tears. The authors define hypotrophic labrum by a width of 5 mm, and opt to reconstruct when it is less than 3 mm. Hypotrophic labrum can be caused by an anatomic variation or by previous labral débridment. Complex tears are defined as tears that completely disrupt the longitudinal fibers of the labrum. In these situations, there is not enough healthy tissue for a labral repair, and a labral reconstruction is the authors' method of choice for treatment.

Patient positioning and portal placement are similar to the aforementioned. When a labral tear is considered unrepairable, it is débrided until only healthy tissue is left. At this time, the acetabular rim is trimmed for an acetabular overhang if existent or just as a bleeding bed for the graft. Then the labral deficiency is measured using the tip of a motorized burr as a reference.

The iliotibial band is used as the graft donor site. The operative leg is taken out of traction, and it is straightened and internally rotated. An incision is done just distal to the anterolateral portal over the greater trochanter. The iliotibial band is exposed, and the graft is harvested at the junction between the anterior two-thirds and posterior one-third. The graft is retrieved as a rectangle with 15 mm to 20 mm in width, and it should be 30% to 40% longer than the actual defect to guarantee adequate length to restore the labrum.

The graft is taken to the back table and prepared while the defect in the iliotibial band and the incision are closed after a trochanteric bursectomy is performed if indicated. The graft is kept moist and cleared of all soft tissue attached to it. Number 2 Vicryl sutures (Ethicon, Somerville, NJ, USA) are used to capture both extremities of the graft. The graft is placed in a Graftmaster (Smith & Nephew, Andover, MA, USA) using the sutures in its extremities and is now tubularized using 2–0 Vicryl stitches. A suture loop of number 2 Vicryl is made at the thickest lateral end of the graft to facilitate later maneuverability. Platelet-rich plasma is injected in the graft to enhance cellular healing potential.

Traction is now reestablished. An anchor is placed at the most anterior part of the defect through the midanterior portal. One of the limb sutures is passed through the graft outside the joint with a free needle. A knot then is made and pushed with a knot pusher at the same time when the graft is introduced into the joint through a plastic canula (**Fig. 8**). The other suture limb of the suture anchor can be passed through the native labrum to create a side-to-side anastomosis between the graft and native labrum. Then, a second suture anchor is placed at the most posterior part of the defect, and the graft is fixed using the suture loop to aid in control and anchoring the graft. After the knot placement, the graft is addressed as a regular bucket–handle labral tear. Additional suture anchors are placed approximately 1 cm apart along the midportion of the graft until stable fixation is achieved (**Fig. 9**).

Traction is released, and the hip is evaluated with dynamic examination in all planes of motion to assess the fixation and position of the graft. The graft should resemble the native labrum and should recreate the suction seal of the hip joint. A flexible

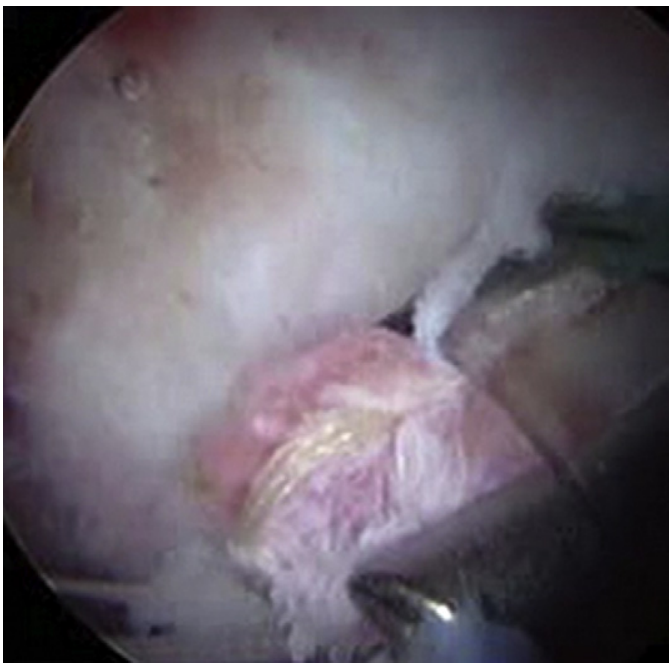

Fig. 8. Iliotibial band graft entering the joint through the midanterior portal.

radiofrequency device can now be used to make the graft and the native labrum smooth, by removing fraying edges to ensure good visualization of the reconstruction.

Clinical Outcomes of Labral Reconstruction

The authors' clinical experience with labral reconstruction has now reached over 150 procedures, and results are promising.[38] Second-look arthroscopies have been done in several patients to treat adhesions and residual chondral lesions, and in all cases the graft was incorporated and the suction seal well maintained. Modified Harris Hip Score raised from 62 to 85, and the median patient satisfaction was 8 out of 10 after an average follow-up time of 18 months. Hip replacement was performed in 9% of cases. Joint narrowing was a predictor of lower satisfaction, and age below 30 years old was a predictor of better patient satisfaction after labral reconstruction.

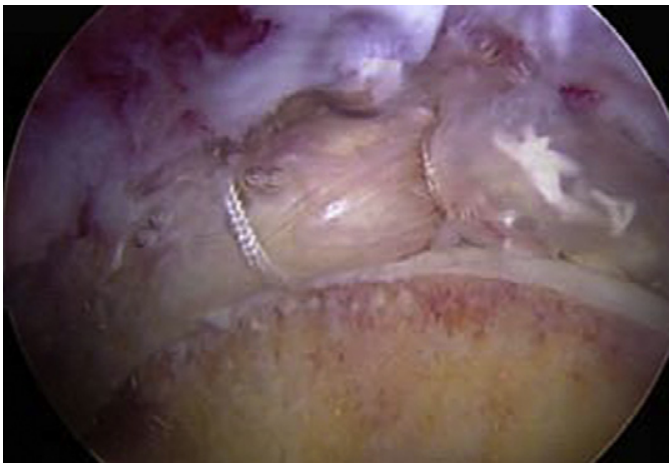

Fig. 9. The labral reconstruction is complete with the graft secured and with a tight seal to the femoral head during dynamic examination.

POSTOPERATIVE PROTOCOL

Protocols are the same for labral repair and labral reconstruction. The authors like patients to get on a stationary bike with no resistance within 4 hours after surgery, and to use a continuous passive motion (CPM) machine until 2 to 3 weeks after surgery. Patients are kept at 10 kg of flat-foot weight for 2 to 3 weeks also. This time is increased to 8 weeks if a microfracture procedure was performed. Patients are advised to wear an antirotational bolster and a hip brace to prevent stress in the repaired capsule. In order to prevent flexor contracture, patients should lay prone for 2 hours per day. All these measures are done with the objective of preventing capsular adhesions, which is one of common reasons for revision arthroscopy.[36]

SUMMARY

Labral tears are the most common finding in hip arthroscopies. The acetabular labrum is essential for adequate joint mechanics, so preserving the labrum and its function as a suction seal is mandatory to keep the hip stable and delay the development of joint degeneration. Labral repair is the preferred method to treat labral tears, and when this is not possible to do, labral reconstruction with the iliotibial band graft is an alternative treatment with promising early outcomes.

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