MR and CT Arthrography of the Hip

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Abstract

CT arthrography (CTa) and MR arthrography (MRa) are useful tools for the investigation of intra-articular hip disease. They are minimally invasive techniques with a very low rate of complications and can be performed safely. CTa or MRa can be performed after an intra-articular injection of diluted contrast, but both techniques can also be performed after a single injection. As radiologists we should be able to address the surgeon's questions and work together to standardize terminology and classifications systems for accurate reporting. This update emphasizes radiological findings with a clinical perspective. CTa and MRa allow the precise diagnosis of labral tears, loose bodies, and intra-articular ligaments (capsular and ligamentum teres). The use of careful technique and a tailored protocol has improved our ability to detect and describe cartilage lesions. This is essential because knowledge of the status of the cartilage may dictate a specific surgical approach, and when cartilage lesions are extensive, they are a negative prognostic indicator for arthroscopic treatment.

Keywords
- hip arthrography
- CT arthrography
- MR arthrography
- labral tear
- cartilage
- femoroacetabular impingement

The hip joint is deeply located and surrounded by a thick capsule and large muscles; its cartilage is thin with the cartilage surfaces of the femoral head and acetabulum closely opposed. These anatomical factors have limited its access for high-resolution images and arthroscopy. In the past 10 years, improvements in arthroscopy together with many advances of imaging have changed the diagnosis and treatment algorithms and approaches to intra-articular hip lesions. Indications of arthroscopy are still expanding. However, although MR arthrography (MRa) with or without traction, 3T, new coil, or CT arthrography (CTa) have been proposed as good techniques for intra-articular evaluation, for true imaging the method of choice is still under some debate. Their accuracy for detecting intra-articular lesions and labral pathology is variable, but the detection and characterization of cartilage lesions remains challenging. Intraobserver variability has been related to the degree of training. There is a lack of uniformity in describing lesion location and characterization, and there are many different classification systems without consensus.[1–3] Significant controversy regards the relevance of hip impaction syndromes with the early development of hip osteoarthritis and therefore the need to treat such syndromes.

Arthrography Technique

Arthrography can be performed using anatomical landmarks, ultrasound (US), CT, or, most commonly, fluoroscopic guidance. The advantage of fluoroscopic guidance is that if the tip of the needle is not correctly located, it can be easily adjusted; the volume of injected contrast can also be controlled. We mark femoral vessels with US to avoid accidental puncture during the procedure. The patient is placed on the table in the supine position with the leg in neutral or slightly internal rotation to increase visualization of the femoral neck. The procedure is done under the usual strict sterile conditions.

The dilution is different depending on whether CTa, MRa, or combined CT-MR arthrography will subsequently be performed. The dilution of saline, gadolinium, iodine contrast, and local anesthetic has been reported safe worldwide, although the Food and Drug Administration has not yet approved gadopentetate dimeglumine (Gd-DPTA) for intra-articular use.[4] The dilution of Gd-DPTA with iodinated contrast material is safe because there is no release of free gadolinium and therefore no increase in its systemic or joint toxicity effect.[5] A decrease of signal intensity on T1-weighted images is seen after a mixture of iodine contrast media and

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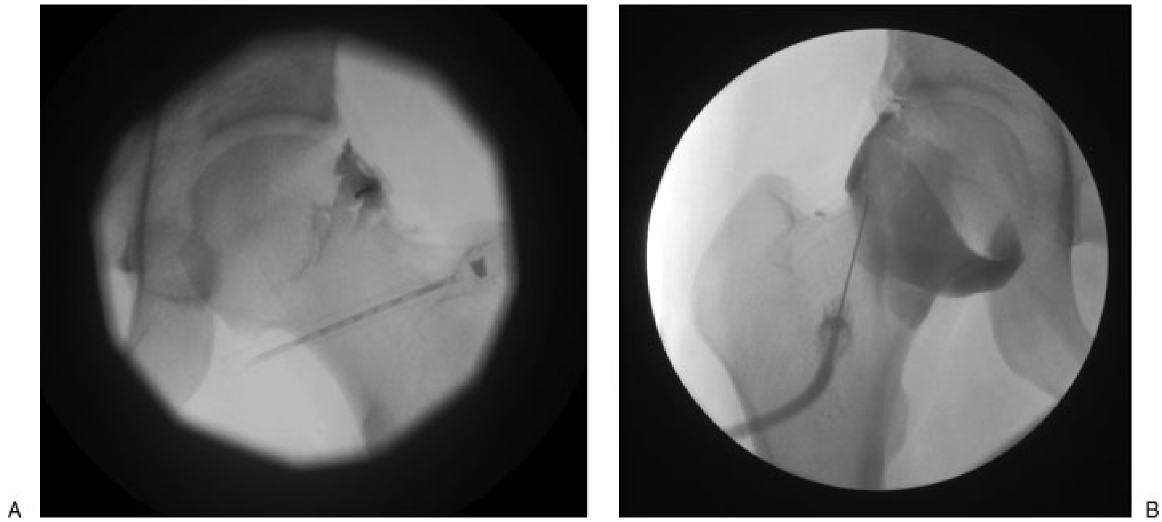


Figure 1 Arthrography technique. (A) Vertical approach to the superolateral quadrant of the femoral head. (B) Oblique approach to the femoral neck.

Gd-DPTA when the concentration of iodine is >25%; this should be kept in mind if combined CT-MR arthrography is performed. However, in our experience, 30 to 40% of iodine in the dilution allows high-quality images on T1 as well as high-quality CT images, and, as such, this is the concentration we use to perform combined CTa and MRa. When MR is performed after intra-articular injection, the Gd-DPTA concentration should remain between 0.5 and 2 mmol/L. Local anesthetic injection can decrease pain related to the patient's disease and increase the tolerance for joint injection. We use lidocaine as the local anesthetic. Although not used in our practice, if a delay between injection and MR is anticipated, epinephrine can be added to the mixture.[6,7]

For combined CTa-MRa, the dilution is 1 mL of Gd-DTPA mixed in 100 mL of saline; 8 mL of this mixture is then diluted with 7 mL of iodine solution (340 mg/cc) and 3 mL of lidocaine 2%. CTa dilution is made combining 10 mL of iodine and 5 mL of lidocaine. The volume injected varies from 10 to 20 mL, with a mean of 15 mL. The injection is stopped when the patient reports pain and feels resistance. However, one should keep in mind that hip arthrography is performed resistance, unlike shoulder, ankle, or wrist arthrography. The hip joint needs pressure to be distended.

We use a 22-gauge (G) 9-cm needle unless there is significant hip osteoarthritis in which case we use a 20G needle. In rare instances and with exceptionally large patients, we may have to use 15-cm-long needle.

The two common target points for injection are the femoral neck and the superior femoral head-neck junction (►**Fig. 1**). We recommend avoiding puncture in the orbicular zone because of the need for increased pressure due to the thickness of its fibers. Duc et al found that neck injection technique produced less discomfort but was associated with greater extra-articular contrast leakage.[8] We found in our experience that using a slightly oblique compared with a perpendicular approach decreases contrast leakage; the orientation of the tip of the needle medially toward the joint helps the contrast flow. For hip arthrography, local anesthetic is injected at and under the skin entry site. The position of the needle is confirmed by injecting 1 to 2 mL of iodinated contrast that should flow smoothly inside the joint. If smooth flow is not observed and only a small focal dot is shown or contrast leaks directly into the iliopsoas bursa or muscles, the tip of the needle should be repositioned (►**Fig. 2**). We should not forget that communication with the iliopsoas bursa is a normal variant seen in up to 15% of the patients and may not be related to faulty injection technique (►**Fig. 3**).

Complications of hip arthrography are rare and similar to other joint injections, mainly vasovagal reaction and, very rarely, infection. Infection is infrequent and no antibiotic prophylaxis is needed, but the patient should be told that if fever, redness, or local heat appears he or she should return for evaluation. Pain after a hip arthrogram is frequent, and patients should be warned that it is most pronounced 4 hours after the injection and decreases progressively during the next 24 hours. Pain is likely related to postarthrogram chemical irritation caused by contrast media, appears to depend on the patient's age (more common in younger patients), and is not necessarily related to the volume of contrast injected.[7,9]

CT and MR Techniques

Ideally CT should be performed immediately after the injection and MR should be performed within 90 minutes after the initial injection. There have been reports of using higher intra-articular Gd-DPTA doses and performing delayed images. If technical problem occurs and imaging is delayed, T2 fat saturation sequences can be used.[10]

CTa should be performed using a multidetector CT (MDCT) scanner, preferably 32, 64, or more detectors to decrease radiation dose and increase resolution. Our protocol is based on 64 MDCT; parameters are 120 kVp, 200 mAs, and thickness 1 mm. Reconstructions with low and high kernel are

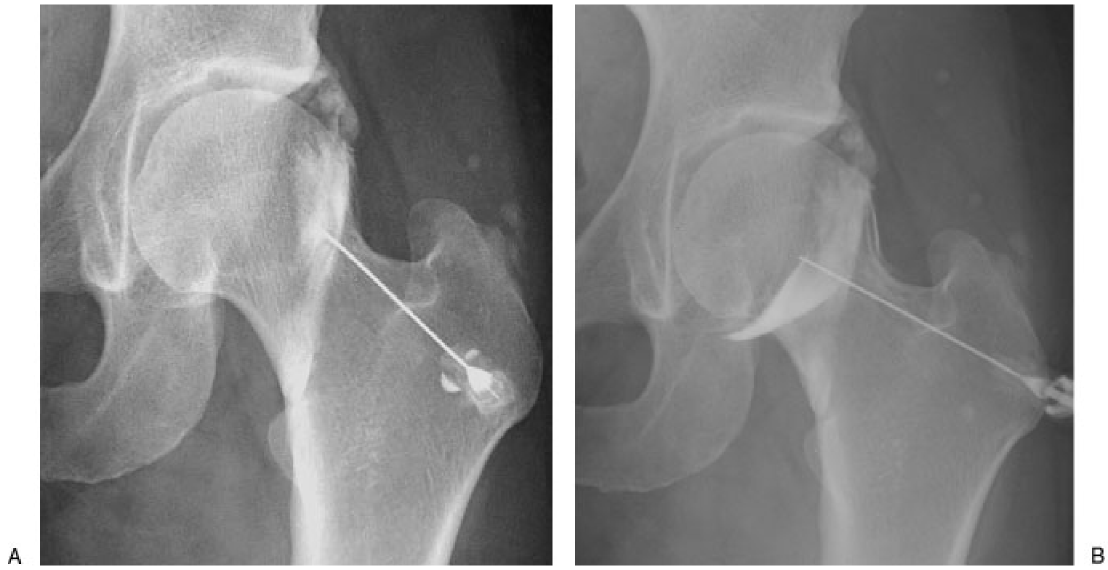


Figure 2 Arthrography. (A) Technical error with intramuscular contrast leakage. (B) Needle tip was changed and the intra-articular position was confirmed.

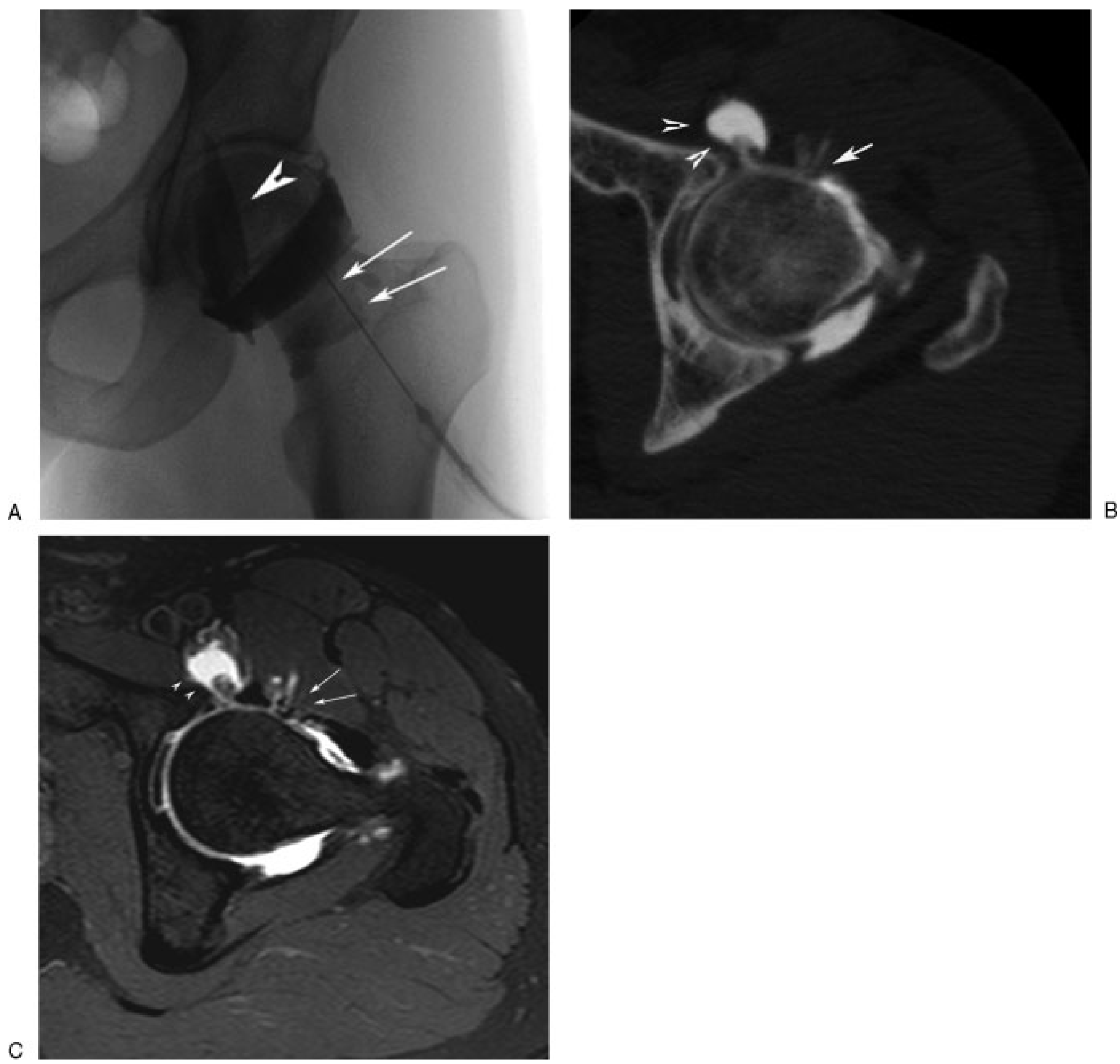


Figure 3 Normal communication with iliopsoas muscle bursa. (A) Arthrography contrast injection is performed in the femoral neck (arrows), and contrast communication is seen with the iliopsoas bursa (arrowhead). (B) CTa and (C) MRa demonstrate the puncture site (arrows) and the extension into the iliopsoas bursa (arrowheads).

important to allow bone and soft tissue reconstructions. Multiplanar reformats in coronal, oblique axial (following femoral neck axis), and sagittal images allow assessment of cartilage, labrum, and bones. In addition, volume rendering can aid in assessing the bones.[11]

MRa should be performed on a high field magnet, using coronal, sagittal, axial, and oblique sagittal planes, and combining T1, fat-suppressed T1, and at least one fluid-sensitive sequence. Our fat-saturated T1-weighted MR sequence protocol is TR/TE 450/15; matrix size, 256×512; section thickness, 3 mm; interslice gap, 0.3 mm; number of signals per data line acquired, 3; field of view, 16 cm^2. New volumetric fast spin-echo techniques are promising and should allow multiplanar reconstructions without losing quality.

The hip is a ball-and-socket joint. This morphology together with the sealant effect of the labrum explains why contrast has difficulty reaching the central compartment, thus making it hard to distinguish the cartilage surfaces of the femoral head and acetabulum as distinct structures. Therefore we strongly recommend manual traction to allow the fluid to enter into the central compartment for CTa followed by 6 to 9 kg continuous traction (depending on the patient) for MRa because of the length of the procedure. A small amount of contrast is enough to delineate cartilage surfaces.[3,12]

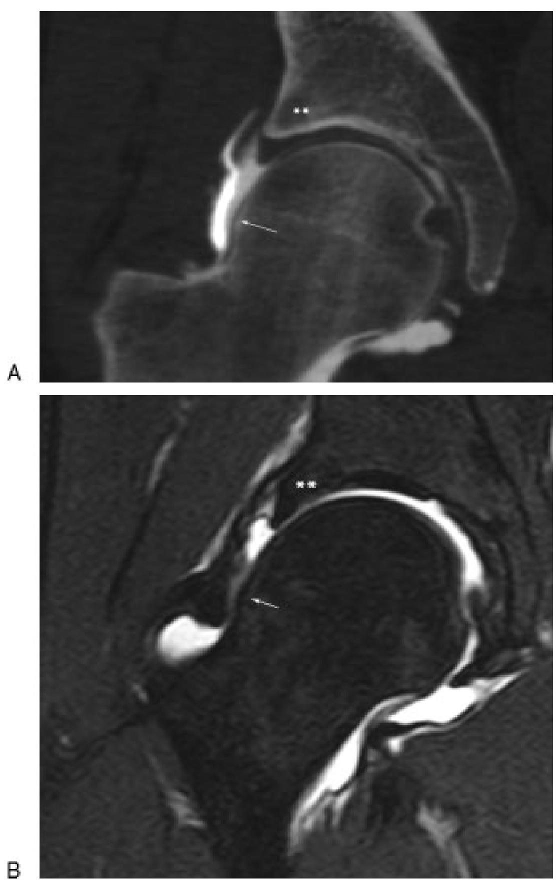


Figure 4 Femoroacetabular impingement–type cam. (A) Small neck bump (arrow) and normal acetabulum (stars) demonstrated on CTa multiplanar reconstruction (MPR) and (B) coronal T1 fat saturation MRa in this 20-year-old man.

Performing CT and MR after a single intra-articular injection increases the length, radiation dose, and cost of the procedure, and there is no long-term evidence that it improves diagnostic capability and patient outcome; However, if logistically possible we recommend it because these techniques are complementary for the evaluation of some structures and offer additional value. CT is better for the evaluation of bone deformities including calcification of the acetabulum. MR is better for soft tissue structures such as ligaments and labrum (especially intrasubstance changes). Cartilage imaging is still the cornerstone for intra-articular imaging. CTa is in general slightly better than MRa for morphological abnormalities, but having both techniques increases our confidence in cartilage evaluation. If there are technical problems such as movement artifacts on MR, CTa acts as a backup.

Femoroacetabular Impingement

In the past 10 years, controversy has arisen about the association of femoroacetabular impingement (FAI) with early osteoarthritis and whether FAI truly represents a pathological condition or is a borderline normal anatomical feature. FAI is defined as an abnormal contact between the femoral head and the acetabulum that limits normal range of motion. Although two types were defined (pincer when focal or general acetabular overcoverage occurs and cam when there is an abnormal contact between the femoral head-neck junction and the anterior acetabulum), most patients have mixed types (►**Figs. 4**, **5**, and **6**).[13,14] The cam type has been reported as a complication after femoral neck malunion, slipped capital femoral epiphysis, and Perthes disease, but it is also secondary to repetitive impact in some sports. Pincer impingement is related to anterosuperior overcoverage, coxa profunda, protrusio acetabuli, and acetabular retroversion.

Kassarjian et al described three classic MR findings in cam-type FAI including anterosuperior cartilage abnormalities, anterosuperior labral abnormalities, and abnormal head-neck morphology, measured with α angle and abnormal over 55 degrees (►**Fig. 7**).[15] The measurement of the femoral epiphyseal overgrowth with α angle on both cross-table plain film view or MR has a wide intra- and interobserver variability, and although other measurements have been also proposed such as anterior femoral distance (>3.6 mm is considered normal), none have yet been proven to be a reliable sign, and the most valuable sign is still the positive clinical impingement test.[16] Intra-articular injection of anesthetics has also been used as a clinical test for intra-articular origin of pain. Some authors have even questioned if the femoral head-neck overgrowth represents pathology versus a normal variant.

Proper patient selection is the first step for successful arthroscopy. When clinical and radiological impingement is demonstrated without significant osteoarthrosis or instability, surgery is recommended. The surgical goal is first to remove the cause of impingement, trimming the acetabular rim and/or osteochondroplasty of the femoral-neck bump, and second to treat any associated labral or chondral

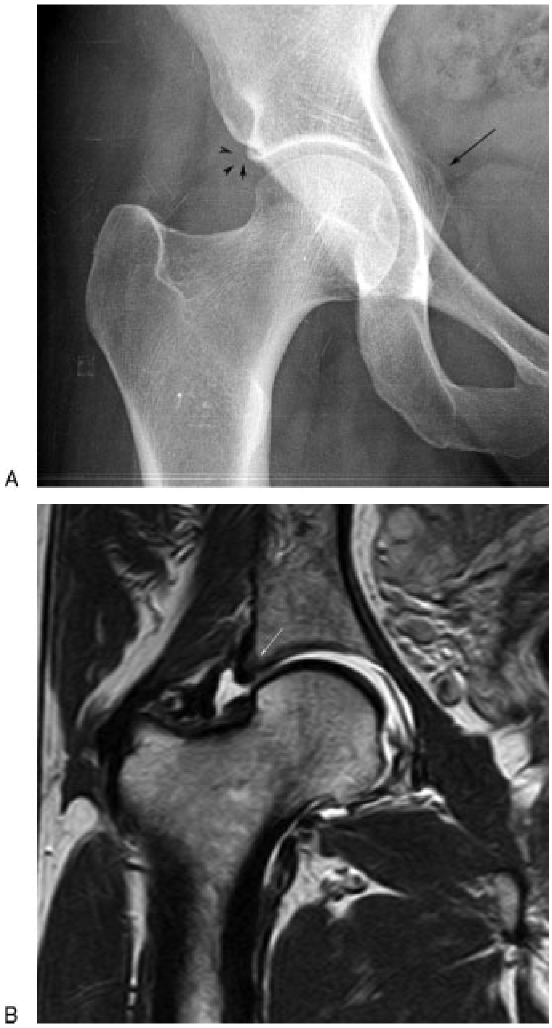


Figure 5 Femoroacetabular impingement–type pincer. (A) Plain film shows acetabular retroversion with a crossover sign (arrowheads) and ischial spine prominence (long arrow). (B) MR shows acetabular overcoverage and labral degenerative changes (white arrow).

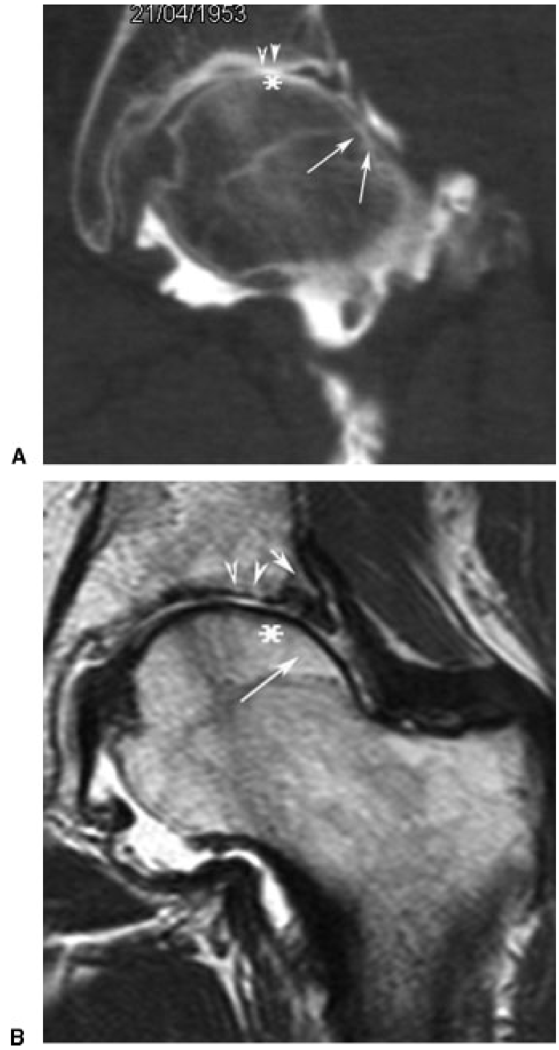


Figure 6 Mixed femoroacetabular impingement. (A) Coronal multiplanar reconstruction CTa and (B) proton-density-weighted MRa show femoral head-neck junction bump and acetabular component (arrows) with full-thickness chondral lesion on the acetabulum (arrowheads) and femoral chondral lesion (star).

lesions.[14] The method for addressing these pathological lesions depends on location and size of the impingement lesion, the underlying pathology, and the degree of labral damage. Incomplete reshaping of the FAI deformity is the most frequent indication for hip arthroscopic revision.[17]

Osteochondroplasty should try to recreate the anatomical sphericity of the femoral head, and precaution must be taken to avoid injury to the lateral retinacular vessels that perforate through the lateral femoral neck at its capsular insertion. Management of pincer lesions includes detaching the labrum attachment, bony removal of the acetabular rim overgrowth, and reattachment of the viable labrum. A center-edge angle <20 degrees is a contraindication for rim trimming because it may lead to instability.[2]

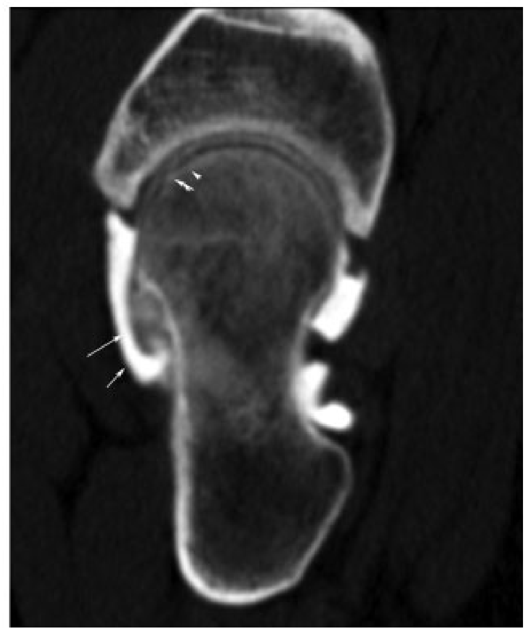
CTa is a useful tool to provide a multiplanar view of the osseous deformity. Standard measurements have not yet been validated for CT (►**Fig. 8**).[18] Some surgeons routinely use MDCT to plan surgery. The advantage of CTa is that together with the bone deformity (femoral and acetabular) we have information regarding the cartilage and labrum. Overresection of the femoral neck is a concern especially with arthroscopic techniques. To avoid femoral neck fractures, resection should be limited to <30% because resection of 30% of resection has been shown to decrease the amount of energy necessary to produce a fracture by 20%.[17] The acetabular morphology is much better depicted with CT than MR.

Labrum

The labrum is a fibrocartilaginous triangular-shaped incomplete ring that surrounds the bony acetabulum and blends inferiorly with the transverse ligament. The labrum increases the depth of the acetabulum, thereby assisting hip stability and distributing hip load. It also seals the hip joint, helping to maintain synovial fluid within the central compartment and becoming a mechanical stabilizer.[2,3] The labrum is thinner anteriorly and thicker posteriorly. Although the labrum is most frequently triangular, its shape changes with aging and

Figure 7 The α angle is the angle between the femoral neck axis and a line connecting the center of the femoral head with the point of beginning asphericity of the head neck contour. An angle >55 degrees is an indicator of an abnormal femoral head neck contour.

A



B

Figure 8 Multidetector CT. (A) Coronal and (B) oblique sagittal reformats give precise images and information about bone deformity (arrows) and about cartilage defects such as this chondral lesion in the femoral head (arrowheads).

may become more rounded (►**Fig. 9**). Although absence of the labrum has been described in up to 16% of the population, in our experience this percentage is much lower. We have found agenesia very infrequently with the occasional association of anterior labral hypoplasia with thickening of the iliofemoral ligament, especially in patients with pincer-type FAI. We think it could be a biomechanical adaptation. Labral tears may contribute to the progression of hip osteoarthritis; they are closely related to cartilage lesions, especially those at the chondrolabral junction. The transition zone with acetabular hyaline cartilage is a difficult area to image and should be carefully analyzed to avoid under- or overdiagnosing labrum tears or cartilage defects because this is a frequent starting point for delaminating cartilage injuries. Fluid in the labral tear might furrow under the cartilage creating a carpet-like lesion or extend along the subchondral bone resulting in a subchondral cyst.[1]

It is important to become familiar with normal labral recesses. The posteroinferior labrum has a frequent groove or recess; however, there is still no consensus on the relevance of a sublabral recess located along the superior labrum.

Labral tears may be traumatic or secondary to entities such as femoroacetabular impingement, hip dysplasia, instability, and degenerative change. Traumatic injuries can be acute or associated with repetitive traumas, especially related to sports that require excessive rotation or kicking such as soccer or martial arts.[19]

The diagnosis of a labral tear is made on CTa and MRa when contrast fluid gets inside the labrum. Fluid-sensitive sequences are needed on MRa to detect intrasubstance labrum changes, especially those that do not extend to the articular surface. Unless calcified, these changes are missed on CTa (►**Fig. 10**). The best imaging planes for detecting labral tears are the coronal and oblique sagittal images planes. Because of the obliquity of the anterosuperior and posterosuperior aspects of the labrum, some tears in these regions are missed on conventional planes. No additional value has been demonstrated with radial sequences. CTa has the option for multiplanar reconstruction without loss of image quality (►**Figs. 11** and **12**).[20,21]

The multicenter Arthroscopic Hip Outcomes Research Network (MAHORN) recently proposed a classification system for labral tears and chondral lesions (acetabular rim and acetabulum except the rim).[1] Labral tears should be

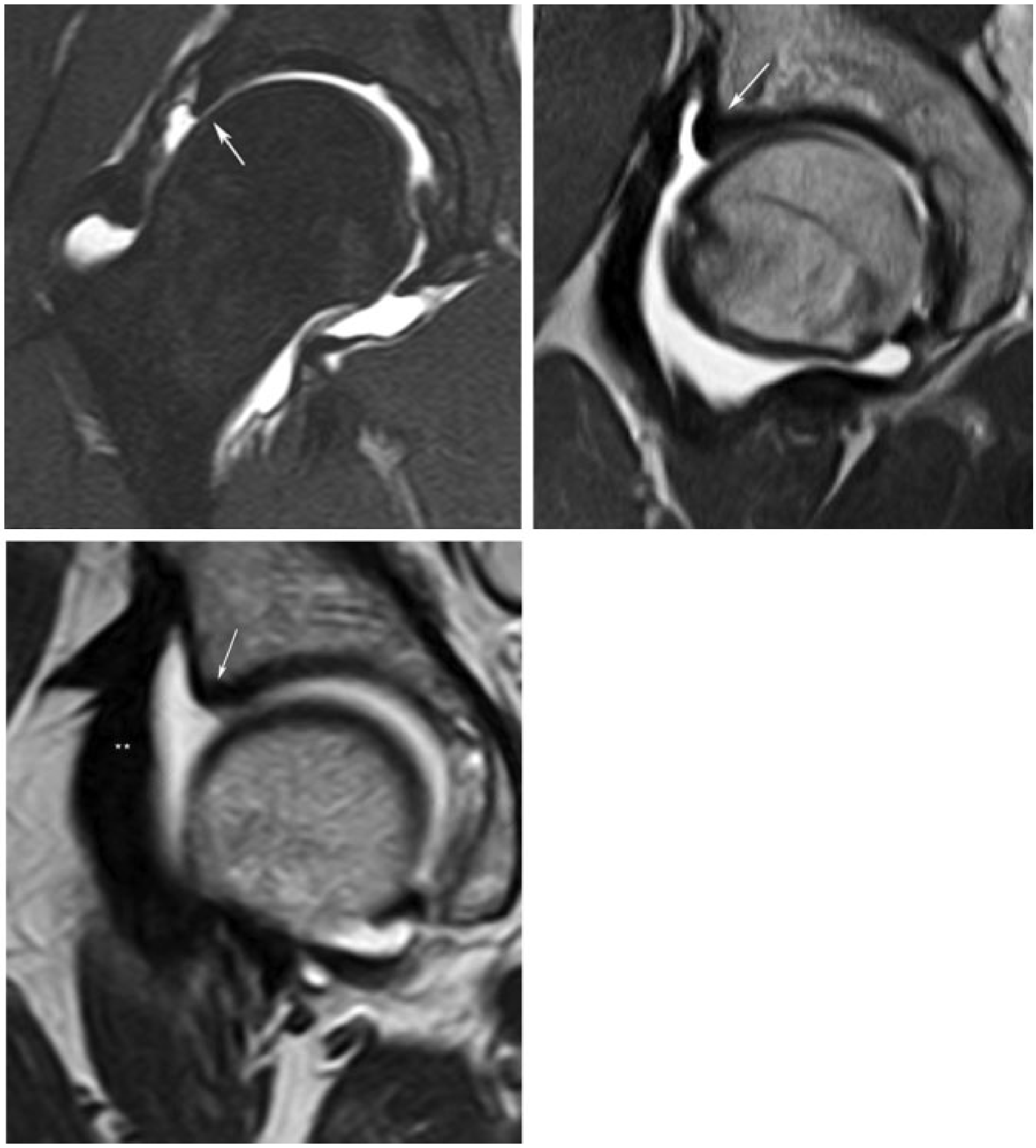


Figure 9 Labrum shape normal variants: coronal proton-density fast spin-echo images showing different labrum morphologies. (A) Triangular shape. (B) Rounded shape. (C) Anterosuperior labrum hypoplasia (arrow) associated with thickening of the iliofemoral ligament (stars).

characterized depending on their location (divided into anterosuperior, posterosuperior, anteroinferior, and posteroinferior) and their morphology. Most labral tears are located in the anterosuperior quadrant, followed by posterosuperior, with the latter more frequent in young athletes than the general population. If the chondrolabral junction is involved, it should be described. Morphologically, tears can be divided into intrasubstance (partial or complete) or radial flap (fibrillation, longitudinal, and unstable). Paralabral cysts are not always filled with intra-articular contrast dilution; therefore, fluid-sensitive sequences are helpful to depict them because they can be occult at CTa (►**Figs. 12** and **13**). Small flaps and torn portions of the labrum are removed and debridement is performed in the case of labral fibrillation. There is an increasing tendency to repair a torn labrum and intrasubstance splits, preserving as much labrum as possible. It is important to describe to surgeons the extension of the tear, quality of the tear borders of the labrum, and if there is displacement or detachment from the acetabulum rim; in cases of displacement, anchor sutures are used to attach the labrum back to the rim, sometimes after debridement of the bony lesions on the acetabular rim.[2,21]

Cartilage

The articular cartilage of the acetabulum has a horseshoe-shaped appearance with an opening at the acetabular notch; usually it is divided into anterosuperior, superolateral, and posterosuperior regions. The MAHORN group separates acetabular lesions into rim and nonrim or peripheral lesions.[1] The

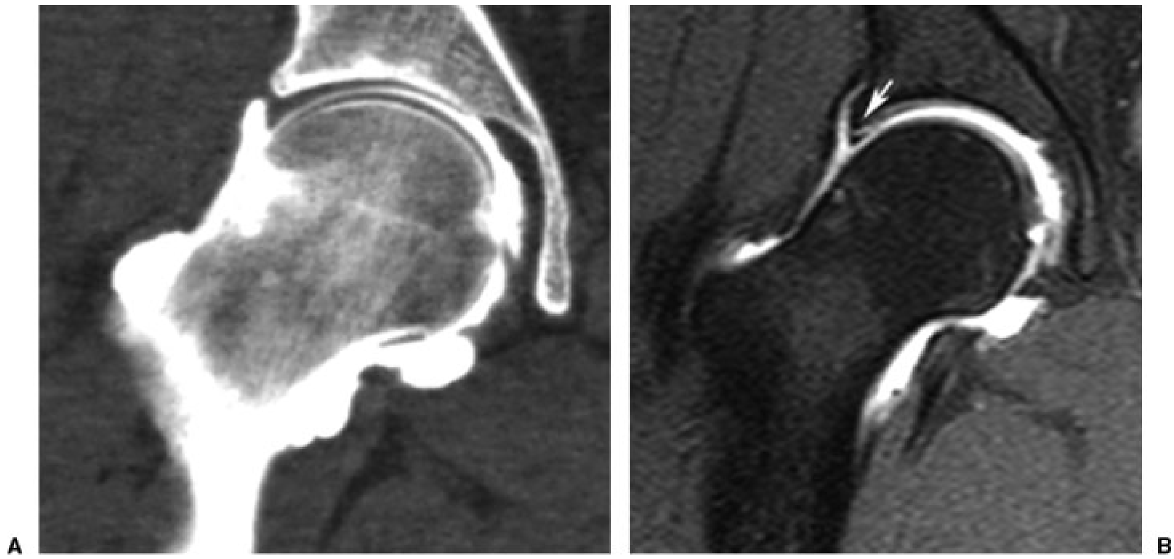


Figure 10 Intrasubstance tear. (A) Small lineal tear not extending to the articular surface is occult at CTa and (B) demonstrated on coronal proton-density-weighted MRa (arrow).

femoral head is covered completely by cartilage except at a central depression where the ligamentum teres inserts into the fovea capitis. The femoral cartilage is split into four parts: anteromedial, anterolateral, posteromedial, and posterolateral.

Treatment and prognosis of many intra-articular hip conditions such as labral tears and FAI depend primarily on whether there is a concomitant cartilage defect. Improvement of the arthroscopic approach to the central compartment has made it possible to treat cartilage lesions with debridement, microfractures, or chondral transplant. Knowledge of the status of the cartilage preoperatively is essential for appropriate surgical decision making and for counseling patients regarding their prognosis and recovery. If chondral delamination is present at the labrum-chondral junction, resection of part of the acetabulum rim may be planned instead of conventional arthroscopy, thereby changing surgical approach, prognosis, and the postoperative regime. Chondral lesions should be debrided to a stable border to minimize the risk of further delamination. Large focal chondral defects may require femoral replacement.[1,2]

There is no consensus on the method of choice for cartilage evaluation, and the orthopedic literature shows little accuracy of imaging techniques in detecting cartilage defects. Most of the studies do not describe the size or location of the cartilage lesions. Arthritic changes on the hip were divided radiographically into Tonnis grade1 subchondral sclerosis,

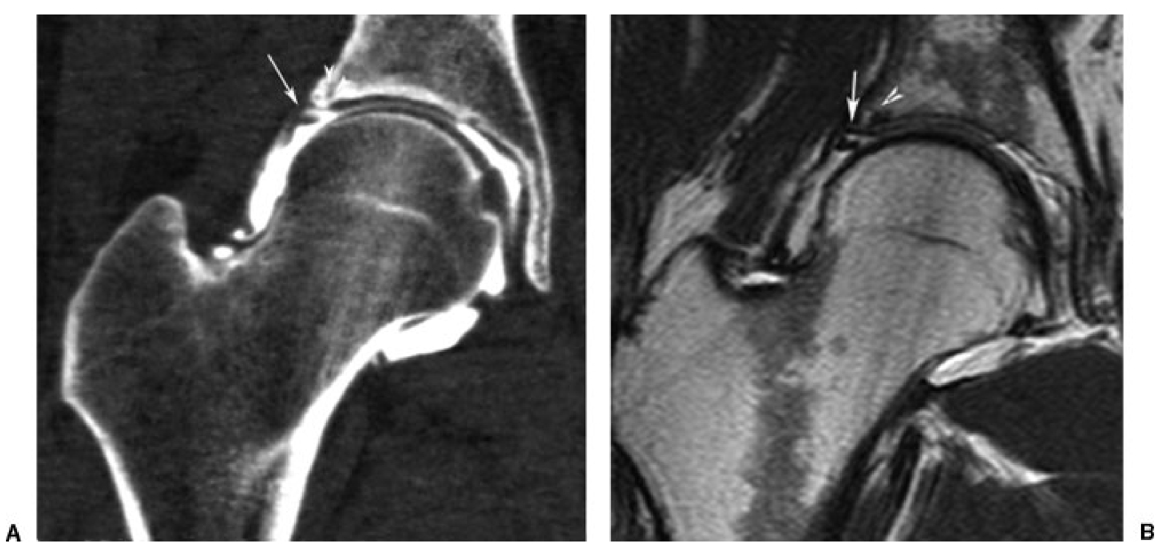
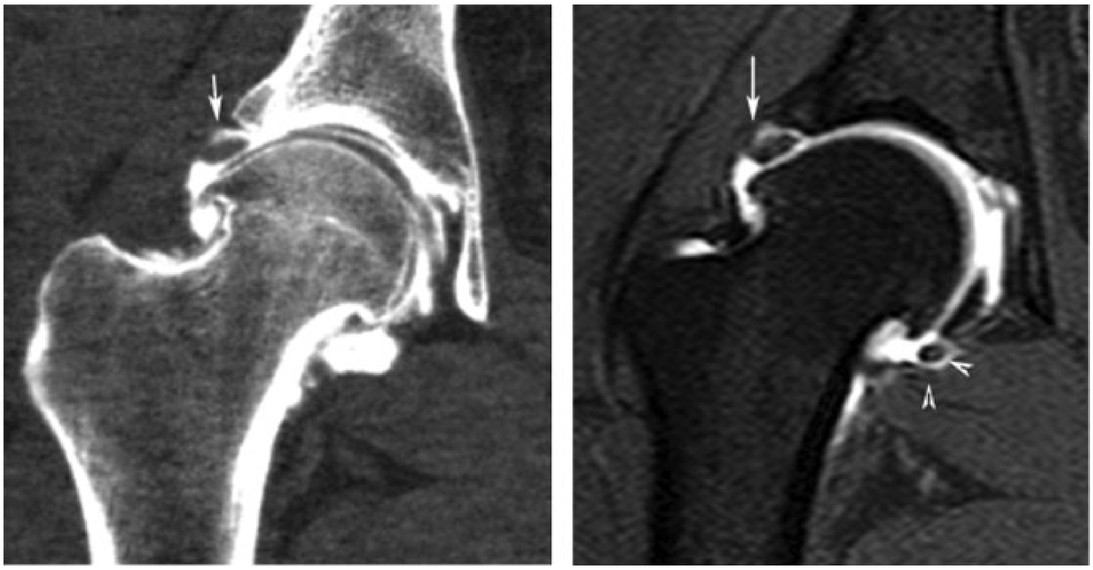
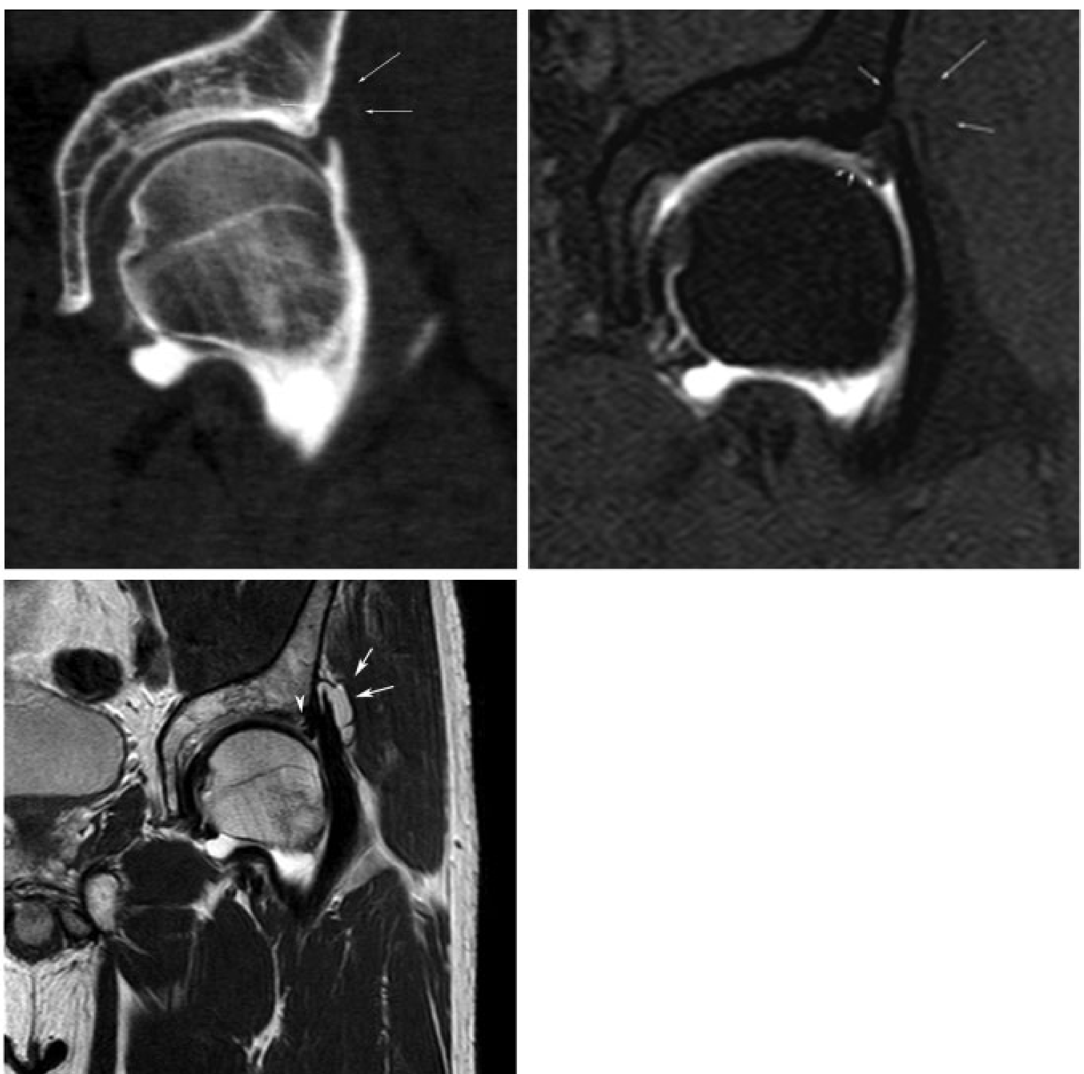


Figure 11 Labrum lineal tear. Contrast demonstrates the extension to the articular surface (arrows) demonstrated on (A) CTa and (B) MRa. Arrowheads show calcification on the labrum.



A B

Figure 12 Labrum tear with detachment of the acetabular rim (arrows). (A) Coronal multiplanar reconstruction of CTa and (B) coronal T1 fat-saturated MRa also show a loose body in the inferior recess (arrowheads).



A B C

Figure 13 Paralabral cyst (arrows). (A) CTa and (B) T1-weighted fat saturation fast spin-echo (FSE) coronal MRa images only showed small labral tear (arrowheads). (C) Paralabral cyst was demonstrated thanks to T2-weighted FSE images.

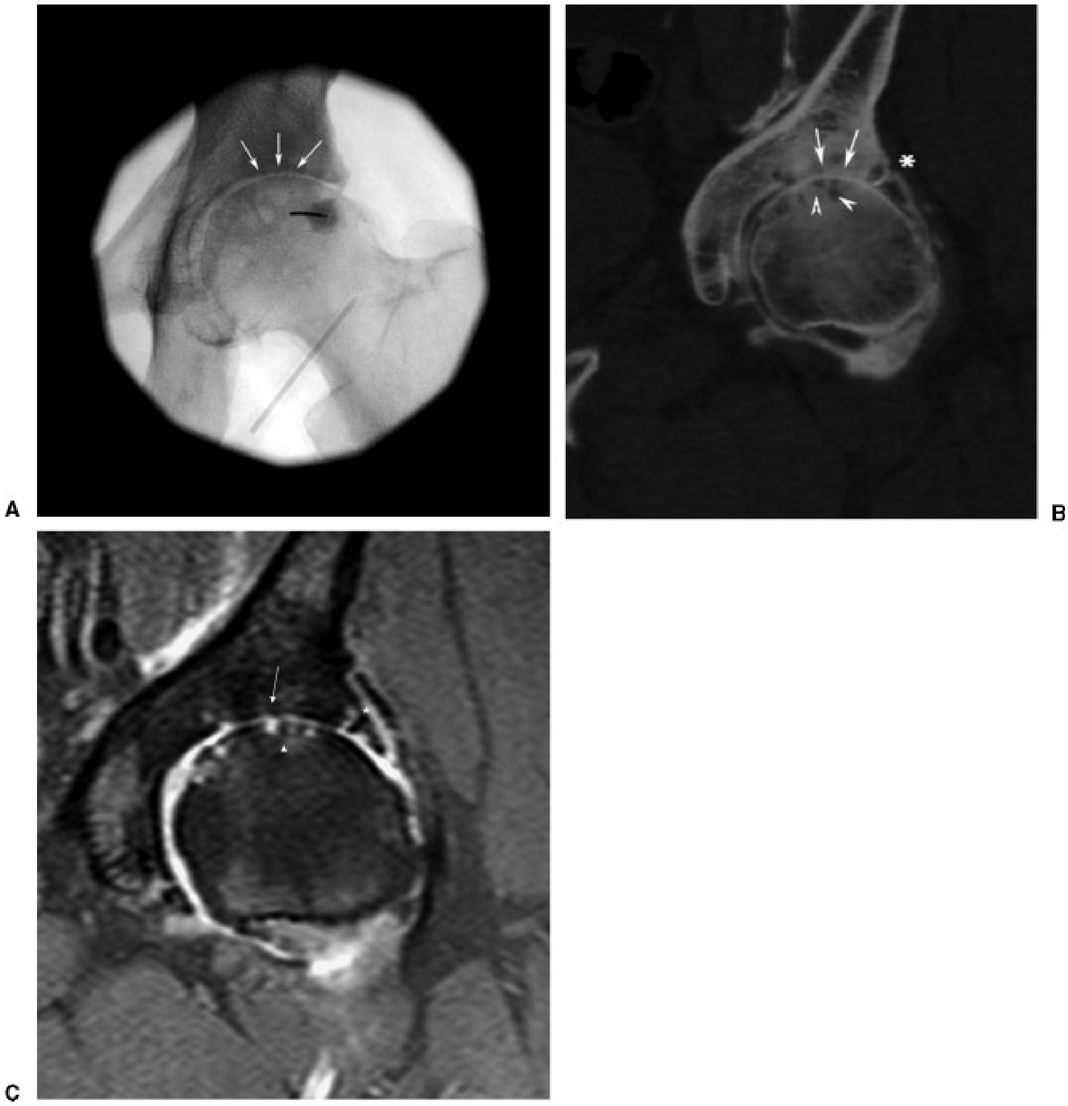


Figure 14 Advanced hip osteoarthrosis. (A) Plain film shows complete loss of joint space (arrows). The information obtained with (B) CTa and (C) MRa is similar. Joint space narrowing (arrows), subchondral degenerative cysts (arrowheads), and labrum degeneration (stars) are seen.

Tonnis grade 2 partial joint space narrowing, and Tonnis grade 3 complete joint narrowing. However, this grading system only shows late changes, and imaging techniques for earlier depiction of cartilage lesions are needed (►**Fig. 14**). Delamination cysts have been described as an indirect radiological sign related to an underlying cartilage defect, evidenced by an acetabulum cyst or a subchondral crack in the acetabulum. These cysts are better visualized on CT, especially on CTa where the cartilage is outlined (►**Fig. 15**).[22]

Cartilage defects are frequently classified arthroscopically using the Outerbridge staging system. This system is useful for femoral head and nonrim acetabulum but not valid for acetabulum rim lesions. The MAHORN system has been accepted by the International Cartilage Repair Society for a rim and nonrim staging system.[1] A modified Outerbridge classification can be used on MR (grade 0, normal; 1, abnormal signal intensity and surface slightly irregular; 2, <50% focal or diffuse chondral loss; 3, excessive cartilage defects) or simplified by dividing defects into complete defect (>50%), partial defect (<50%), fissures, and fibrillation (►**Figs. 16**, **17**, and **18**). However, reports should include extent of the chondral lesion, thickness, if chondrolabral junction is or is not affected, its detachment from subchondral bone, and if there is an associated flap. MRa and CTa have adopted the same staging system. Adding traction to the arthrography procedure allows contrast to extend between acetabular and femoral surfaces in 70% of the cases, thereby improving the ability to depict lesions.[12] CTa has been demonstrated in other joints as a valuable tool for cartilage detection due to its excellent spatial resolution and

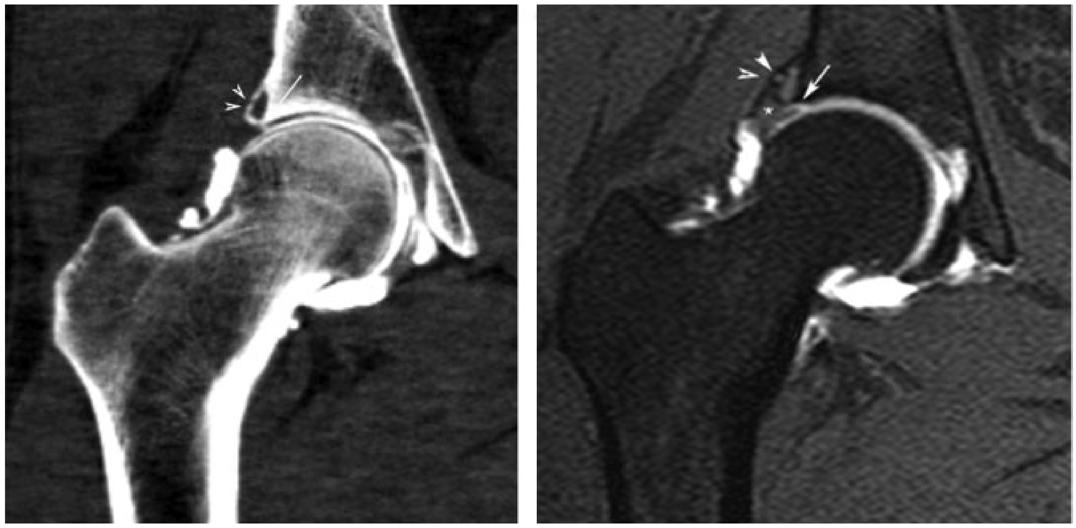


Figure 15 Delamination cyst: (A) coronal MPR CTa and (B) coronal MRa. This sign was described on plain films and is associated with delamination cartilage injuries. In this patient (A) CTa shows small chondral lesion along the labro-chondral transition (arrow) and subchondral bone cyst (arrowheads) better depicted than with (B) MRa. However, intrasubstance changes of the labrum and its small detachment from the labro-chondral transition zone are better seen with (B) MRa (star).

contrast resolution. The higher signal intensity variability on MR with artifacts due to magnetic field inhomogeneities and partial imbibition of the contrast by the cartilage make it more difficult to depict small cartilage lesions at MR.[23] A slightly higher resolution of CTa compared with MRa has been published, and this is consistent with our experience because defects are better detected at CTa and also small delamination cysts are better seen, increasing our confidence in the diagnosis.[6]

Delaminating chondral lesions are a common abnormality associated with FAI, especially with the cam type (►**Fig. 19**). Acetabular overcoverage might be protective against delamination.[24] Hypointense areas in the acetabular cartilage seen on intermediate-weighted fat-saturated or T1-weighted images have been described as a reliable radiological sign of delamination.[25] Careful attention should be directed at the chondrolabral junction. Sometimes, especially after traction, fluid separates the femoral and acetabular cartilage and helps to delineate these lesions.[12]

Instability

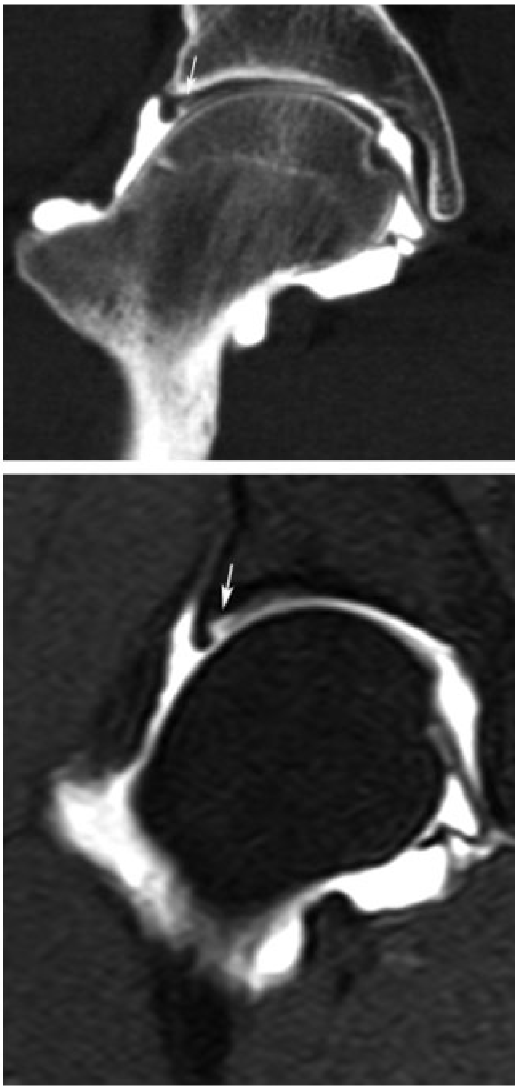
Hip instability is unusual due to the strong capsular and muscular support of the hip joint. The capsule is reinforced by three longitudinal ligaments—iliofemoral, pubofemoral, and ischiofemoral—and circumferentially by the zona orbicularis. Instability can be traumatic or atraumatic, traumatic secondary to dislocation or subluxation of the femoral head produced by high energy, or atraumatic as a result of overuse or hyperlaxity. Overuse is usually focal and rotational in patients requiring great flexion movements such as in martial arts or in sports with excessive rotation maneuvers such as golf. Recently concern was raised over postcapsulotomy instability secondary to iliofemoral ligament injury.[2] If capsular ligaments are injured, excessive load is placed on the dynamic stabilizers such as the iliopsoas and abductors tendons.[26]

Ligamentum Teres

The ligamentum teres has only recently been appreciated as a cause of hip pain. Its biomechanical function is not yet completely clear. Gray and Villar divided tears into type I complete (associated with traumas that frequently have labrum and chondral injuries); type II partial, and type III degenerative. CTa and especially MRa are superior to conventional MR for detecting and grading ligamentum teres tears. The oblique axial plane is particularly useful because of its normal orientation. Chronic injuries show granulation tissue with increased signal intensity and irregular contour of the ligament. Thickening of the proximal ligamentum teres secondary to degeneration and partial ruptures might cause mechanical impingement (►**Fig. 20**).[26,27]

Synovial Plica

Synovial plicae are remnants of the synovial membranes and commonly located at the interface of articular surfaces and derived from mesenchymal tissue. Two morphological variants have been reported: flat (leaflike) and villous. Their function includes synovial fluid production, transmission of neurovascular structures, and joint stabilization. Depending on their location they are divided into superior, middle, and inferior, and recently new ones have been described: neck plicae, ligamentous plicae, and labral plicae. Labral plicae are located between the acetabulum labrum and the anterior joint capsule, and they can be flat or villous with the latter increasing with aging and mainly located along the transverse ligament. They have been associated with entrapment during medial rotation of the thigh. A neck plica is a linear



A

B

Figure 16 Chondral flap. (A) Coronal multiplanar reconstruction CT and (B) coronal T1-weighted fast spin-echo fat-saturated MRa show contrast at the labral-chondral junction and extending to the subchondral labral transition (arrows) creating a flap lesion.

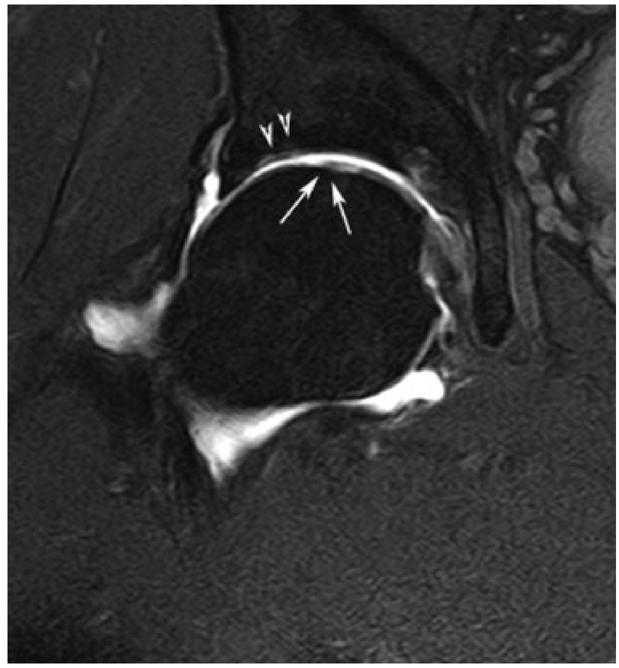
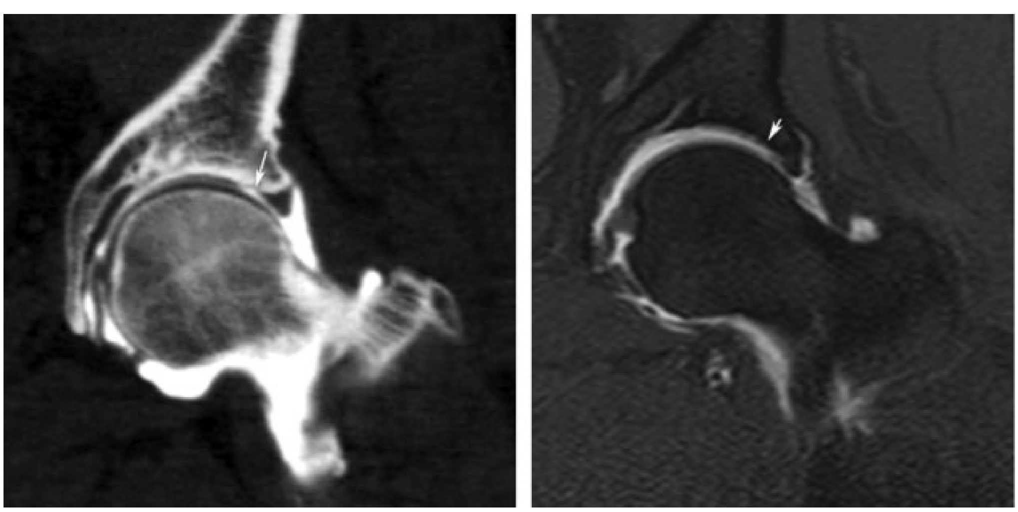


Figure 18 Coronal T1 fat saturation fast spin-echo MRa image shows irregularities on the acetabulum surface (arrowheads) and a small chondral flap with contrast extending through the subchondral-chondral junction (arrows).

hypointense structure that extends from the anterior aspect of the intertrochanteric area, along the anterior aspect of the femoral neck to the articular margin of the femoral head. The pectinofoveal fold is a subtype of medial or neck plica from the lesser trochanter to the fovea capitis of the femur (►**Fig. 21**). The ligament plica extends parallel to the ligamentum teres from its base at the acetabular fossa and should not be mistaken for ligament teres split tears (►**Fig. 20**).[28]



A

B

Figure 17 Small chondral lesion in the labro-chondral junction (arrow). (A) CTa better outlines the chondral defect than the MRa (B).

Figure 19 Coronal T1 fat saturation fast-spin echo MRa shows delamination lesion as contrast separates the chondro-subchondral junction (arrow). This type of lesion is typically seen in cam-type impingement and usually progresses rapidly medially; it is also called a carpet chondral lesion (arrow).

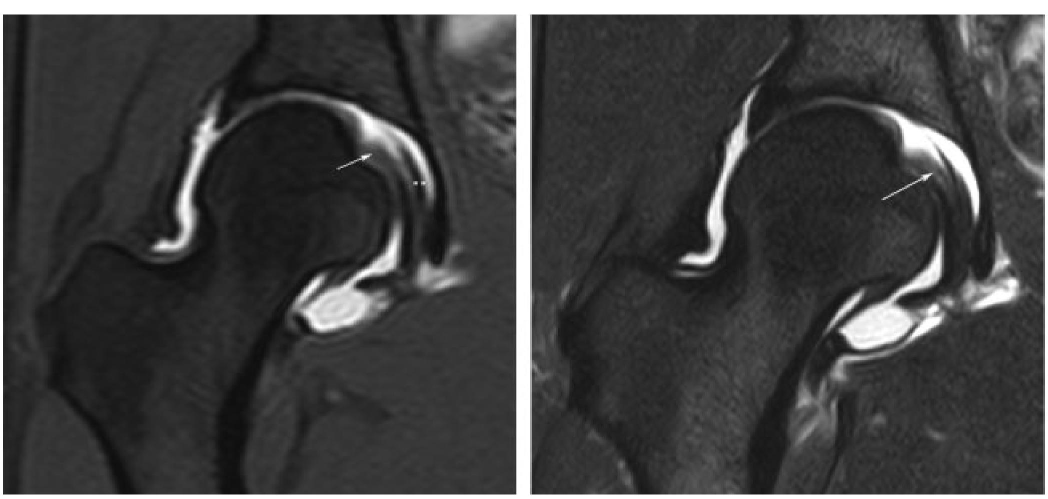
Figure 21 Intra-articular plica. Coronal proton-density-weighted images from MRa show superior plica (arrowheads) and pectinofoveal plica (arrow).

Folds and normal plicae should not be confused with symptomatic plicae. Ligament plicae can thicken and cause mechanical pain with clicking and popping in young athletes. There are only a few cases described in the literature, and all have plicae thicker than 4 mm.[29]

Loose Bodies

Intra-articular loose bodies are defined as rounded or oblong filling defects completely or nearly completely surrounded by contrast material. They can be cartilaginous, osseous, or mixed. If the defect is more elongated and connected with the capsule or plica, it is usually a synovial fold or synovitis. The most frequent locations for loose bodies are the fovea and inferior recess. Loose bodies may be secondary to acute or chronic trauma, fragments associated with osteoarthrosis, osteochondritis dissecans, and primary osteochondromatosis. The sensitivity of MRa has been reported as 50% and specificity as 96% (►**Fig. 22**).[30]

A



B

Figure 20 A 19-year-old female gymnast with thickening of the ligament teres plica (stars) and irregularity on its attachment on fovea capitis (arrow). (A) fat saturation T1-weighted and (B) T2-weighted images from MRa.

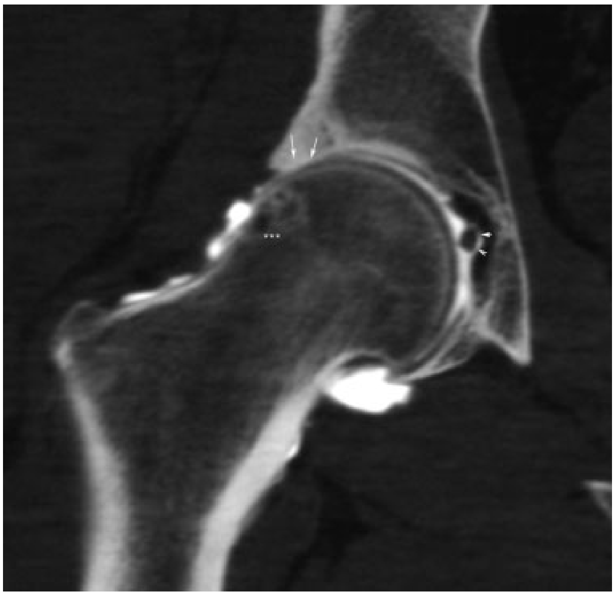


Figure 22 Loose bodies. Coronal multiplanar reconstruction from CTa shows loose body (arrowheads) in the acetabular fossa; fibrocystic changes (stars) and acetabular chondral lesion (arrows) are also demonstrated on a mixed-type femoroacetabular impingement.

Conclusions

The combination of better imaging modalities and less invasive arthroscopic techniques expands the possibilities for the treatment of intra-articular lesions. Essential information to plan surgery includes knowledge of the cartilage status (especially the chondrolabral junction), labral status, if there is acetabulum bone or femoral head-neck deformity, and other associated abnormalities such as loose bodies, ligamentum teres lesions, or capsular lesions. We need standardized classification systems that unify chondral, labral, or bone lesion descriptions. Nowadays CTa and MRa are essential to rule out those structural injuries with higher accuracy than conventional (nonarthrographic) images. Although CTa and MRa are slightly more invasive, they have very low complication rates and provide a valuable preoperative evaluation.

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