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Imaging of the Acetabular Labrum

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The labrum is a critical structure within the hip joint. Its role in the function and pathology of the hip is only currently being fully explored. Over the past 5 years, our understanding of this structure has evolved significantly. Detailed studies of its anatomy have been performed. Many reports have been written regarding its appearance on MR imaging and at MR arthrography and its appearance under direct visualization at arthroscopy and in cadaveric specimens. Labral pathology is currently known to be a significant cause of pain. It is believed that labral pathology is a significant factor in the development and progression of osteoarthritis of the hip, and this role is only beginning to be understood. This association between labral pathology, anatomic variations within the hip joint, and osteoarthritis is one of the driving forces behind the efforts to improve the diagnosis and treatment of labral pathology.

Anatomy

The labrum is a fibrocartilaginous structure that is firmly attached to the rim of the acetabulum (Fig. 1) [1]. Its junction with the osseous margin is irregular, and there may be extension of bone into the substance of the labrum [1,2]. The labrum is widest anteriorly and superiorly; it is thickest superiorly and posteriorly [1,3,4]. At the margins of the acetabular notch the labrum blends imperceptibly with the transverse ligament. Sulci are formed at the junction of these two structures and should not be confused with labral pathology. The joint capsule attaches to the acetabular rim adjacent to the labrum. At the anterior and posterior margins of the joint the capsule attaches at the base of the labrum, which creates small perilabral or labrocapsular sulci. At the superior aspect of the joint the capsule inserts several millimeters above the labrum, which creates a larger perilabral sulcus or recess.

According to some investigators, the labrum blends imperceptibly with the articular cartilage [1,4]. Other investigators describe a cleft at the junction of the articular cartilage and labrum at the anterosuperior quadrant of the hip joint, however [5,6]. The anatomy of this junction is critical to the interpretation of MR arthrography and is discussed later in this article.

Detailed histologic examination of the labrum has demonstrated that it is composed of fibrocartilaginous tissue and dense connective tissue [5]. Three separate layers have been identified within the labrum. Along the articular surface a randomly oriented fibrillar network is present. Chondrocytes that are present within these collagen fibrils create a fibrocartilaginous layer [5,6]. Next a lamellar layer of collagen fibrils is seen. Along the external surface of the labrum the main substance of the labrum is composed of circumferentially oriented collagen fibrils, which blend with the transverse ligament at the margins of the acetabular notch [5]. These circumferentially oriented fibers are reinforced with perpendicularly oriented collagen fibrils [7].

The blood supply of the labrum is from capsular blood vessels, which are derived from the obturator, superior gluteal, and inferior gluteal arteries [5,8,9]. The blood supply to the labral substance is through small vessels that are located along the capsular side of the labrum [1,5,10]. These vessels do not penetrate deeply, and the articular surface of the labrum is avascular. Vessels also have been identified within the adjacent acetabular rim; however, they do not penetrate into the substance of the labrum [8,10]. The relative

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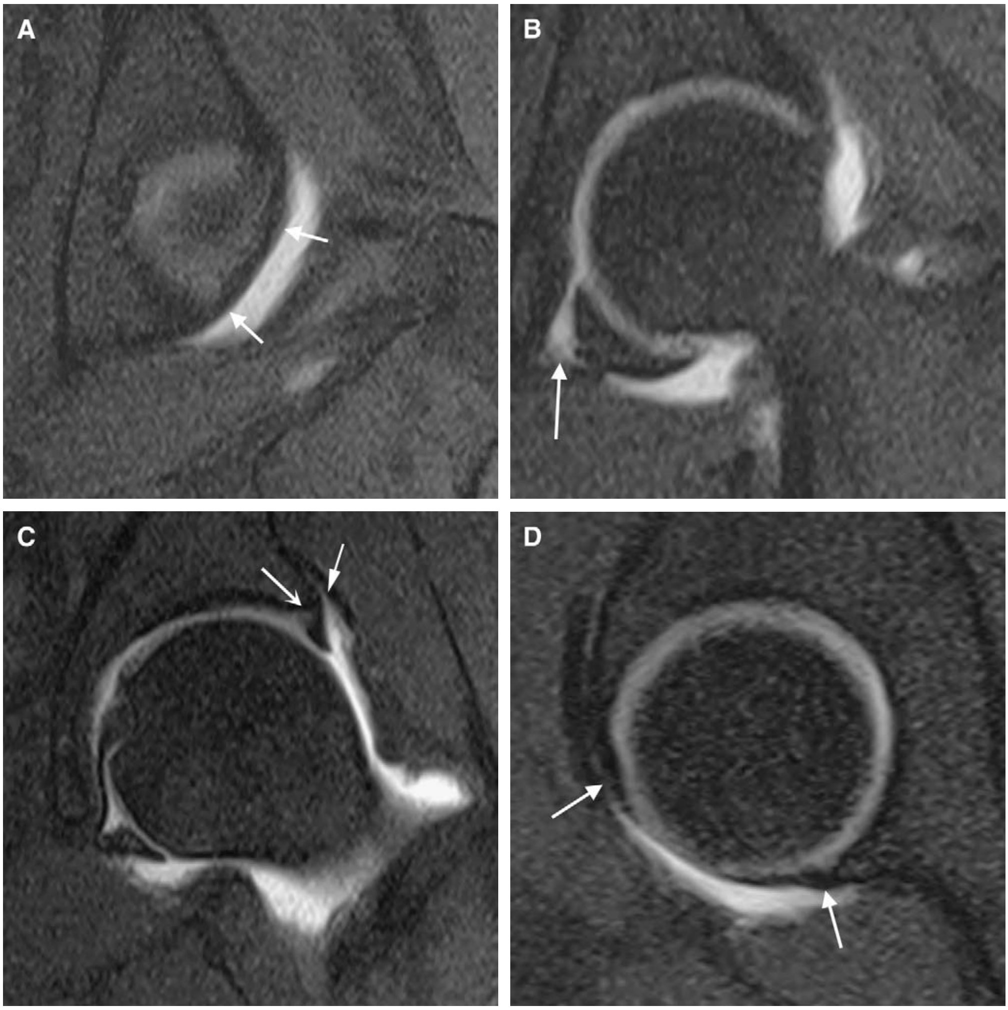

Fig. 1. Normal anatomy with intra-articular gadolinium. Coronal fat saturated T1-weighted images from posterior to anterior (*A–C*) demonstrate the attachment of the labrum along the posterior rim (*A*, *arrows*) and the labroligamentous sulcus at the posteroinferior corner of the joint where labrum and transverse ligament join (*B*, *arrow*). The normal attachment of the superior labrum to the acetabular rim is seen (*C*, *arrow with curved head*) and no separation between the labrum and articular cartilage is evident. The normal perilabral sulci are seen, superiorly where it is larger (*C*, *arrow with straight head*) and posteriorly where it is smaller (*E*, *arrowhead*). On the sagittal fat-saturated T1-weighted image (*D*) the normal labrum blends imperceptibly with the transverse ligament (*arrows*). The posterior perilabral recess is small; the anterior recess (to the left) is barely perceptible. The oblique axial gradient echo image (*E*) also demonstrates the normal labral attachment (*arrow with straight head*). In this image, a portion of the labrum overlies the articular cartilage. Contrast material has entered the iliopsoas bursa medial and lateral to the iliopsoas tendon (*arrows with curved heads*). This communication is normal.

lack of vascularity within the labrum suggests that it has little capacity for repair [10].

Functionally, the role of the labrum is not well understood. It does deepen the socket of the acetabulum, which increases the surface area of the hip [4]. It may play a role in weight bearing [4]. Biomechanical studies have demonstrated that the labrum aids in sealing the hip joint and preventing the expression of fluid when the joint is stressed [11]. By maintaining this seal, forces are distributed within the joint in a manner that protects the articular cartilage [12,13]. The labrum also maintains stability within the joint and prevents lateral subluxation of the femoral head [12]. This

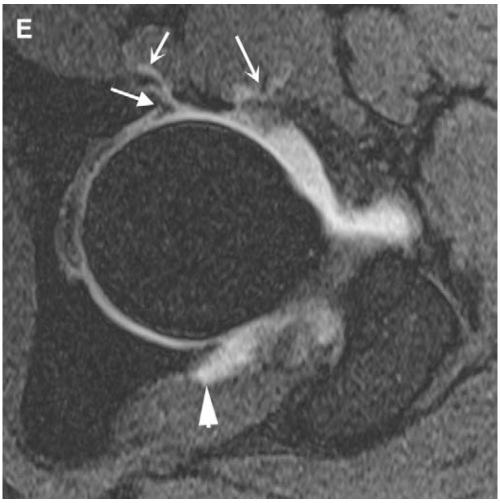

Fig. 1 (*continued*)

function was identified clinically by recognition of the fact that superolateral joint space narrowing on radiographs is an indicator of osteoarthritis secondary to labral pathology [14].

Clinical background

Initially, identification of labral abnormalities was important because of the role these abnormalities played in the production of hip pain. Treatment was guided by the desire to reduce a patient's pain. Occasionally concerns were raised regarding the relationship between labral pathology and osteoarthritis. Over time our understanding of the association between labral pathology, anatomic variations within the hip joint, and osteoarthritis has evolved [10,14–23]. Currently, labral pathology is believed to be part of a continuum of abnormalities that result in osteoarthritis. Underlying anatomic variations within the hip that lead to labral pathology are recognized.

From his study of 436 patients, McCarthy and associates [10] provided data to support the concept that labral lesions contribute to the development of osteoarthritis. They found a twofold increase in the relative risk of chondral erosion in the presence of labral lesions (Fig. 2) [10]. They proposed the following sequence of events: traction or impingement leads to excessive loading of the labrum at the extremes of joint motion, which leads to fraying along the articular margin of the labrum, which leads to tearing of the articular margin of the labrum, which leads to delamination of the articular cartilage, which produces a cartilage flap adjacent to the labral lesion and eventually more global labral and chondral pathology [9]. Underlying mechanisms of the initial

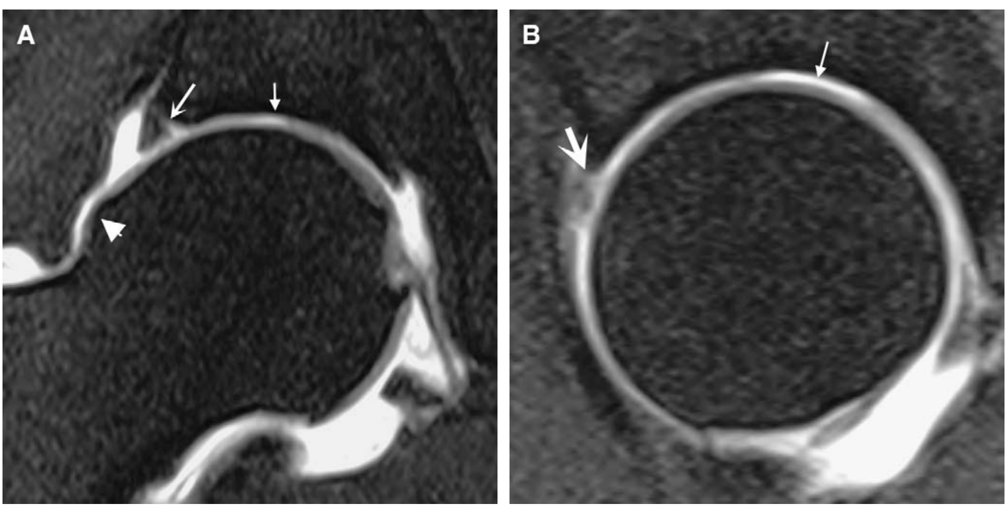

Fig. 2. Fat-saturated T1-weighted coronal (*A*) and sagittal (*B*) images reveal a partial labral detachment with contrast interposed along a portion of the acetabular rim–labral interface (*arrows with curved heads*). Generalized cartilage loss is seen adjacent to the labrum on the sagittal image, and larger defect is noted more centrally within the joint (*A* and *B*, *arrow with straight head*). The changes in this hip are secondary to femoroacetabular impingement as identified by the lateral femoral bump (*arrowhead*).

traction or impingement include developmental dysplasia and femoroacetabular impingement.

Leunig and colleagues [24] explored the cause for peripheral degeneration of the acetabulum in hips of elderly patients. They were driven by the observation that joint degeneration was more commonly found in the periphery rather than a central location, as one would expect if the mechanism of joint wear along the weight-bearing surface were accepted. They found that impingement—and its associated labral pathology—is the most likely reason for this peripheral distribution of degenerative disease.

Clinical presentation

Patients who have labral pathology may present with pain referable to the hip, groin, pelvis, and even the medial knee. The differential diagnosis in these patients is extensive and includes arthritis, bursitis, infection, stress fracture, musculotendinous injuries, tendon avulsion, and even hernias. Symptoms of mechanical hip pain help to differentiate patients who have labral tears [25]. These mechanical symptoms include pain with range of motion, which may be accompanied by locking, clicking, or catching. A significant correlation between anterior inguinal pain, painful clicking, transient locking, and giving way has been associated with arthroscopically confirmed labral tears [26]. A significant traumatic event is usually not remembered; however, there is an increase in symptoms in young athletic individuals. If any injury is remembered, it is typically a minor twisting injury [9,27]. No female or male predilection is known [10].

Until the introduction of MR arthrography into the arsenal for assessment of the painful hip, these patients often went undiagnosed for many months or years. Because MR arthrography is more widespread, labral pathology is being recognized with greater frequency. As with most soft tissue injuries, radiographs are typically not useful for these patients. The radiographic presence of osteoarthritis is associated with a poor outcome, however [25].

Anatomic variations within the hip joint may predispose patients to the development of labral abnormalities. Patients who have developmental dysplasia of the hip are at increased risk for labral abnormalities, especially superiorly. With the deficient acetabulum superiorly, the labrum is subjected to stresses not present in the normal hip. In patients who have developmental dysplasia, labral pathology should be considered when a patient's pain is out of proportion to radiographic changes. MR arthrography also may be a useful preoperative examination in adolescents and young adults who are considering an osteotomy. In these patients, inspection of the intra-articular structures is not typically performed at the time of surgery, and concomitant labral pathology may not be recognized and treated. Failure to address the associated labral pathology may lead to a poor outcome after osteotomy. Conversely, labral pathology should be considered in patients who have undergone a technically successful osteotomy but continue to have pain.

Femoroacetabular impingement is another form of anatomic variation within the hip joint that is associated with labral pathology. In the Cam type of impingement, an abnormal femoral head neck junction leads to impingement between the abnormal femur and a normal acetabular rim. The first stage of injury occurs within the articular cartilage of the acetabular rim. As the condition progresses, detachment of the labrum may occur. In the Pincer type of impingement, overcoverage of the femoral head by the acetabulum leads to pinching of the labrum between the femur and acetabulum, which leads to labral tear. (See the article by Bredella and Stoller elsewhere in this issue for further discussion of femoroacetabular impingement.)

Labral pathology is less commonly associated with significant injury to the hip. Dislocations of the hip may detach or tear the posterior labrum at the time of dislocation or relocation of the hip. The labral fragment may become trapped between the head and acetabulum and prevent an anatomic reduction [28–31]. Transverse acetabular fractures also may lead to damage of the labrum with avulsion of the labrum from the acetabular rim [32].

MR imaging of the labrum

Technique

MR imaging is the ideal tool for assessment of the acetabular labrum. As with many other joints, MR arthrography of the hip with its joint distention is the preferred imaging modality for evaluating the labrum. There are reports of the successful assessment of the labrum without joint distention, however [33]. In a study by Czerny and associates [34], the sensitivity and accuracy for nondistended joints were 30% and 36%, respectively, when compared with surgical findings. Sensitivity and accuracy increased to 90% and 91%, respectively, after joint distention [34].

Joint distention for MR arthrography may be achieved by injection of normal saline or a dilute solution of gadolinium. The standard dilution of gadolinium for joint distention is 0.2 mmol/L of gadopentetate dimeglumine. For a single hip this dilution may be achieved by mixing 0.1 mL of gadopentetate dimeglumine in 20 mL of normal saline. By mixing 15 mL of the dilute gadolinium solution with 5 mL of iodinated contrast, an opacified solution can be injected into the joint. The joint capacity is 8 to 20 mL [35,36]. Intra-articular lidocaine injection also may be useful. Pain relief with intra-articular lidocaine further supports an intra-articular source. Failure to produce pain relief, however, does not exclude an intra-articular source.

With the use of intra-articular gadolinium, a combination of T1-weighted images with and without fat saturation may be used. A surface coil should be used with the following imaging parameters: field of view 14 to 16 cm; section thickness 3 to 5 mm for spin echo and 1.5 mm for gradient echo sequences; matrix 192 to 256×256.

Because of the spherical nature of the acetabulum, it is important to use at least three imaging planes to ensure that all portions of the labrum are assessed adequately. This author prefers to use fat-saturated T1-weighted images in the sagittal, coronal, and oblique axial planes and T1-weighted images in the axial plane. The oblique axial plane is oriented along the long axis of the femoral neck on a coronal image (Fig. 3). This plane has the advantage of providing a more thorough examination of the labrum and is useful for assessing the femoral head neck junction in patients suspected of having acetabulofemoral impingement.

Radial imaging also may be used to achieve this goal [37,38]. Radial imaging has the advantage of providing perpendicular images of the labrum at each portion within the joint with a single imaging sequence. Radial images are obtained with the use of gradient echo sequences. Reconstructions are performed at 10° to 15° increments around the joint. Volume artifacts are partially reduced. With their use of radial imaging, Plotz and colleagues [38] demonstrated an increase in sensitivity and accuracy from 60% and 70%, respectively, for oblique axial and coronal image to 80% and 85%, respectively, with radial imaging. Specificity was 100% for both techniques. As with every patient who presents with pain referable to the hip or groin, an assessment of the entire pelvis is performed with short tau inversion recovery (STIR) coronal images that include the entire symphysis pubis and the sacrum.

Fig. 3. The axis for the oblique axial/sagittal plane is oriented along the long axis of the femoral neck on a coronal image. Note the difficulty in separating labrum and capsule in this nondistended joint. On this T1-weighted image the labrum has diffuse intermediate signal.

Normal imaging anatomy

An understanding of the MR appearance of the normal labrum has been derived from imaging of asymptomatic individuals, assuming that the asymptomatic labrum represents the spectrum of normal. These labra also have been studied without the benefit of joint distention. Unfortunately, it is difficult to know whether these morphologic variations are real or created by the apposition of capsule and the labrum. Significant variations in labral morphology and intrasubstance signal contribute to difficulty in differentiating normal from abnormal labra without the benefit of joint distention.

In studies of asymptomatic individuals, the labrum was triangular in cross-section in 66% to 94% [3,39,40]. Rounded, blunted, and irregular margins have been described. The incidence of triangular labra decreases with increasing age, whereas the incidence of rounded and irregular margins increases with age [39,40]. Absent labra have been noted in 10% to 14% of individuals

[3,39]. A consistent constellation of findings has been associated with the absent labrum [3]. This group of findings includes an absent anterior labrum with a blunted remnant along the anterosuperior and superior portion of the joint. Although those who described this constellation of findings on imaging examination suggested that it represented an anatomic variant of the normal labrum, additional MR arthrographic and arthroscopic studies have not confirmed this impression [1,41].

The labrum is typically of diffuse low signal intensity on all imaging sequences, although in asymptomatic individuals this pattern was only seen in 44%, and the incidence decreased with increasing age [39]. Focal intermediate to slightly high signal intensity may be seen at the labral base [2,3,41]. A wide spectrum of intermediate intrasubstance signal has been reported in asymptomatic labra, and the incidence of intrasubstance signal increases with increasing age [39,40]. Intrasubstance signal is more common in men than women [39]. This intermediate signal is most commonly located within the superior and anterior labrum but may be identified at any point within the joint [3,40].

Globular, linear, or curvilinear intermediate or high signal intensity is seen in 58% of labrum on T1-weighted and proton density–weighted images [3]. This signal may involve the articular surface, making distinction between these labra and labra with tears difficult. Intralabral intermediate signal has been described in 37% of labra on T2-weighted images. Bright signal on T2-weighted images has been reported in 15% (7/47) of labra [3]. The cause of this intrasubstance signal is not clear. Studies have demonstrated poor correlation between histologic changes of degeneration and labral signal [2]. The increasing incidence with age, however, does suggest at least a degenerative component.

The perilabral sulcus

Few pitfalls have been recognized in the interpretation of MR arthrography of the hip. The one that continues to plague persons who perform this test is a question about the presence of a normal sulcus at the anterosuperior aspect of the joint (Fig. 4). To date, no conclusive data are available about whether such a sulcus may exist normally. A review of the existing information will help the reader to draw his or her own conclusion.

Fig. 4. MR appearance of probable normal labrocartilaginous cleft. On this coronal fat-saturated T1-weighted image with intra-articular gadolinium, contrast material is present between the articular cartilage and the labrum (*arrow*). As opposed to the detachments seen in other figures, this contrast does not extend into the interface between the labrum and the bone.

A discussion of the terminology for all of the sulci of the hip should be the first step in this discussion. First are the perilabral sulci, which are located at the labrocapsular junction on the capsular surface of the labrum. They are normal, although loss of the sulcus can be an indicator of labral disease [34]. To avoid confusion, spaces should be referred to as the perilabral recesses. Next is the sulcus created by the junction of the transverse ligament and the labrum, also a normal finding. This sulcus should be known as the labroligamentous sulcus. Another sulcus is located at the posteroinferior aspect of the joint, and it recently has been described as a normal variant [42]. This sulcus is actually a labrocartilaginous cleft. It was found in 22.6% of the 23 hips examined. The last and most confusing of the sulci is the sublabral sulcus at the anterosuperior margin of the joint. This perilabral sulcus is also actually a labrocartilaginous cleft. Whether this finding is a normal variant or always pathologic is a subject of great debate.

Cadaveric studies of fetal specimens have demonstrated a cleft that was seen only in the anterosuperior portion of the joint [5,6]. This cleft was identified in 4/74 (5%) of specimens [6]. In another study of 25 cadavers (age range 23–77 years), Peterson and associates [5] described a physiologic cleft at the junction of the articular cartilage. The cleft was partial in 6 (24%) and complete in 13 cadavers. Cotten and colleagues [3] identified a possible sublabral sulcus in 3 young volunteers in their study of 46 (6.5%) asymptomatic individuals. At surgery, a cleft between the cartilage and the acetabular labrum is commonly identified (Robert Sterling, MD, personal communication, 2005).

Histologic studies have concluded that the articular cartilage and the labrum blend together seamlessly, which suggests that a separation between the articular cartilage and labrum would be abnormal [1,2,4]. Hodler and associates [2] examined 12 cadaver hips from elderly individuals to make their observations. The conclusions of Seldes and colleagues [1] and Tan and colleagues [4] are drawn from studies of 67 cadaveric specimens with an average age of 78 years.

Seldes and Tan, however, report tears at the anterosuperior margin in 74% of hips, and 89% of these tears were detachments [1,4]. In their study, few normal anterosuperior labral margins were examined. The average age of their specimens was 78 years. Is it possible that this abnormality is similar to the Type I superior labral anterior to posterior tear (SLAP) in the shoulder? The finding is of significance is the younger population but not the older population.

In their study of six cadaveric hips (age range 72–84 years), Czerny and colleagues [41] did not identify any sublabral sulci. Dinauer and colleagues [42] and Petersilge and colleagues [36] in their studies of 23 and 24 hips, respectively, were unable to confirm the presence of a sulcus (labrocartilaginous cleft) at the anterosuperior portion of joint.

In an arthroscopic study of 56 hips, Fitzgerald [27] found 41 tears with separation of the articular cartilage and labrum. Most tears were in the anterior aspect of the hip. Based on visual inspection, they reported that evidence of attempted healing of the defect was usually seen but a residual sulcus could be identified. The sulcus measured 2 to 5 mm in width and 8 to 20 mm in length, which would suggest that the sulcus is abnormal.

This author currently believes that a normal cleft is located between the margin of the articular cartilage and the labrum. The literature suggests that this normal variant has an incidence of 5% to 6%, thus any conclusive evidence would require examination of at least 20 hips to identify one cleft. In this author's experience, the cleft is seen in the anterosuperior aspect of the joint without extension anteriorly or superiorly in a joint that is otherwise normal. The margins of the cartilage edge and the border of the labrum are sharp. In contrast, any extension of contrast into the acetabular (osseous) labrum junction should be considered abnormal. Any irregularity of the margins of the cartilage edge or the adjacent labrum would indicate that the separation between labrum and cartilage is abnormal.

Labral pathology

A combination of imaging and clinical and laboratory studies has contributed to our overall understanding of labral pathology. Evaluation of the labrum includes an assessment of morphology, distribution of contrast material, and assessment of the perilabral recess [34]. Pathologic changes are most commonly located in the anterosuperior aspect of the hip joint [1,4,10,21,27,34,36,41]. Extension of the abnormalities into other portions of the joint may be seen in 32% of cases (Fig. 5) [1,4,10]. Tears at multiple separate sites are less common and occur in only 6.9% of joints [10]. These multiple tears usually involve the anterior and posterior portions of the joint. The posterior lesion is believed to be a secondary lesion created by instability that results from the anterior lesion [10]. Isolated posterior lesions were most commonly associated with direct trauma to the hip [9,10]. Tears isolated to the posterosuperior aspect of the joint were more common than anterosuperior abnormalities in the Japanese literature on adolescent patient tears [20,43].

Traditionally in the imaging literature the terms "tear" and "detachment" when applied to structures such as the labrum have distinctly different definitions. Detachments are recognized by the interposition of contrast material at the acetabular-labral interface, whereas tears are identified by the presence of contrast material within the substance of the labrum (Figs. 6 and 7) [34,36]. Within the clinical literature, however, the terms tear and detachment are intermingled. Detachments are often reported as one form of tear. In most series, detachments are seen much more commonly than intrasubstance tears, with up to 90% of tears being detachments [1,27,41,44]. These differences in terminology should be noted whenever reviewing this literature.

At arthroscopic and cadaveric inspection, the description of labral pathology varies. Seldes and

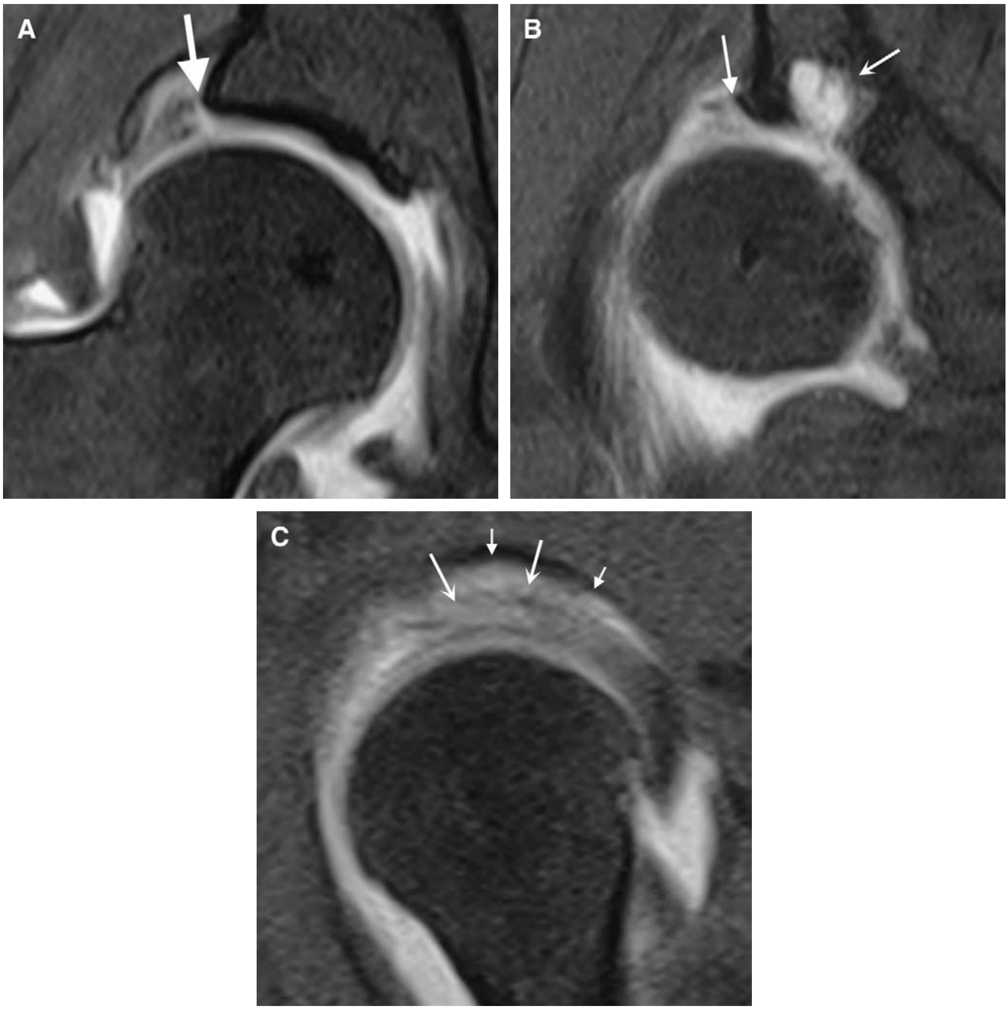

Fig. 5. Fat-suppressed T1-weighted images with intra-articular gadolinium from a patient with developmental dysplasia of the hip. Coronal images from posterior to anterior (*A* and *B*) reveal a labral detachment (*arrows with straight heads*). The labrum is likely degenerative with irregular margins and diffuse intermediate signal. A large subchondral cyst is present (*B*, *arrow with curved head*). Note the disruption of the articular cartilage and subchondral bone at the base of the cyst. On the sagittal image (*C*) the labral detachment is visible (*short arrows*). An intrasubstance tear (*long arrows*) is also seen with significant distortion of the anterior aspect of the labral (on the left). The tear and detachment involve the anterior and superior labrum.

associates [1] reviewed 77 cadaveric hips and described two types of labral tears. Type I tears (detachments) occur between the articular cartilage and the labrum, and type II tears occur within the substance of the labrum [1]. The same definition is used by Leunig and associates [44]. Tears and detachments occur along the articular surface of the labrum [1,10]. Tears occur along the course of the circumferentially oriented fibers of the labrum, which explains the appearance of longitudinal or bucket handle–type tears (Fig. 8).

Lage and associates [21] classified labral tears into four types. Radial flap and radial fibrillated tears occur within the substance of the labrum. Longitudinal peripheral tears occur at the labral base and likely represent what other authors refer to as detachments. Longitudinal peripheral tears (detachments) were not the most common type of tear identified in this study; they accounted for only 16.2% of tears. The last type of tear is the unstable tear, which is identified by subluxing labral fragments.

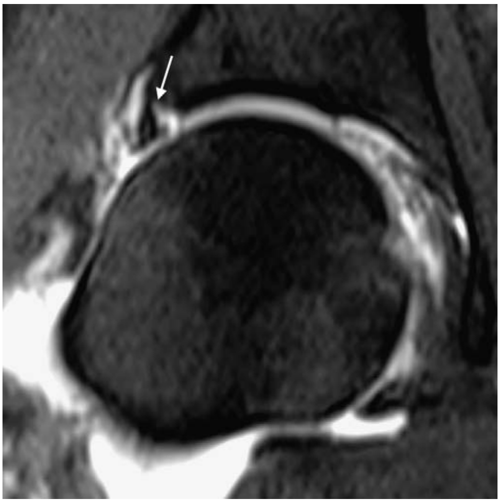

Fig. 6. Coronal fat-saturated T1-weighted image with intra-articular gadolinium demonstrates an extensive partial detachment of the superior labrum. The arrow identifies the point at which the labrum remains attached to the rim.

Based on his study of 436 patients with an average age of 37.4 years, McCarthy and colleagues [10] also described two types of labral pathology, although the types differ from those of Seldes. They described fraying at the labral-cartilage junction and tearing of the labrum with separation from the articular cartilage (chondrolabral separation) [10]. They referred to this chondrolabral separation as the watershed lesion. Fraying occurs at all regions within the hip, whereas 86% of chondrolabral separations are present in the anterior aspect of the joint. Fraying and chondrolabral separation did not occur adjacent to each other. Posterior and lateral fraying was associated with anterior tears, however, which suggested that they may be secondary lesions related to abnormal joint motion caused by the anterior tear.

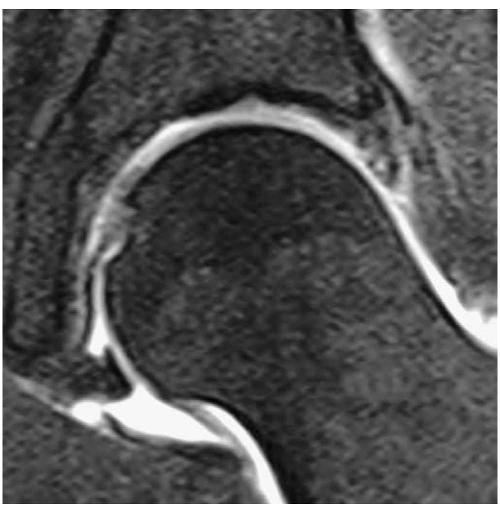

Fig. 7. On this coronal fat-saturated T1-weighted image with intra-articular gadolinium, the superior labrum has diffuse heterogeneous intermediate signal within. A tear is confirmed along the articular surface with the intrasubstance collection of contrast material.

Cartilaginous lesions are frequently associated with labral pathology. Complete assessment of an MR arthrogram includes detailed evaluation of the articular cartilage. Only moderate sensitivity for detection of cartilage lesions has been reported, however [45,46]. This lower sensitivity is partly caused by the thin articular cartilage of the hip. Cartilage flaps are particularly difficult to identify because they often lay within their bed against the subchondral bone. Cartilaginous abnormalities predominate on the acetabular articular surface, especially anterosuperiorly, with few lesions on the femoral head [24,46]. As the severity of labral pathology progresses, the incidence of cartilage lesions increases [1]. The most severe cartilaginous abnormalities are seen when the labrum is completely detached from the margin of the acetabulum [1].

In McCarthy and colleagues' [10] study of 436 patients, 62.6% had cartilaginous lesions. Most lesions were located in the anterior aspect of the joint, and the most severe lesions were seen anteriorly. A statistically significant relationship was identified between the severity of cartilage lesions and the presence of labral lesions. Chondral flaps were most common (present in 62% of hips), whereas localized full-thickness wear was seen in 38% and global degenerative disease with foci of full-thickness loss was seen in 6%. A strong association was seen between labral lesions and cartilaginous lesions, with 73% of labral lesions accompanied by a cartilaginous lesion. Only 6% of cartilaginous lesions did not have associated labral lesions. The strongest association was identified between labral disease (tears and fraying) and the presence of serious articular degeneration. Similar findings also were identified in a study of patients with mild developmental dysplasia of the hip [47]. Labral tears, labral fraying, and cartilage lesions all increase in prevalence with increasing age.

Fig. 8. Sagittal fat-saturated T1-weighted images with intra-articular gadolinium from medial to lateral demonstrate a labral detachment that extends from anterior (*A*, *arrow*) to superior (*B, arrows*) in the configuration of a longitudinal peripheral tear along the circumferentially oriented fibers of the labrum.

Distinct pathologic changes occur in the labrum and acetabular rim in association with developmental dysplasia of the hip, and the term ‘‘acetabular rim syndrome’’ has been used by Klaue and associates [48] to describe these changes (Fig. 9). These investigators recognize two types of anatomic abnormalities with different pathologic changes within the rim. In type I changes, the acetabulum is shallow and vertical, and the femoral head and acetabulum are incongruent. In this situation the labrum is subject to chronic shear stress because of the increased weight-bearing role. This stress leads to labral hypertrophy and subsequent separation from the

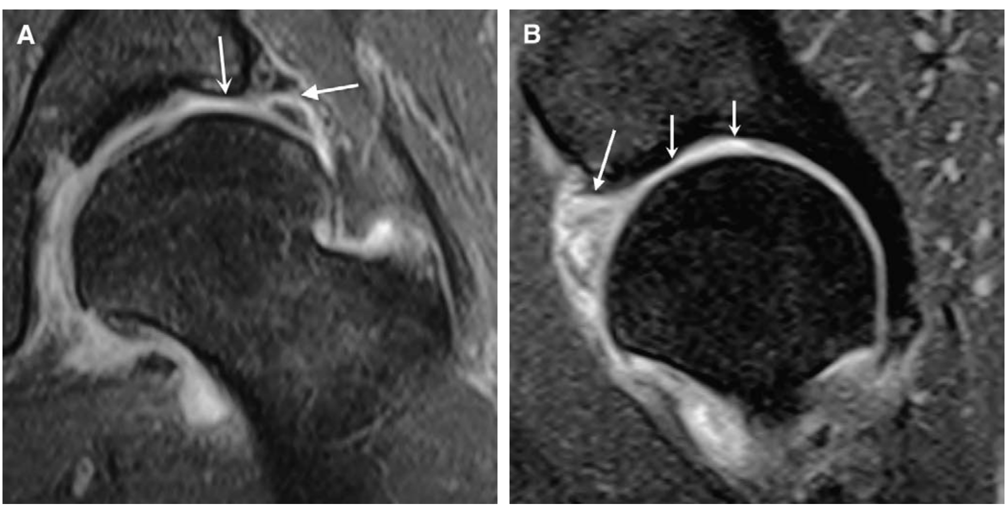

Fig. 9. Coronal and sagittal fat-saturated T1-weighted images with intra-articular gadolinium in a patient with developmental dysplasia. A detachment is present at the base (*A* and *B*, *arrows with straight heads*). A large cartilage defect is present in the acetabular rim adjacent to the labral abnormality (*A* and *B*, *arrows with curved heads*). On the sagittal image, note the hypertrophy of the anterior labrum with a large intrasubstance collection of contrast consistent with tear.

acetabular margin. These findings also have been identified by other investigators [10,49–51]. Soft tissue para-acetabular cysts may form. Identification of periarticular cysts should suggest the possibility of underlying labral tear or detachment [18,52]. Although these cysts are more commonly seen in patients with developmental dysplasia, they are not unique to that patient population [36,42,48,51,53].

With type II changes, the acetabulum and femoral head are congruent and the acetabular roof is short. The acetabular rim is stressed and eventually may fail with a fatigue fracture and os acetabuli formation. Intraosseous cysts may form. McCarthy and Lee [47] hypothesized that with disruption of the chondrolabral interface, joint fluid is driven into the subchondral bone. This fluid leads to undermining of the articular cartilage and creates cartilage flaps, continued subchondral injury, and subchondral cyst formation.

The labrum plays a critical role in producing hip pain and is a key structure in the development of osteoarthritis. Our knowledge of this structure continues to grow, including the spectrum of the normal and the appearance of pathologic changes.

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