Femoroacetabular Impingement: Femoral Morphology and Correction

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Misty Suri, John J. Christoforetti, Rami Joseph Elkhechen, and Shawn Evette Johnson

Introduction

There has been an explosion of interest in treating hip pathology arthroscopically recently. One of those entities, femoroacetabular impingement (FAI), has received much of this attention. FAI encompasses both cam-type and pincer-type impingement, both of which need to be addressed for successful management. Harris and colleagues first observed asphericity of the femoral head, referring to its morphology as a "pistol grip deformity" [1]. They discovered a high correlation of early-onset osteoarthritis occurring in patients with this deformity. Ganz and colleagues coined and popularized the theory behind "femoroacetabular impingement," categorizing it into two types: cam and pincer impingement [2]. They felt this entity, and with great foresight, was a precursor for early-onset osteoarthritis. In the late 1990s, safe surgical correction of this type of impingement was described allowing open treatment of this condition in attempt to decelerate the degenerative changes felt to be initiated by this process [3]. As early results of surgical management appeared to be promising, surgeons explored arthroscopic ways to effectively treat FAI minimally invasive [4].

The scope of this chapter will focus on the femoral-sided contribution to FAI, including its diagnosis and surgical management. After a brief introduction, a case-based format will demonstrate the correlation between imaging studies and surgery for correction of femoroacetabular impingement. Femoral morphology and its correction arthroscopically will be the focus. Review of diagnosis and management will be performed with the aid of three cases:

1. Conventional anterolateral cam lesion in the middle-aged working male
2. Atypical anterior and posterior cam lesions in the younger male athlete
3. Conventional anterolateral cam lesion in the younger female dancer

Pathoanatomy

Cam-type impingement occurs secondarily to an aspherical femoral head rotating into the acetabulum. This morphologic variant in itself may not primarily cause pain, but predisposes the joint to intra-articular pathology that can become symptomatic. For instance, it can lead to delamination of cartilage from subchondral bone as well as tearing of the labrum. These pathologic conditions have most commonly been found on the anterosuperior aspect of the acetabulum correlating to between 1 and 2 o'clock [5]. Acetabular contributions to impingement exist including coxa profunda, protrusio, and retroversion, but their discussion is beyond the scope of this chapter [6]. Many different theories exist to explain the etiology of the asphericity of the femoral head with most focusing on the physis. They include a subtle, subclinical slipped capital femoral epiphysis or a premature asymmetrical closure of the physis [7].

A bimodal distribution of patients has been elucidated, including the middle-aged patient and the younger athletic patient [8]. Both have demonstrated a male predilection and similar cam-related pathology. The difference in timing of presentation is likely due to a higher physiologic demand placed on the hips of the younger patients by their participation in athletic activities.

M. Suri, MD (✉) • S.E. Johnson, MD
Department of Sports Medicine, Ochsner Clinic, Jefferson, LA, USA
e-mail: msuri@ochsner.org; Swtdst96_2@me.com

J.J. Christoforetti, MD
Department of Orthopedic Surgery, Sports Medicine Division, Allegheny Health Network, West Penn Hospital, Pittsburgh, PA, USA
e-mail: John.christoforetti@gmail.com

R.J. Elkhechen, MD
Orthopedic Care Specialists of North Palm Beach, North Palm Beach, FL, USA
e-mail: Rami.joseph.elkhechen@gmail.com

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History and Physical Examination

FAI commonly presents in an insidious and intermittent manner mirroring the repetitive and progressive nature of its development. Many times the patient places higher demands on the hip joint through lifestyle or athletics than it is possible given structural limitations defined by the patient's morphology. Thus, our history taking includes but is not limited to duration of symptoms, daily activities producing symptoms, prolonged positional symptoms, athletic involvement, and lifestyle activities.

Our hip examination is comprehensive including assessment of gait, leg lengths, and noting areas significant for tenderness and/or crepitus. Pertaining specifically to patients with impingement, they can present with reduced range of motion with secondary compensatory mechanisms. Thus, they are assessed for mechanical limitations as well as pain during specific periods in arc of motion and at terminal ranges of motion. To better understand the patient's clinical entity, we attempt to reproduce the patient's symptoms with provocative maneuvers in the office setting. Provocative exams include dynamic internal rotatory impingement (DIRIT) and posteroinferior impingement tests [9]. These maneuvers aid in localizing location of cam lesions when involved in the process of FAI. Weakness of core and hip musculature is demonstrated with our assessment of step-down and bridge testing [10].

Stand-alone fluoroscopic intra-articular injections of 4–6 mL of 0.25 % bupivacaine and/or corticosteroids provide diagnostic and prognostic value and are performed occasionally to aid in surgical decision making and address patient's expectation of surgical intervention [11]. To ascertain diagnostic value, the percentage relief should be quantified by patient in the hours after injection. Corticosteroids are usually limited to the older population.

Imaging

Imaging modalities play a confirmatory diagnostic role as well as preparation for surgical planning. Complete radiographs are obtained with good techniques including standing AP, Dunn, and cross-table lateral and frog lateral views [12]. Meyer et al. were able to demonstrate that the radiograph that best demonstrates the location of maximal cam deformity is the 45° Dunn view [13]. Although measuring alpha angles remains popular in quantifying cam lesions, there is substantial overlap between measurements between asymptomatic volunteers and symptomatic FAI patients [14]. Thus, the presence of a cam lesion must be viewed in context of the patient's clinical presentation and recreational activities. Appreciating the presence of a cam lesion on radiographs in the appropriate clinical context provides more importance than accurately assigning a maximum alpha angle value in the diagnosis of symptomatic cam-type impingement. It can be difficult to accurately measure a true peak alpha angle on two-dimensional imaging, demonstrated by Milone et al. [15].

Magnetic resonance arthrography (MRA) with 5–20 mL of gadolinium–DTPA injected fluoroscopically provides very sensitive and specific detection of the presence of cam lesions and soft tissue pathology related to their impingement, such as chondral or labral injury [16]. MRA provides another modality to measure alpha angles on reformats, but with three-dimensional surface renderings unavailable, they do not provide the most accurate method to spatially localize and quantify bony anatomy associated with cam lesions.

Computed tomography (CT) with three-dimensional static renderings and simulation for motion analysis does provide a precise definition of bony anatomy for surgical planning. CT more accurately localizes and quantifies the amount of bony resection needed to relieve impingement in order to best avoid revision surgery as a result of under resection [17]. This is of course at the expense of substantial radiation exposure as novel protocols are not yet routinely available to limit exposure.

Preferred Operative Technique

Hip arthroscopy most frequently is performed in the supine position. Traction is performed and confirmed via fluoroscopy. A standard anterolateral (AL) portal is established followed by a mid-anterior (MA) portal at a 45° angle to the longitudinal axis, 7-cm distal and medial to AL portal [18]. Dry capsulotomy is performed connecting the two portals. At this time, diagnostic arthroscopy of the central compartment is performed, and pathologies secondary to cam lesion are evaluated and addressed. Traction is released and the hip is flexed to approximately 30°. Dimensions of the cam lesion are identified, and a line of demarcation occurring at the junction between normal articular cartilage and abnormal fibrocartilage covering the cam lesion is produced. To facilitate assessment of the cam lesion and its resection, limited 1–1.5-cm "T-capsulotomy" can be performed at this time. Resection of cam lesion is initiated, viewing from the AL portal and working through the MA portal. Femoroplasty is performed by 5-mm spherical burr with goal to recreate the concavity at this junction with a smooth, gradual transition at the chondral-bone interface. Alternating viewing and working portals allow full appreciation of the dimensions of the cam lesion, especially the lateral aspect of an anterosuperior lesion. This is a critical step as incomplete resection to restore the offset remains one of the leading causes of revision surgery [15]. Generally speaking, the MA portal is used to address the medial and anterior aspect of the cam lesion,

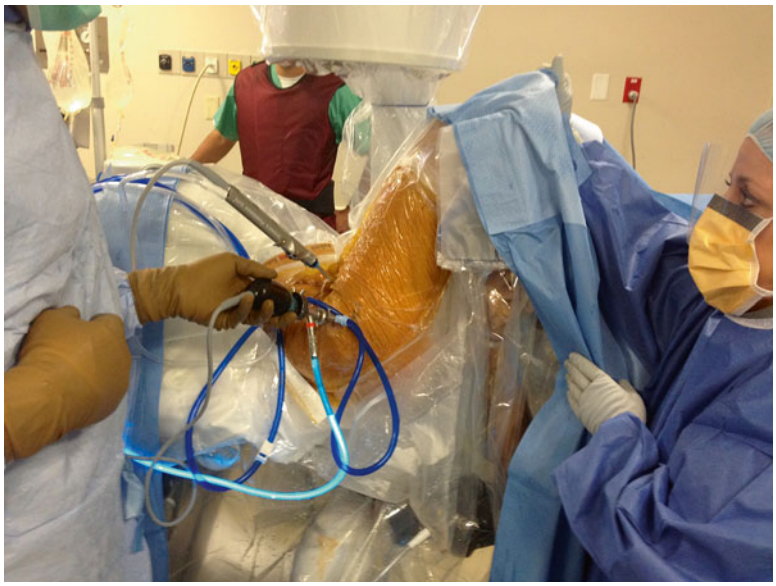

Fig. 29.1 After cam lesions have been resected arthroscopically, adequacy of the resection is checked via direct arthroscopic visualization on dynamic examination. Hip is flexed to 90° in neutral rotation

Fig. 29.2 Afterward, hip is rotated internally and externally to confirm no areas of impingement remain

while the anterolateral portal is utilized to treat the lateral and posterior-most extent of the lesion. Strong emphasis is placed on preserving the lateral retinacular vessels and avoidance of notching on the tension side of the femoral neck [19]. All bone debris from femoroplasty is removed to diminish risk of heterotopic ossification.

Periodic arthroscopic dynamic examination cannot be overemphasized at this time to confirm adequate resection. This is performed with the hip flexed to approximately 90° (Fig. 29.1) with visualization of the head-labral junction during internal and external rotation (Fig. 29.2). Goals of the test include demonstration of no remaining impingement between femoral neck and labrum and preservation of seal or contract between labrum and area of previously resected cam lesion. "T-capsulotomy" closure is performed with one (sometimes two) nonabsorbable high-strength sutures passed with a 90° suture-passing device and tied in a simple fashion.

Rehabilitation

An orthotic hip brace set for 0–90° flexion is utilized postoperatively while awake for 2 weeks, with formal physical therapy beginning on the first postoperative day. In addition, patient is instructed on the use of rotation precaution hip

boots and pillow during sleep for 10 days to prevent inadvertent external rotation. Toe-touch weight bearing with crutches is implemented for 3 weeks after a formal femoral osteochondroplasty is performed in order to protect against torsion at the site of resection and femoral neck fracture. Protocol is modified for concomitant procedures such as microfracture by toe-touch weight bearing for 8 weeks, along with continuous passive motion for 6 h daily, lasting 4–6 weeks [20].

Case 1: Classic FAI in the Middle-Aged Working Male

History/Exam

A 49-year-old male, who works as a production supervisor, presented to the orthopedic sports clinic reporting 3 months of left hip pain when ascending stairs and doing computer work, requiring prolonged sitting. His pain measures 5/10 on VAS. He also reports pain with driving and getting into and out of his car. He has a history of right hip arthroscopy for FAI 2 years ago, for which he underwent labral debridement and femoroplasty for large cam lesion. His symptoms improved greater than 80 %. He states that pain is similar in nature to his contralateral hip prior to surgery, and it is preventing him from doing yard work; it requires him to bend down.

His physical examination revealed a positive flexion impingement test and pain with circumduction of the hip. It also demonstrated FABER asymmetry and weakness in hip musculature manifested by positive step-down and bridge tests. Passive range of motion was limited to flexion of 100°, IR 20°, ER 40°, abduction of 45°, and adduction of 20°. Due to the fact that he had failed extensive nonsurgical options and was unable to perform his ADLs, decision was made to proceed with imaging and surgical intervention. He also received 90 % effective, but temporary relief from an intra-articular cortisone injection lasting only a few weeks.

Imaging

Radiographs in Figs. 29.3 and 29.4 reveal extensive asphericity of his femoral head with significant cam lesion. His head–neck offset was significantly diminished and a minimal cross over sign. Lateral center-edge angle was measured at 24° with minimal joint space narrowing. Magnetic resonance imaging with contrast arthrography exhibited a manifestation of impingement via herniation pit on the lateral aspect of the femoral neck on the coronal images (Fig. 29.5). The axial images made it evident that the patient had a labral tear extending from anterior to superior (Fig. 29.6). Some mild adjacent chondral shearing was evident. Significant asphericity was again noted with decreased head–neck offset. Alpha angle was high and evidence of impingement was noted on the lateral aspect of head–neck junction.

Arthroscopy

Patient was taken to the operating room for hip arthroscopy via technique stated above. After capsulotomy and labral repair were performed under distraction, arthroscopy of the peripheral compartment with the hip reduced revealed significant cam

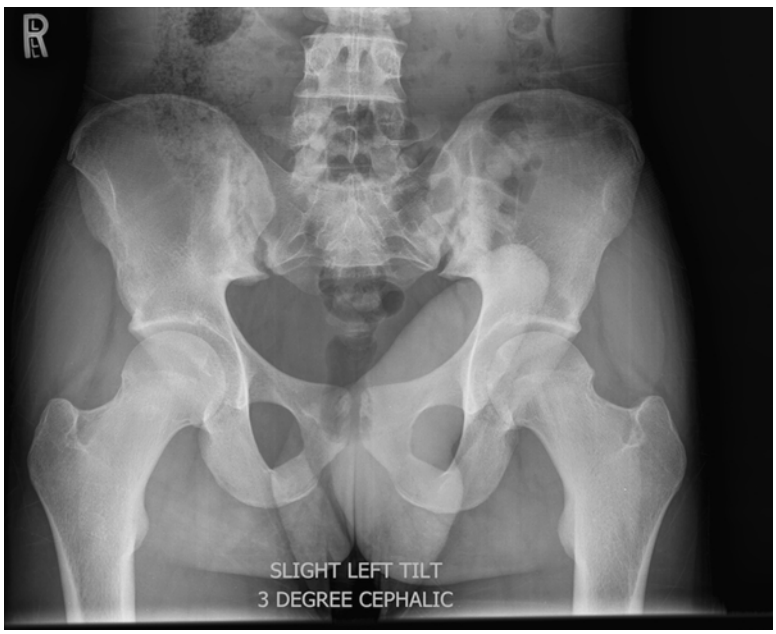

Fig. 29.3 AP pelvis demonstrates anterolateral cam lesion of left hip and loss of asphericity manifested by decrease in femoral head–neck offset when compared to contralateral hip

Fig. 29.4 Dunn view radiographs confirm this loss of femoral head–neck offset when compared to contralateral hip which has undergone previous hip arthroscopy, femoroplasty

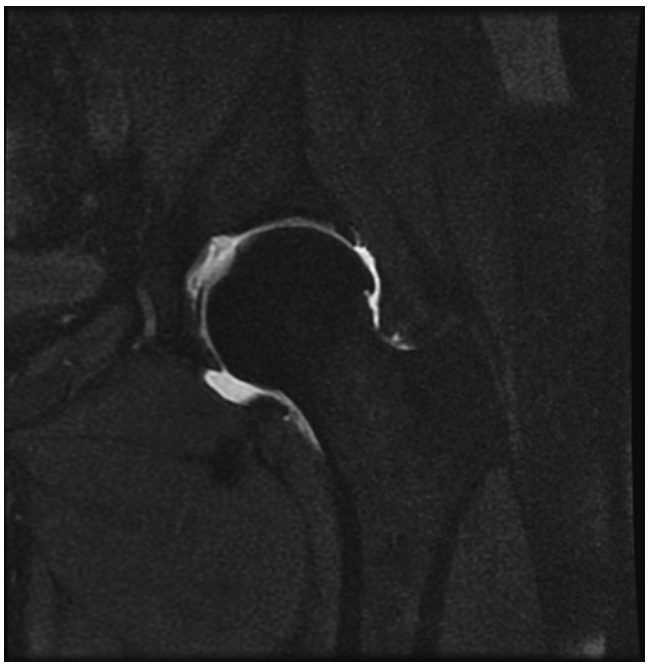

Fig. 29.5 Coronal T2 MRA demonstrates anterolateral cam lesion with herniation pit manifested by high, bright fluid signal on lateral aspect of the head–neck junction

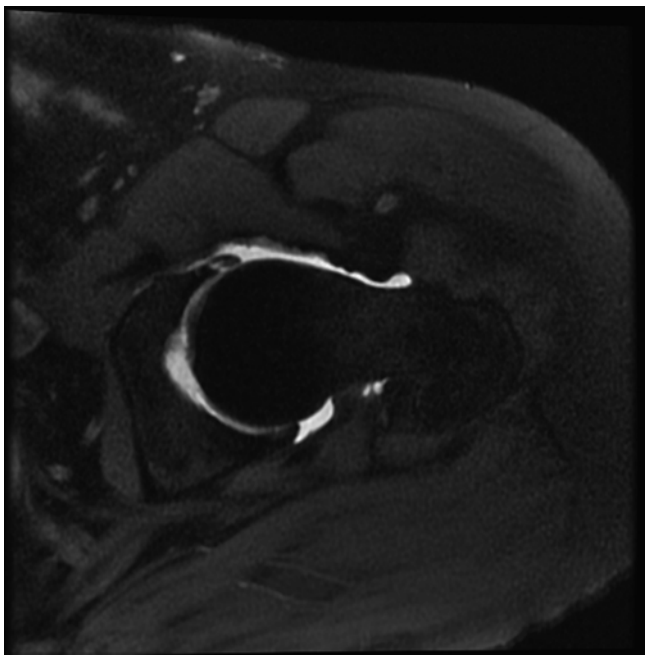

Fig. 29.6 Axial T2 MRA demonstrates same anterior cam lesion with adjacent anterior labral tear suggested by high, bright fluid signal at the labral–chondral junction

lesion on the anterolateral aspect of the head–neck junction seen in Fig. 29.7. Areas of impingement were noted and quantified in this area on arthroscopic impingement test. Thus, cam lesion was removed utilizing a 5-mm-round burr while viewing from the anterolateral portal and working through the mid-anterior portal (Fig. 29.8). A critical step in fully appreciating and adequately resecting the entire lesion is to switch the viewing and working portals in order to obtain a different vantage point. Figure 29.9 demonstrates this and allows complete resection of the lateral gutter. Cam resection measured 5-mm deep and 35-mm wide from a medial 6 o'clock position to a lateral 12 o'clock position. Periodic dynamic examination was performed to indicate sufficient resection with no impingement.

After completion of femoroplasty, hip flexion is removed in neutral rotation and "T-capsulotomy" closure is performed with one nonabsorbable high-strength suture passed with a

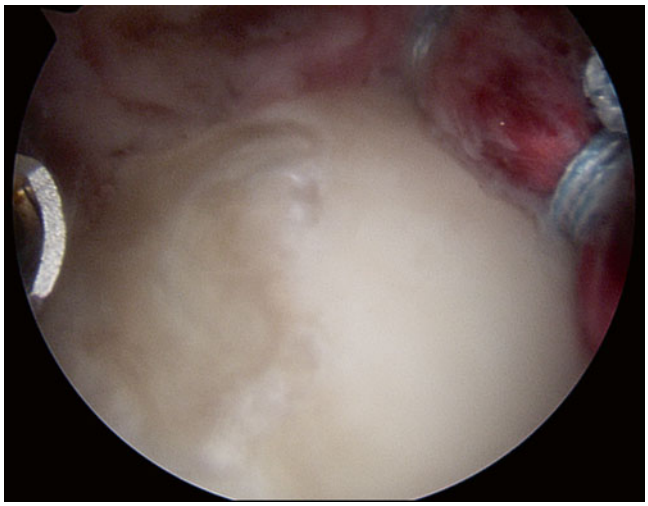

Fig. 29.7 Anterolateral cam lesion apparent during visualization of peripheral compartment via standard anterolateral portal after capsulotomy and labral repair seen in the background

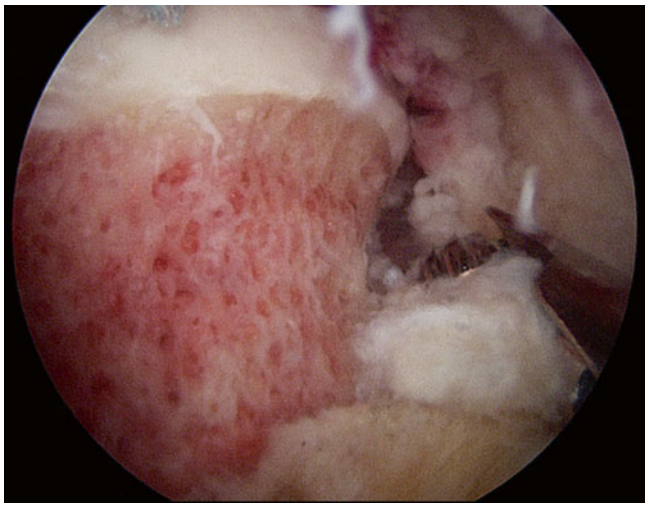

Fig. 29.9 Critical step in relieving entire cam lesion involves moving arthroscope to the distal anterior portal in order to adequately visualize and resect the lateral-most aspect of the lesion

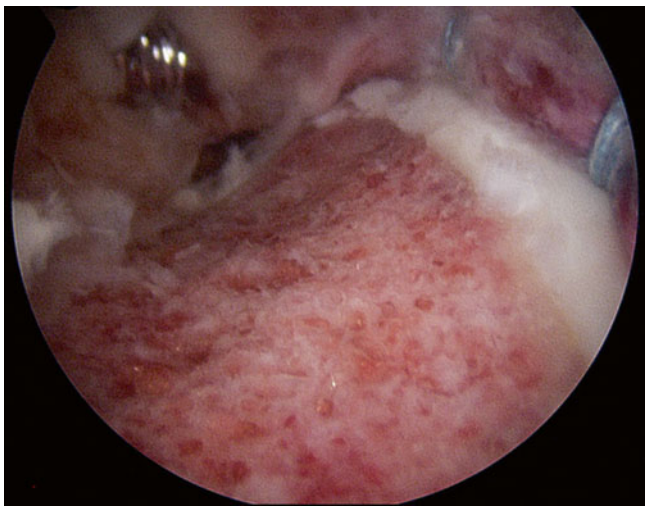

Fig. 29.8 Combination of electrocautery and high-speed burr is utilized to resect the cam lesion to reestablish the femoral head–neck offset and relieve source of impingement

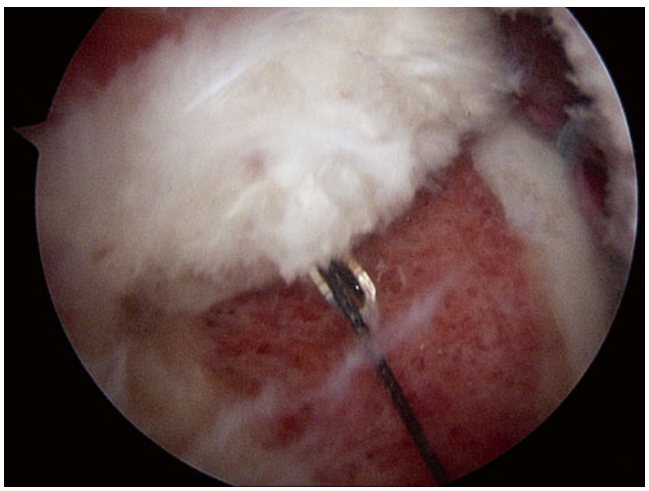

Fig. 29.10 A 90° suture-passing device is used via cannula in the mid-anterior portal to pass a nonabsorbable high-strength suture, aiding to close "T-capsulotomy"

90° suture-passing device and tied in a simple fashion (Figs. 29.10, 29.11, and 29.12).

Discussion

The clinical history of reduced hip motion and increasing pain with deep-flexion activity coupled with prior success with contralateral side correction indicated imaging with MRI for this case. The MRI signs of articular chondral and labrum tearing in the anterior superior regions of the hip along with the femoral head asphericity were pertinent positives. Pertinent negatives included absence of severe subchondral cystic change and bone edema within the femoral head or acetabulum. The intraoperative decision making describes the importance of correlating preoperative imaging and exam findings with arthroscopic exam to adequately correct impingement.

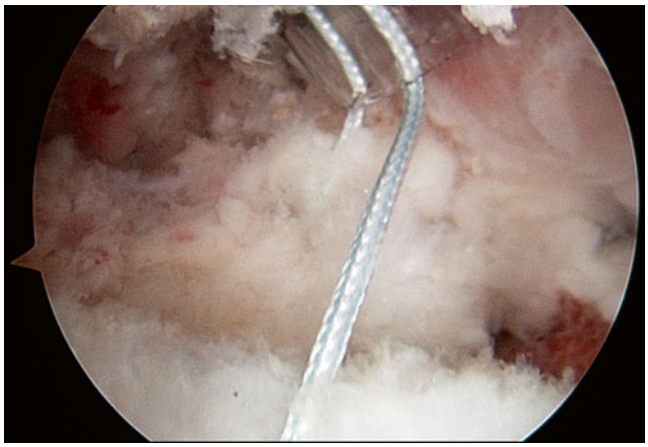

Fig. 29.11 Nonabsorbable high-strength suture visible passed through each limb of the "T-capsulotomy," exiting cannula via the mid-anterior portal

Fig. 29.12 One nonabsorbable high-strength suture tied in a simple fashion demonstrating closure of "T-capsulotomy" and good coverage of femoral neck and femoroplasty region

Case 2: Atypical FAI in the Younger Male Athlete

History/Exam

A 17-year-old high school baseball player presented with bilateral hip pain, L>R, for the last 5 years that worsened with sports activity and twisting motions. He rated the pain as a 5/10 on a daily basis on the VAS. He had recently stopped participating in baseball due to his hip pain. The only relief from pain was rest from activities and anti-inflammatory medication.

On physical examination, there was no tenderness to palpation or crepitus. Both flexion impingement and posterior rim impingement tests were markedly positive. He also demonstrated a positive posterior rim impingement test. There was pain with circumduction of the hip. Patient also demonstrated weakness in hip musculature manifested by positive step-down and bridge tests. Patient's passive range of motion was limited to flexion of 110°, IR 30°, ER 40°, abduction of 45°, and adduction of 20°. These symptoms with prolonged duration and recent regression in his chosen sport facilitated the decision to proceed with imaging studies and subsequent intervention.

Imaging

Radiographs demonstrated asphericity of the femoral head in bilateral hips. When examining the left hip, it was evident in Fig. 29.13 on the frog leg radiograph that there was a large posterior cam lesion in addition to the standard anterolateral lesion causing classic FAI. The lateral center-edge angle was measured at 35° with maintained joint space [21]. Magnetic resonance imaging with contrast arthrography confirmed the presence of anterior and posterior cam lesions. It also suggested a large labral tear manifested by significant contrast visualized medial to the labrum (Figs. 29.14 and 29.15). Enhancement of the tear is secondary to the use of contrast to improve sensitivity and specificity.

In addition, fine 2-mm-cut CT scan of the hip joints was performed to characterize detailed bony anatomy of cam lesions in order for surgical planning. On axial CT scan in Fig. 29.16, posterior impingement is evident by a posterior cam lesion and herniation pit as a result of impingement episodes. Three-dimensional reconstruction aids in full appreciation, spatial anatomical localization, and quantification of the cam lesion size. Figure 29.17 exhibits the large anterolateral lesion with loss of femoral sphericity.

Surgery

Given the presence of posterior cam lesions, a decision was made to perform surgical hip dislocation in order to effectively and safely resect them (Fig. 29.18). The procedure is performed utilizing a technique described by Ganz et al. [22], with the patient in the lateral decubitus position. A straight incision is made centered over the anterior border of the greater trochanter. Dissection is carried through the subcutaneous tissue down to the deep fascia. Gibson's interval was identified and used between the tensor fascia lata and gluteus maximus. Care needs to be taken when performing trochanteric osteotomy, preserving insertions of the gluteus medius/minimus and vastus lateralis tendons. Incomplete osteotomy is performed after which the fragment is levered anteriorly, allowing controlled fracture of the anterior cortex. Z-shaped

Fig. 29.13 Frog leg radiograph demonstrates bilateral anterior cam lesion with suspicion of posterior cam lesion and impingement in the left hip

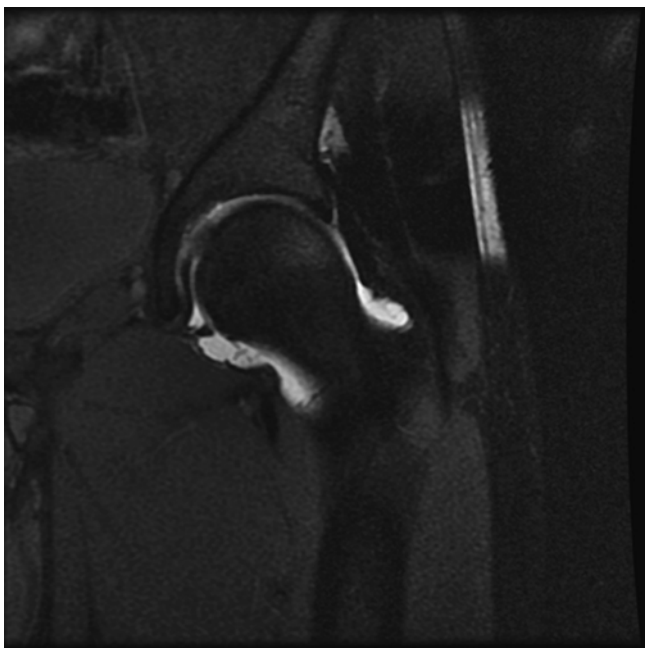

Fig. 29.14 Coronal T2 MRA demonstrates asphericity of femoral head with evidence of a large anterior cam lesion and loss of femoral head–neck offset. A labral tear is suggested by a bright fluid signal medial to the labral tissue

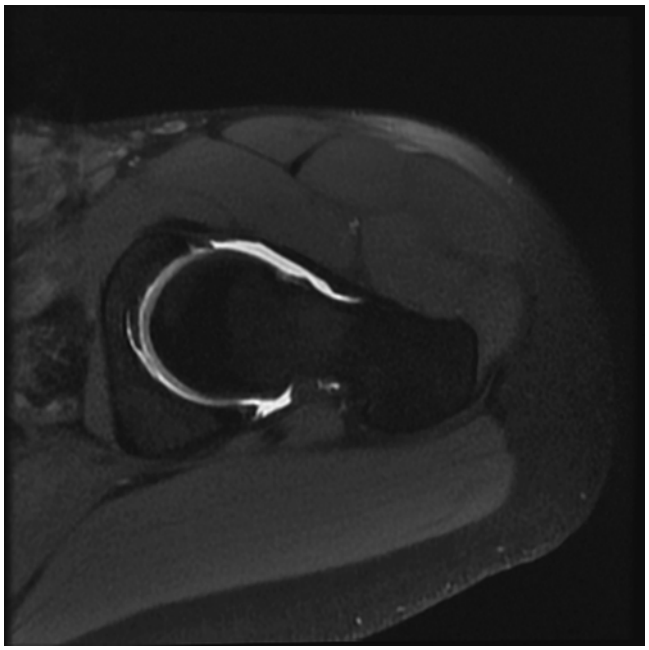

Fig. 29.15 Axial T2 MRA identifies anterior and posterior cam lesions with evidence of a labral tear suggested by a bright fluid signal medial to the labrum

capsulotomy is performed for visualization followed by incising of the ligamentum teres, utilizing ligamentum teres skid knife or curved Mayo scissors.

Flexion and external rotation allows for controlled anterior dislocation of the femoral head and assessment of chondral surfaces, cam lesions, and labral pathology. Figure 29.19 reveals the posterior cam lesion well by tangentially viewing the posterior aspect of the femoral head. Resection of the lesion is performed via rongeur and high-speed burr reestablishing the sphericity of the femoral head posteriorly (Fig. 29.20). Attention is turned to the anterolateral cam lesion in Fig. 29.21. There is obvious loss of femoral head–neck offset at the site of the forceps. A semicircular plastic template can be used to mark out the osteotomy site for the

Fig. 29.16 Axial CT scan clearly demonstrates anterior and posterior cam lesions. Herniation pit is demonstrated adjacent to the posterior lesion

Fig. 29.17 CT scan was reconstructed to produce this three-dimensional image to aid the understanding of the anterior cam lesion's spatial relationship

cam lesion. An osteotome in Fig. 29.22 is used in a controlled manner to perform the resection. Reevaluation of the sphericity with the semicircular plastic template and the use of a high speed burr and rongeur to fine-tune resection is performed (Fig. 29.23). Final resection of femoral head and reestablishment of femoral head–neck offset is evident in Fig. 29.24.

After completion of the cam resections, the labral tear is addressed. Unlike in arthroscopy where traction is being performed via hip table while addressing central compartment and labral pathology, open surgery precludes this. Thus, these pathologies are addressed while the hip is dislocated for access. Discussion of these is beyond the scope of this chapter and will be discussed in another chapter. Upon completion of central compartment and labral pathology, the hip is subsequently reduced and a dynamic open impingement test is performed as in Fig. 29.25. Goals of the test include demonstration of no remaining impingement between femoral neck and labrum and preservation of seal or contract between labrum and area of previously resected cam lesion.

Discussion

The MRI findings in this case confirmed the severity of the posterior femoral deformity suggested by plain radiography. Expert understanding of the anatomical limitations of arthroscopic correction of aspherical femoral head includes the knowledge that limitations exist. This case highlights the appropriateness of considering open surgical dislocation when MRI and radiographs significant offset abnormality or proximity of femoral deformity to the lateral epiphyseal vessels.

Case 3: Classic FAI in the Younger Female Dancer

History/Exam

A 21-year-old college student, working as a dancer, presented with right hip pain that began 4 months previously after attempting to perform a dance move at work involving a quick squat and external rotation of both hips. She described her symptoms as a deep-seated groin pain exacerbated by hip flexion and abduction activities. She denied any snapping episodes. She was unable to continue dancing for work as well as difficulty getting into and out of her car.

On physical examination, she had no tenderness to palpation or snapping appreciated when ranging the hip joint. She had a classically positive flexion impingement test as well as pain on pure abduction of the hip. She demonstrated mild weakness with step-down and bridge testing. Her range of motion was limited in flexion to 110°, IR to 20°, ER to 50°, abduction to 35° with pain, and adduction of 20°. Patient presented with an MRI already performed at an outside institution.

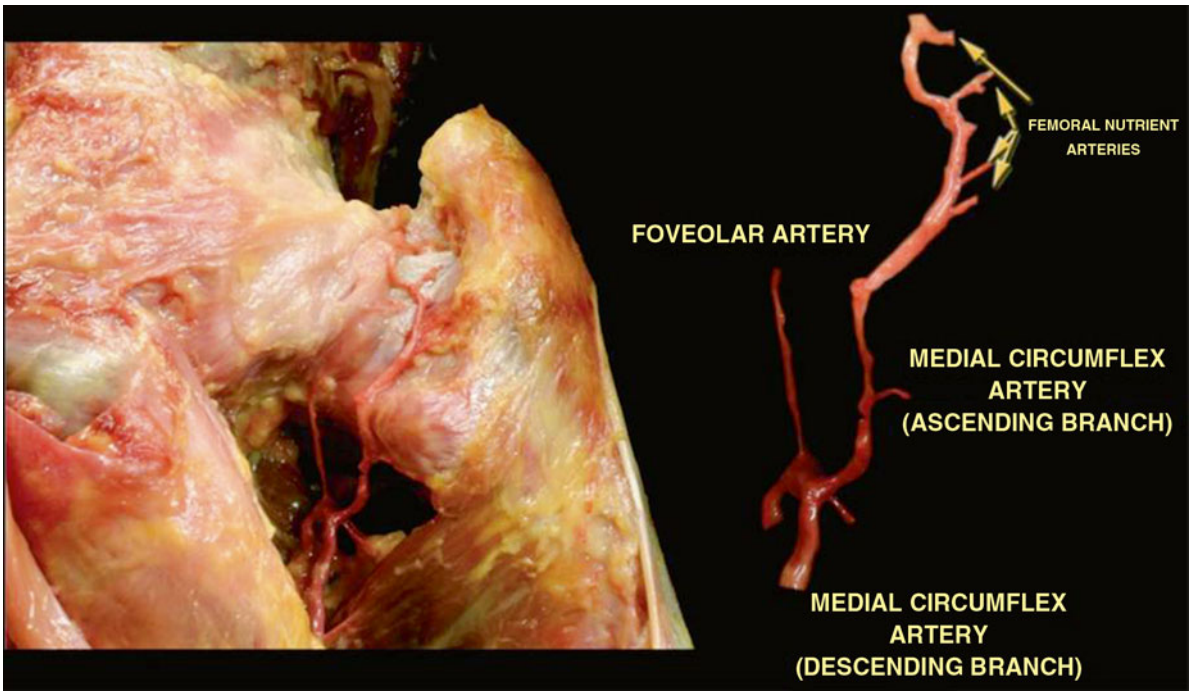

Fig. 29.18 Anatomical study of the hip demonstrates that the main blood supply of the adult femoral head or medial femoral circumflex artery courses along the posteromedial aspect of the femoral neck

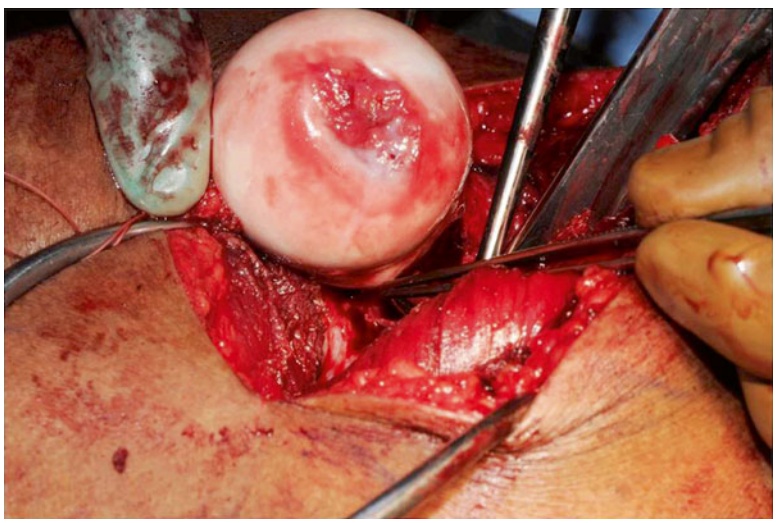

Fig. 29.19 Tips of forceps demonstrate posterior cam lesion after surgical anterior hip dislocation of left hip

Imaging

Radiographs demonstrated mild asphericity of the femoral heads in the right hip. There was no crossover sign present and the lateral center-edge angle measured 31° without narrowing of the joint space. Magnetic resonance imaging had been performed without contrast at an outside facility but confirmed the presence of a cam lesion on the anterolateral aspect of the neck more conspicuous on the lateral aspect of the T2 coronal images (Figs. 29.26 and 29.27). Also present was a likely disruption of the labrum at its junction with the chondral surface. She was sent for an intra-articular bupivacaine to confirm diagnosis as well as predict success of surgical intervention. She received 100 % relief for 48 h, and pain had regressed back to baseline by two weeks postinjection. Thus, she was indicated for hip arthroscopy.

Arthroscopy

Patient was taken to the operating room for hip arthroscopy via preferred technique. After capsulotomy and labral repair were performed, arthroscopy of the peripheral compartment with distraction removed revealed significant cam lesion on

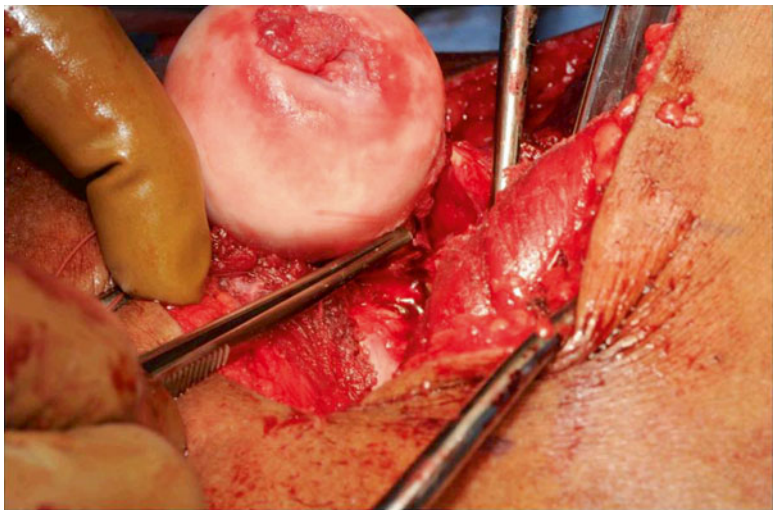

Fig. 29.20 Tips of forceps demonstrate area where posterior cam lesion had been excised using combination of rongeur and high-speed burr technique

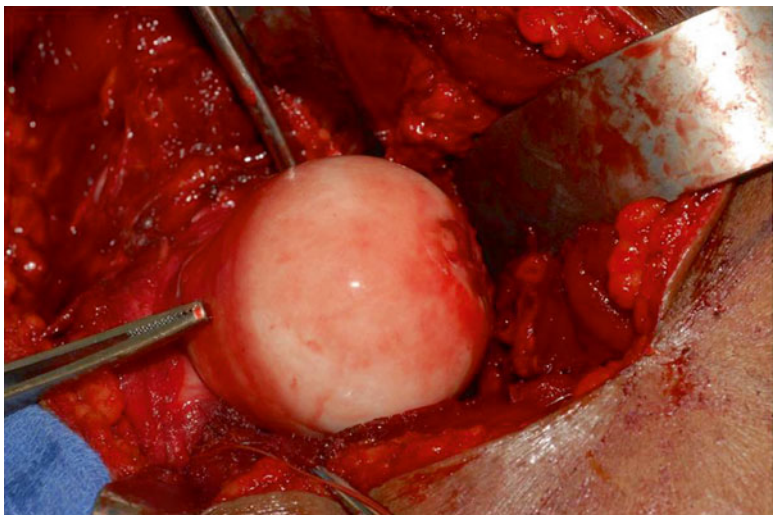

Fig. 29.21 Tips of forceps demonstrate a large anterior cam lesion with significant asphericity of femoral head

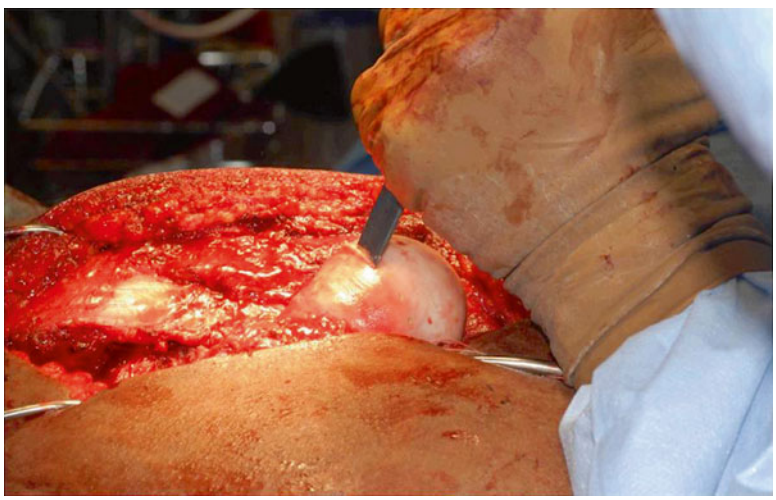

Fig. 29.22 Osteotome being used at the fibrocartilage-articular cartilage junction of the femoral head in order to remove anterior cam lesion

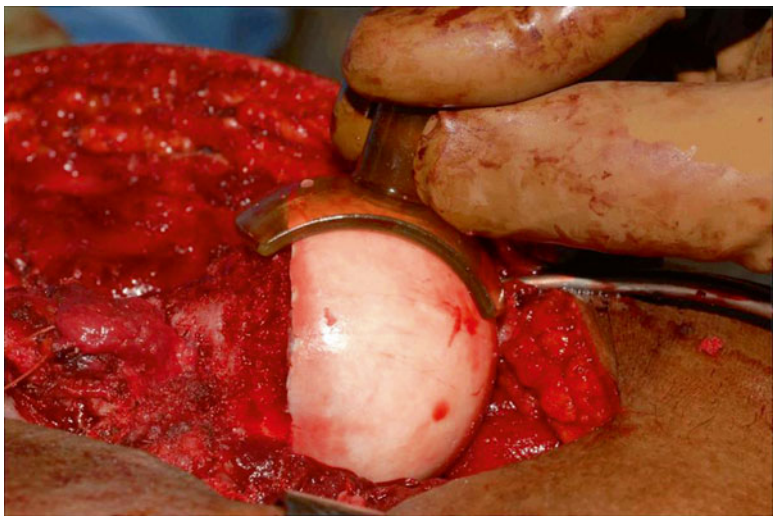

Fig. 29.23 Completed resections of both anterior and posterior cam lesions causing impingement

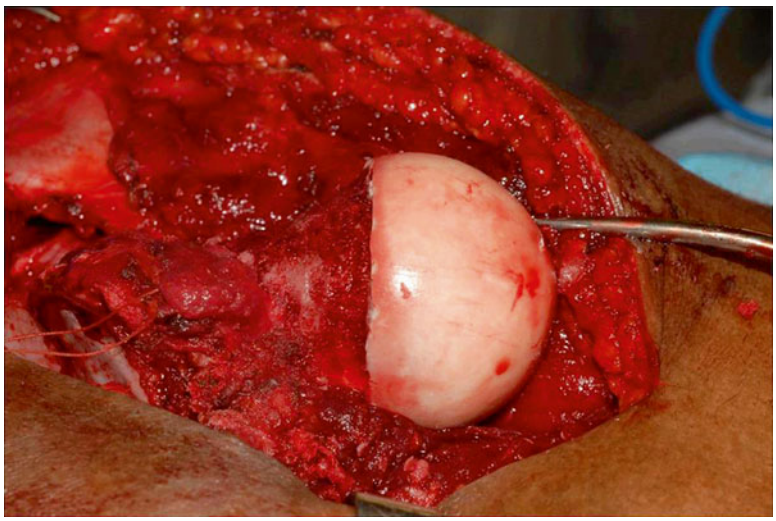

Fig. 29.24 Semicircular plastic template is used to confirm adequate resection of cam lesions

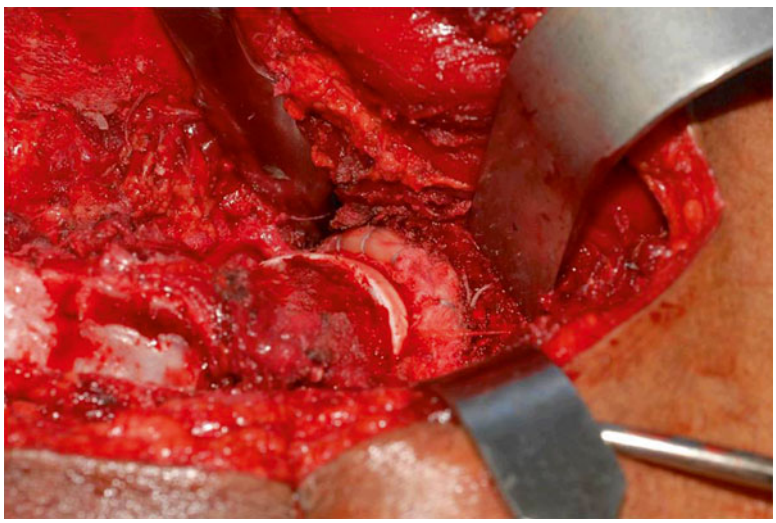

Fig. 29.25 Hip is subsequently reduced and final check is performed under direct visualization with a dynamic examination. Labral repair can be visualized here with cam resections

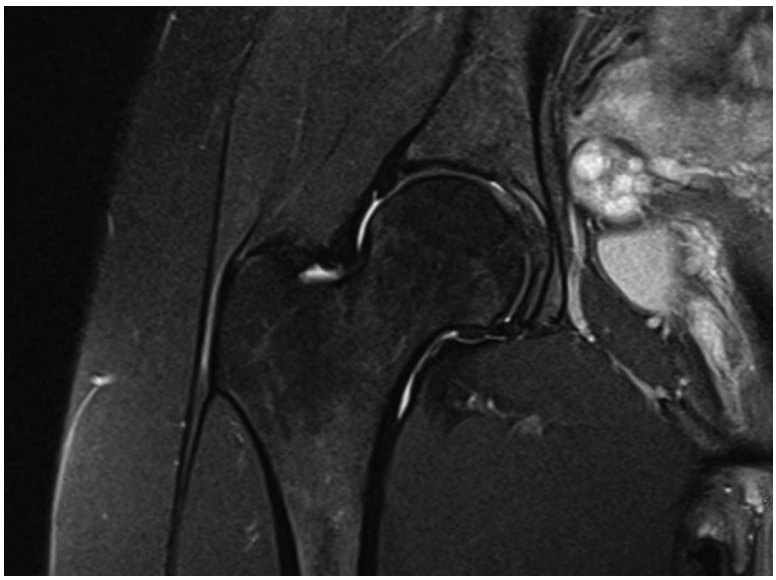

Fig. 29.26 Coronal T2 MRI sequence shows asphericity of the femoral head on lateral margin of head–neck junction with possible disruption at the chondral–labral junction laterally

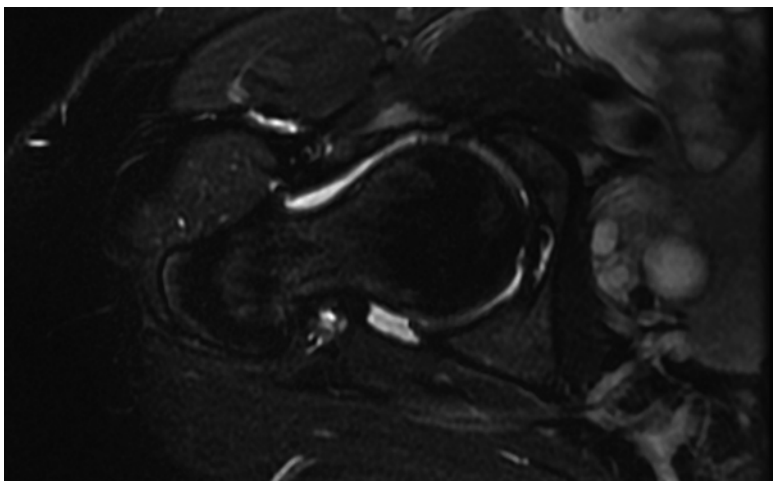

Fig. 29.27 Axial T2 MRI appears relatively normal with mild loss in head–neck offset anteriorly

anterolateral aspect of the head–neck junction seen in Fig. 29.28. Areas of impingement were noted and quantified in this area on arthroscopic impingement test. Thus, cam lesion was removed utilizing a 5-mm-round burr while viewing from the anterolateral portal and working through the mid-anterior portal (Fig. 29.29). Again, to fully appreciate and adequately resect the entire lesion, we switch to the mid-anterior portal for viewing in order to visualize the lateral aspect of her lesion. Figure 29.30 demonstrates this and allows complete resection of the lateral gutter. Cam resection measured 3-mm deep and 30-mm wide from a medial 6 o'clock position to a lateral 12 o'clock position. Periodic dynamic examination was performed to indicate sufficient resection with no impingement.

Discussion

This case reinforces the role for understanding isolated mild femoral deformity and activity in treating labrum tears. The MRI again instructs awareness of chondrolabrum tearing being the typical variation of labrum tearing in the hip. The mechanism of sheer force disrupting the articular

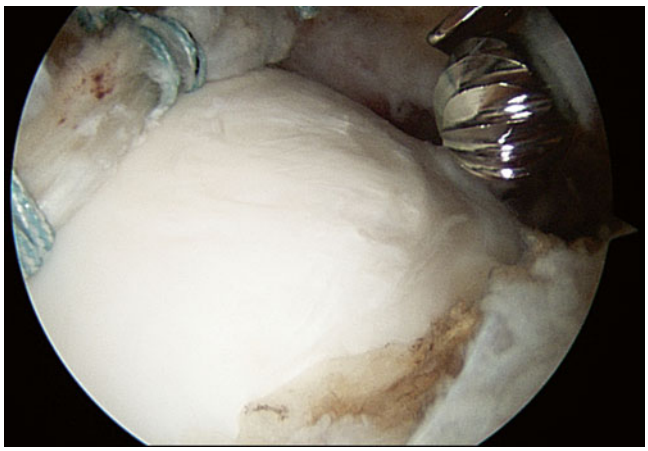

Fig. 29.28 Viewing via anterolateral portal, cam lesion visualized adjacent to the newly repaired labrum. Appearance of cam lesion is different from articular cartilage in color and texture

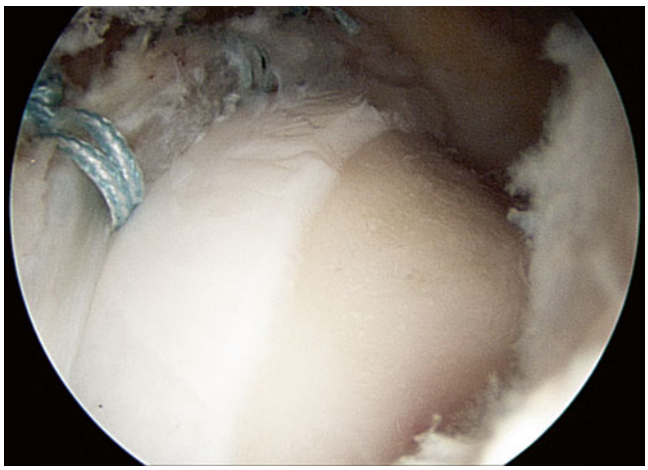

Fig. 29.29 Viewing from the anterolateral portal., femoral head–neck junction has been contoured by high-speed burr to reestablish head–neck offset anteriorly

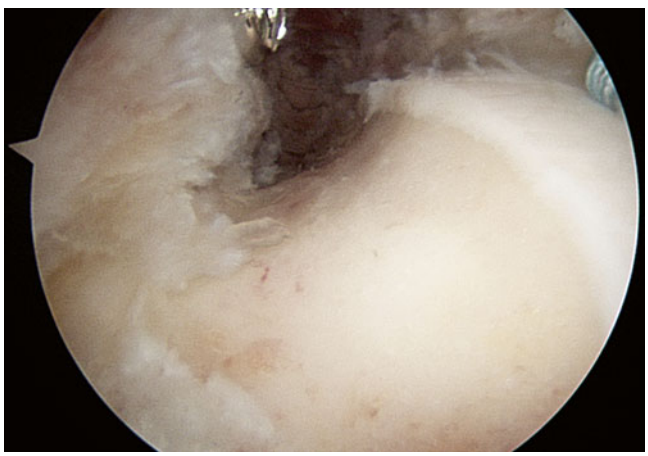

Fig. 29.30 Viewing from the mid-anterior portal, lateral aspect of the lesion is resected to the 12 o'clock position

cartilage/labrum juncture due to femoral asphericity leads to the articular surface tearing from the labrum, rather than the labrum tearing away from the acetabular rim.

Conclusions

The interaction between morphologically abnormal femur and acetabulum combined with extensive, vigorous demands placed on the hip joint culminates in FAI, manifesting as repetitive and progressive intra-articular soft tissue injury. Although cam impingement itself is not painful, it may contribute and lead to pathology that becomes symptomatic over time, including chondral delamination and labral tears. While most cam lesions can be comfortably treated arthroscopically, posterior lesions are difficult to access and thus can safely be treated utilizing an open surgical hip dislocation popularized by Ganz. The key lies in detection and treatment of symptomatic patients prior to the secondary arthritic-disease process becoming too advanced to reasonably benefit from hip preservation surgery. Principles for evaluation of patients presenting with the appropriate clinical picture and lifestyle activities presented in this chapter along with correlation to appropriate imaging modalities allow for appropriate intervention and halt progression of a deleterious process.

References

1. Harris WH. Etiology of osteoarthritis of the hip. Clin Orthop Relat Res. 1986;213:20–33.
2. Ganz R, Parvizi J, Beck M, Leunig M, Notzli H, Siebenrock KA. Femoroacetabular impingement: a cause for osteoarthritis of the hip. Clin Orthop Relat Res. 2003;417:112–20.
3. Ganz R, Gill TJ, Gautier E, Ganz K, Krugel N, Berlemann U. Surgical dislocation of the adult hip a technique with full access to the femoral head and acetabulum without the risk of avascular necrosis. J Bone Joint Surg. 2001;83(8):1119–24.
4. Byrd JW. The role of hip arthroscopy in the athletic hip. Clin Sports Med. 2006;25(2):255–78, viii.
5. Ito K, Minka 2nd MA, Leunig M, Werlen S, Ganz R. Femoroacetabular impingement and the cam-effect. A MRI-based quantitative anatomical study of the femoral head-neck offset. J Bone Joint Surg Br. 2001;83(2):171–6.
6. Audenaert EA, Peeters I, Vigneron L, Baelde N, Pattyn C. Hip morphological characteristics and range of internal rotation in femoroacetabular impingement. Am J Sports Med. 2012;40(6):1329–36.
7. Leunig M, Casillas MM, Hamlet M, Hersche O, Notzli H, Slongo T, et al. Slipped capital femoral epiphysis: early mechanical damage to the acetabular cartilage by a prominent femoral metaphysis. Acta Orthop Scand. 2000;71(4):370–5.
8. Byrd JW, Jones KS. Arthroscopic femoroplasty in the management of cam-type femoroacetabular impingement. Clin Orthop Relat Res. 2009;467(3):739–46.
9. Martin HD, Kelly BT, Leunig M, Philippon MJ, Clohisy JC, Martin RL, et al. The pattern and technique in the clinical evaluation of the adult hip: the common physical examination tests of hip specialists. Arthroscopy. 2010;26(2):161–72.

10. Chinkulprasert C, Vachalathiti R, Powers CM. Patellofemoral joint forces and stress during forward step-up, lateral step-up, and forward step-down exercises. J Orthop Sports Phys Ther. 2011;41(4):241–8.
11. Nepple JJ, Prather H, Trousdale RT, Clohisy JC, Beaule PE, Glyn-Jones S, et al. Clinical diagnosis of femoroacetabular impingement. J Am Acad Orthop Surg. 2013;21 Suppl 1:S16–9.
12. Clohisy JC, Carlisle JC, Beaulé PE, Kim Y-J, Trousdale RT, Sierra RJ, et al. A systematic approach to the plain radiographic evaluation of the young adult hip. J Bone Joint Surg. 2008;90 Suppl 4:47–66.
13. Meyer DC, Beck M, Ellis T, Ganz R, Leunig M. Comparison of six radiographic projections to assess femoral head/neck asphericity. Clin Orthop Relat Res. 2006;445:181–5.
14. Sutter R, Dietrich TJ, Zingg PO, Pfirrmann CW. How useful is the alpha angle for discriminating between symptomatic patients with cam-type femoroacetabular impingement and asymptomatic volunteers? Radiology. 2012;264(2):514–21.
15. Milone MT, Bedi A, Poultsides L, Magennis E, Byrd JW, Larson CM, et al. Novel CT-based three-dimensional software improves the characterization of cam morphology. Clin Orthop Relat Res. 2013;471(8):2484–91.
16. Leunig M, Podeszwa D, Beck M, Werlen S, Ganz R. Magnetic resonance arthrography of labral disorders in hips with dysplasia and impingement. Clin Orthop Relat Res. 2004;418:74–80.
17. Bedi A, Dolan M, Magennis E, Lipman J, Buly R, Kelly BT. Computer-assisted modeling of osseous impingement and resection in femoroacetabular impingement. Arthroscopy. 2012;28(2):204–10.
18. Skendzel JG, Philippon MJ. Management of labral tears of the hip in young patients. Orthop Clin North Am. 2013;44(4):477–87.
19. McCormick F, Kleweno CP, Kim YJ, Martin SD. Vascular safe zones in hip arthroscopy. Am J Sports Med. 2011;39 Suppl:64s–71.
20. Steadman JR, Rodkey WG, Rodrigo JJ. Microfracture: surgical technique and rehabilitation to treat chondral defects. Clin Orthop Relat Res. 2001;391(Suppl):S362–9.
21. Philippon MJ, Briggs KK, Yen YM, Kuppersmith DA. Outcomes following hip arthroscopy for femoroacetabular impingement with associated chondrolabral dysfunction: minimum two-year follow-up. J Bone Joint Surg. 2009;91(1):16–23.
22. Espinosa N, Beck M, Rothenfluh DA, Ganz R, Leunig M. Treatment of femoro-acetabular impingement: preliminary results of labral refixation. Surgical technique. J Bone Joint Surg Am. 2007;89 Suppl 2 Pt.1:36–53.