CME ARTICLE

Femoroacetabular Impingement: Current Concepts in Diagnosis and Treatment

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educational objectives

As a result of reading this article, physicians should be able to:

1. Identify the etiology of femoroacetabular impingement.
2. Assess femoroacetabular impingement on physical examination.
3. Recognize femoroacetabular impingement on imaging studies.
4. Discuss modern techniques to effectively treat femoroacetabular impingement, both open and arthroscopic.

Abstract

Femoroacetabular impingement (FAI) is a recently proposed concept describing abnormal anatomic relationships within the hip joint that may lead to articular damage. Impingement is caused by bony deformities or spatial malorientation of the femoral head-neck junction and/or the acetabulum. These abnormalities lead to pathologic contact and shearing forces at the acetabular labrum and cartilage during physiological hip motion. There is an increasing body of evidence that these forces lead to cartilage wear

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Received: September 10, 2013; Accepted: April 14, 2014.
doi: 10.3928/01477447-20150305-07

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and eventual osteoarthritis. Treatment options for FAI are evolving rapidly. Although the gold standard remains open hip dislocation, arthroscopic techniques have shown significant promise. It is possible that early recognition and treatment of subtle deformity about the hip may reduce the rate of hip osteoarthritis in the future. [*Orthopedics*. 2015; 38(3):185-199.]

Morphological abnormalities of the hip joint occur as sequelae of childhood diseases (eg, developmental dysplasia of the hip, epiphyseal dysplasia, slipped capital femoral epiphysis), inflammatory diseases (eg, rheumatoid arthritis), osteonecrosis (eg, Legg-Calvé-Perthes disease), and posttraumatic conditions. However, the relationship of these childhood morphological abnormalities of the hip joint to the cause of primary, or idiopathic, hip osteoarthritis (OA) remains unknown. Proposed theories for primary hip OA include cumulative damage from axial overload, decreased contact area, and point loading from abnormal acetabular or femoral head anatomy. The concept of impingement was reintroduced by Ganz et al,[1] with the recognition that malunited femoral neck fractures that healed in retroversion could cause abnormal contact between the femoral neck and acetabular rim leading to accelerated posttraumatic OA. Over the past 2 decades, Ganz et al[2] postulated that unrecognized developmental alterations and malorientations of the hip may be the underlying cause of primary or idiopathic hip OA. Femoroacetabular impingement (FAI) is defined as abnormal femoral acetabular contact that occurs within the normal range of motion (ROM) caused by alterations of the acetabulum and/or the femoral head or neck.[3]

Classification

Two patterns of FAI have been described based on their characteristic appearance on plain anteroposterior (AP) radiographs of the pelvis and during arthroscopic or open examination of the hip. Cam FAI is generally caused by morphological factors on the proximal femur, whereas pincer FAI is due to either localized or generalized acetabular overcoverage. These patterns can occur in isolation but are often observed in combination.[2]

Figure 1: Pistol grip deformity of the femoral head with mild posterior and inferior migration of the femoral head resulting in anterosuperior cam deformity and decreased femoral head-neck offset.

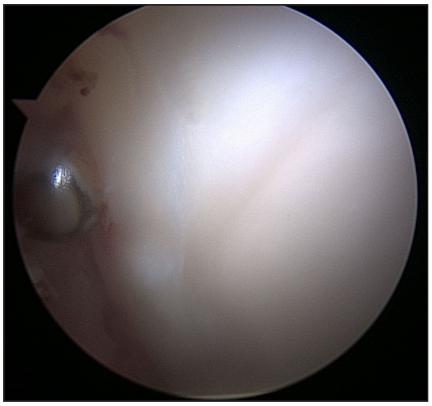

Figure 2: The wave sign is delamination of the anterosuperior acetabular cartilage recognized during hip arthroscopy and represents outside-in damage from cam impingement on the acetabular labrum and the force ultimately transmitted to the articular cartilage.

Cam FAI is typically found in young males with an abnormally shaped femoral head. In 1965, Murray[4] first described the tilt deformity of the proximal femur as a risk factor for primary hip OA. This deformity represented a posterior and inferior migration of the femoral head, a deformity with a resemblance to a mild slipped capital femoral epiphysis. In 1974, Stulberg and Harris[5] coined the term *pistol grip deformity*, referring to a similar abnormal shape of the femoral head (**Figure 1**). At the time, the pistol grip deformity was apparent in 40% of patients who developed primary hip OA. Longitudinal studies of patients with slipped capital femoral epiphysis, Legg-Calvé-Perthes disease, multiple epiphyseal dysplasia, and spondyloepiphyseal dysplasia demonstrated abnormal hip morphology that was similar to the pistol grip deformity of the proximal femur.[6]

The characteristic cam deformity involves an aspherical femoral head with a flat or convex head-neck junction. This deformity, or bump, consists of an increased localized head radius and has been quantified using a number of techniques, including the alpha angle. During hip ROM, due to the increased localized radius, the cartilage in contact with the area of asphericity is delaminated from the bony acetabulum. The labrum is thought to be relatively preserved in the pure cam situation because it is not directly impacted. This outside-in cartilage damage can vary from mild softening of acetabular cartilage to delamination propagating toward the center of the joint and frank cartilage destruction and OA. Delamination is recognized during hip arthroscopy as a wave sign (**Figure 2**).[7]

Pincer FAI is typically found in middle-aged females with a functionally excessive acetabulum that is either too deep or maloriented. This characteristic acetabular deformity involves coxa profunda, coxa protrusio, excessive acetabular anteversion, or acetabular retroversion. In reality, symptomatic acetabular anteversion is exceedingly rare in the current authors' experience. The pincer deformity is quantified radiographically by the center-edge angle, crossover sign, ischial spine sign, posterior wall sign, and relationship of the acetabulum to the tear drop or ilioischial line.[8-11] During hip ROM, the affected region of the acetabulum abuts the femoral head-neck junction. When the pincer deformity impinges on the femoral head-neck junction, the labrum is often injured, resulting in labral cyst formation, fissuring, and tearing. The labrum is in continuity with the articular cartilage of the acetabulum, and, therefore, localized damage to the acetabular cartilage follows. Fortunately, the degree of acetabular cartilage damage is minimal relative to that seen in cam impingement due to the relatively normal femoral morphology. Over time, bone is deposited along the acetabular rim (ie, osseous metaplasia, os acetabulare). This deepens the acetabulum and usually proceeds from the rim outward, pushing the labrum away from the acetabulum. These changes lead to further worsening of the pincer FAI. Ultimately, the abutting region of the femoral head-neck junction can cause acetabular rim fractures, osteophyte formation (ie, pincer exostosis), and ulcerations in the femoral periosteum (eg, herniation pits, fibrocysts).[12-14] Based on observations made at the time of surgical hip dislocations, secondary wear of the posterior inferior aspect of the acetabulum also occurs. This contrecoup lesion may be secondary to leverage of the femoral head-neck junction against the anterior acetabulum rim, driving the femoral head posteriorly.[8]

Although cam and pincer FAI are often described as separate entities, approximately 42% of affected patients present with some combination of both conditions.[15] In isolation or together, FAI causes abnormal forces within the hip joint that lead to clinical symptoms and may drive the progression of primary hip OA.

History and Physical Examination

Femoroacetabular impingement usually presents in patients younger than 50 years. Presentation can be variable, but patients often report a gradual onset of groin pain or buttock pain and loss of terminal hip ROM.

On physical examination, the patient has decreased hip ROM, particularly when internally rotated or adducted in flexion.[8] Hip flexion is limited in some cases to as little as 45º but can also be equal to the asymptomatic side. Hip internal rotation with the hip flexed to 90º is also limited. With severe deformities, obligatory external rotation with hip flexion is observed.[16] Gait patterns can range from normal to a slightly antalgic limp.

The anterior impingement sign is a useful maneuver to recreate cam and pincer FAI–related pain. It is performed by placing the patient supine on the examination table. The hip is flexed to 90º, adducted, and internally rotated. The test is positive if the patient feels pain or demonstrates apprehension. This maneuver leads to direct contact between the femoral neck and the acetabular rim or labrum.[17]

The posteroinferior impingement sign is a useful maneuver to recreate pincer FAI–related pain. It is performed by having the patient lie supine at the edge of the examination table. With the hip extended and the knee flexed, the hip is slightly externally rotated. The test is positive if the patient feels pain or demonstrates apprehension. This maneuver loads the posteroinferior aspect of the hip.[18]

Adept clinical and radiographic evaluation of patients with hip pain is imperative because there is usually a substantial delay in determining the correct diagnosis with labral pathology after the onset of initial symptoms.[19-21] The causes of hip pain can be separated into 3 different categories: intra-articular, extra-articular, and hip mimickers.[22]

Intra-articular

Some common intra-articular sources of hip pain include labral tears and loose bodies. Labral tears may be FAI or non-FAI related. Degenerative labral tears have been described in patients with developmental dysplasia of the hip and OA. Structural labral abnormalities with resultant labral pathology were subsequently described in a number of disorders, including trauma, Legg-Calvé-Perthes disease, slipped capital femoral epiphysis, and FAI. Loose bodies may be clustered or solitary fragments, depending on the etiology. They may also be ossified or nonossified. Mechanical symptoms such as clicking and catching or a restriction in ROM may be present in individuals with a suspected labral tear or loose bodies.

Extra-articular

Some common extra-articular causes of hip pain include iliopsoas tendonitis, iliotibial band syndrome, adductor strains, and piriformis strain. Trochanteric bursitis is the result of repetitive friction between the greater trochanter and iliotibial band with subsequent inflammation of the interposing trochanteric bursa. In many cases, patients describe pain over the greater trochanter radiating down the lateral thigh. They may have difficulty lying on their side because of direct compression of the bursa.[23] More recently, gluteus medius and minimus tendinopathy has been noted as the underlying pathological entity leading to many cases of lateral hip pain.[24-29] The majority of patients with trochanteric bursitis can successfully be treated with nonoperative treatments such as activity adjustment, cortisone injections, or physical therapy.[30] In refractory cases or those involving tendinopathy, some have advocated needle tenotomy under ultrasound guidance with injection of autologous blood or platelet-rich plasma.[31] Surgery is rarely required; however, in some cases, both open and arthroscopic techniques of bursectomy, abductor tendon debridement and repair, and iliotibial band release and fenestration have been described for patients refractory to nonoperative measures.[23,32-35]

Hip Mimickers

Another cause of chronic groin pain in athletes has variously been termed athletic pubalgia, sports hernia, and rectus

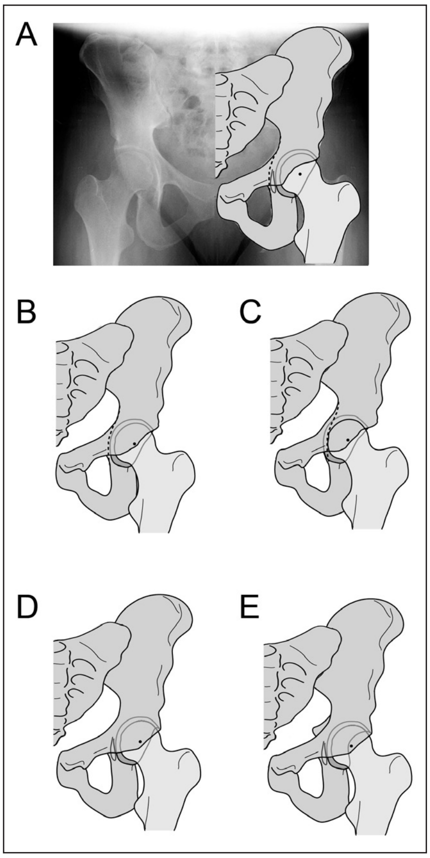

Figure 3: A true anteroposterior pelvis radiograph is one where the coccyx points toward the pubic symphysis and the distance between the sacrococcygeal joint and the pubic symphysis is approximately 32 mm in males and 47 mm in females as demonstrated in the schematic drawing of a normal hip (A). If the acetabulum extends medial to the ilioischial line (dotted line), the hip is classified as a coxa profunda (B). If the femoral head extends medial to the ilioischial line (dotted line), the more severe condition of coxa protrusio exists (C). Acetabular overcoverage can be recognized on standard radiographs by the crossover sign, a figure-of-8 where the anterosuperior acetabular rim extends lateral to the posterosuperior acetabular rim (D). A more distal position of the crossover indicates increasing severity of the acetabular anterior overcoverage or may indicate acetabular retroversion. The posterior wall sign is present when the posterior wall is more medial than the center of the femoral head. The ischial spine sign is present when there is prominence of the ischial spines on a true anteroposterior radiograph of the pelvis (E).

abdominis injury. Patients typically have an insidious onset of pain with activity, resolving with rest, and radiating into the adductor, perineum, rectus, inguinal ligament, or testicular areas. Sports and physical activities that consist of repetitive twisting motions have been shown to have a higher incidence of these types of injuries.[22] Thus, it is important to obtain an appropriate history to be able to rule out this type of injury. The current authors have used a combination of magnetic resonance imaging (MRI) and diagnostic ultrasound in the diagnosis of these conditions.

Imaging

Radiographic evaluation of hip pathology begins with an AP pelvis radiograph (**Figure 3A**). Rotational and sagittal positional errors can lead to inaccurate diagnosis and treatment, highlighting the importance of meticulous radiographic technique. The true AP pelvis radiograph is one where "the coccyx points toward the symphysis pubis with a distance of 1 to 2 cm between them."[8] The distance between the sacrococcygeal joint and the pubic symphysis averages 32 mm in males and 47 mm in females.[36] It is critical to look at multiple radiographic parameters in addition to the evaluation of the hip joint. These additional areas would include the lower lumbar spine looking for degenerative disk disease, scoliosis, increased lumbar lordosis, and evidence of previous surgery such as laminectomy, arthrodesis, or arthroplasty. The next point of review is the sacrum and sacroiliac joint, looking for erosions and sclerosis that may indicate a seronegative arthropathy such as ankylosing spondylitis. Next, the ilium, ischium, and pubis are evaluated for asymmetry or previous trauma. In all of these areas, one must maintain neoplastic disease on the differential diagnosis, particularly in the absence of a more clear explanation of the symptoms. Once the adjacent structures have been fully evaluated, the hip joint itself can be assessed.

The AP pelvis view provides substantial information about the joint space and general morphology of the hip. The best way to organize the assessment of the hip is to look at the acetabulum and the proximal femur independently. Abnormalities of the acetabulum can be divided into those of position, orientation, coverage, and/or degree of degeneration. Abnormal acetabular position has been described with reference to Kohler's line (ie, ilioischial line).[8] If the acetabular cavity extends medial to Kohler's line, the hip is classified as coxa profunda (**Figure 3B**). If the femoral head extends medial to Kohler's line, then the more severe diagnosis of coxa protrusio is made (**Figure 3C**).

The issues of orientation and coverage of the acetabulum are closely linked. Excessive retroversion of the acetabulum would lead to increased anterior coverage at the expense of decreased posterior coverage. Coverage of the acetabulum is also linked to the overall position of the acetabular bone based on the presence of coxa profunda or protrusion, as well as secondary increases in bony coverage of the acetabulum from osseous metaplasia of the labrum. Acetabular overcoverage secondary to acetabular retroversion is often a subtle finding and is most clinically relevant in the superior acetabulum. Qualitatively, it can be recognized on standard radiographs by the crossover sign, a figure-of-8 where the anterior superior acetabular rim extends lateral to the posterior superior acetabular rim (**Figure 3D**).[9,36-38] The position of the crossover is a rough method of determining the general severity of the retroversion, with the more caudal positions indicating more extreme degrees of retroversion. In addition, the visibility of the ischial spine on an appropriately positioned pelvic radiograph has been associated with retroversion (**Figure 3E**).[10,39,40]

As discussed, a variety of abnormalities of the acetabular position, orientation, and osseous metaplasia can, alone or in combination, lead to excessive coverage. In contrast, acetabular undercoverage is commonly seen in developmental dysplasia of the hip. Both of these situations can be quantified using numerous techniques, including the lateral center-edge angle of Wiberg and the acetabular index.[11] Finally, the assessment of the acetabulum requires evaluation of the degree of degeneration pertaining to that part of the hip. Findings of intraosseous cysts, subchondral sclerosis, and joint space narrowing indicate the onset of advanced degenerative changes. The completion of analysis of the acetabulum is closely followed by scrutiny of the proximal femur.

The proximal femoral geometry and its implications on the hip depend on both the version angle of the femoral neck and the morphology of the femoral head. The femoral neck version is typically described based on the angle between the femoral neck and the posterior condylar line of the femur at the knee. Various radiological methods have been described to quantify this angle.[41-43] Increased retroversion angles lead to limited internal rotation of the hip and the potential for closer ongoing proximity between the femoral neck and the acetabular rim.[8,44,45] Thus, femoral retroversion is a predisposing factor for FAI. The morphology of the femoral head can be assessed based on measures of asphericity and on the offset between the femoral head and femoral neck. The alpha angle was first described for quantifying asphericity on MRI in the diagnosis of cam-type FAI. More recently, this measure has been applied to other types of imaging, including standard radiographs and computed tomography (CT) images (**Figure 4A**).[3] To measure the alpha angle, a line is drawn between the center of the femoral head and the center of the femoral neck at its narrowest point. A circular template is then placed on the femoral head. The point where the bone of the femoral neck exits the contour of the circle is marked. A line is then drawn from this point to the center of the femoral head. The alpha angle is defined between this line and the line connecting the femoral head and neck center. Patients with cam FAI have an alpha angle exceeding 50º.[46,47]

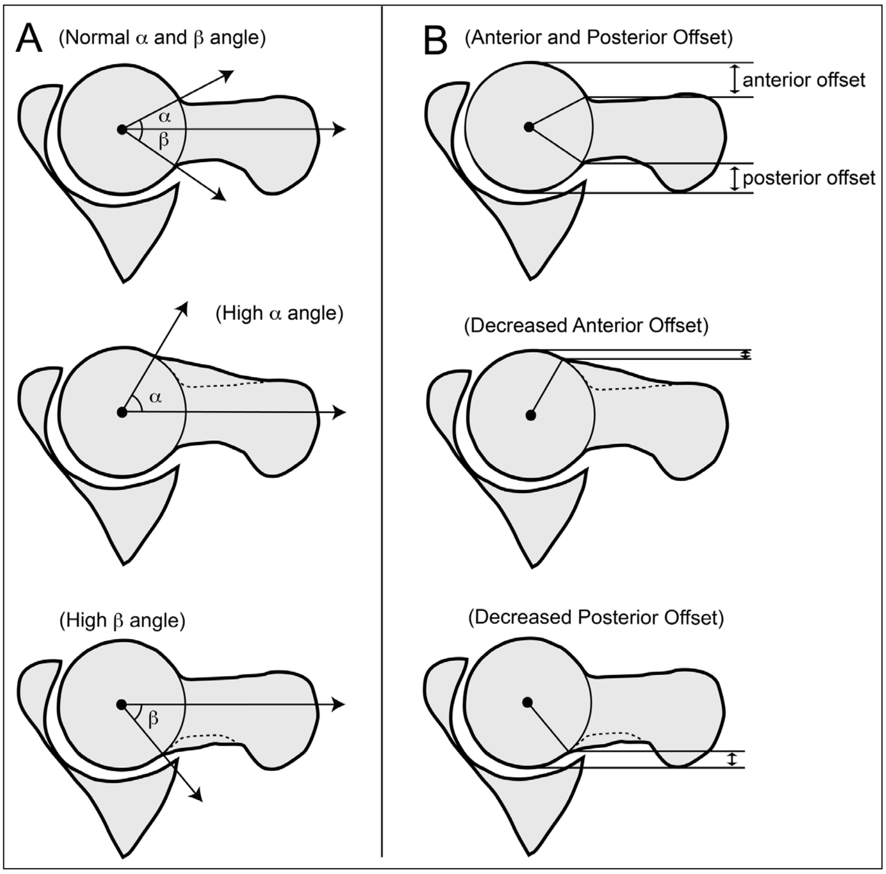

Figure 4: To measure the alpha angle, a line is drawn between the center of the femoral head and the center of the femoral neck at its narrowest point. A circular template is placed over the femoral head. The point where the neck protrudes out from the circular template is marked. A line is then drawn from this point to the femoral head center. The angle between this line and the line connecting the femoral head center and the femoral neck center is defined as the alpha angle. Patients with cam femoroacetabular impingement have an average alpha angle of 74º, whereas those without have an average alpha angle of 42º. The beta angle, a correlate to the alpha angle, has been developed to assess posterior head-neck concavity (A). To measure head-neck offset, a line is drawn bisecting the longitudinal axis of the femoral neck. This line does not have to cross through the femoral head center. A second line is drawn parallel to the first line and tangent to the anterior or posterior femoral neck. A third line is drawn parallel to the other 2 lines and tangent to the anterior femoral head. The perpendicular distance between the second and third line is defined as the head-neck offset, with a value less than 9 mm considered abnormal. The head-neck offset ratio is defined as the ratio of the head-neck offset to the diameter of the femoral head. A ratio less than 0.17 is considered abnormal (B).

The prevalence of cam FAI deformities was studied in a population-based study of radiographs obtained from the Copenhagen Osteoarthritis Study.[48] The alpha angle was measured on 3202 AP pelvis radiographs of patients with an average age older than 60 years; it averaged 52.6° for males and 44.9° for females. Evaluation of hip MRIs in 39 symptomatic hips and asymptomatic volunteers demonstrated an average alpha angle of 42º in the asymptomatic group and 74º in the symptomatic group. Radial sequence MRI of 41 patients with clinical FAI noted a disparity between the measurements on the oblique axial images with a mean alpha angle of 53º and the highest radial sequence alpha angle measurement of 71º.[49] Another study evaluating radial sequence MRIs in 200 asymptomatic volunteers measured the alpha angle at 50º in the 1:30 position and 41º in the 3:00 position.[50] Hips with deficient or excessive acetabular coverage represent a special subgroup. A circumferential radial sequence MRI evaluation of the head sphericity, epiphyseal extension, and alpha angle in 50 hips with acetabular overcoverage showed an average alpha angle of 40º in the anterosuperior quadrant and 33º in the posterosuperior quadrant. Interestingly, there was no statistically significant difference between the 2 groups in the anterosuperior region, the most likely area for clinical FAI to occur in flexion activity.[51]

The beta angle, a correlate to the alpha angle, has been developed to assess posterior head-neck concavity (**Figure 4**).[52] In addition, the head-neck junction can be inspected for herniation pits or synovial fibrocysts as commonly seen in pincer FAI.[12,13] These structures represent intraosseous ganglion cysts, presumably formed by the repetitive impaction of the femoral neck on the acetabular rim. They are seen as well-corticated lucencies of variable size located at the base of the femoral head at the anterolateral femoral head-neck junction.[14]

Lateral radiographs (eg, cross-table, frog-leg, modified Dunn) allow for evaluation and quantification of femoral head-neck offset on the anterolateral aspect of the head-neck junction (**Figure 4B**). A line is drawn connecting the center of the femoral head and femoral neck. A second line is drawn parallel to the first line and tangent to the anterior femoral neck. A third line is drawn parallel to the other 2 lines and tangent to the anterior femoral head. The perpendicular distance between the second and third line is defined as the head-neck offset, with a value less than 9 mm considered abnormal. The head-neck offset ratio is defined as the ratio of the head-neck offset to the diameter of the femoral head.

The optimal technique for assessing femoral head-neck morphology using standard hip radiographs is controversial. Depending on the location of the deformity, both the AP and lateral radiographs of the hip can appear normal. The Dunn view is a specialized lateral view of the hip obtained with an AP projection of the hip with the hip flexed on a leg holder. The Dunn view can be performed at 45° or 90° of hip flexion. One cadaveric study compared the AP pelvis view, Dunn view in 90° of hip flexion, Dunn view in 45° of hip flexion, cross-table lateral view in 15° of internal rotation, cross-table lateral view in neutral rotation, and cross-table lateral view in the 15° of external rotation to determine which radiograph best identifies femoral head-neck asphericity. This study showed that the Dunn view in 45° and 90° of hip flexion or a cross-table lateral view in internal rotation was more sensitive for femoral head-neck asphericity than the AP pelvis view or cross-table lateral view in external rotation.[53]

Magnetic resonance imaging protocols have been developed specifically for the assessment of FAI. It is critical to obtain imaging of the hip with high enough resolution to accurately assess the hip joint and the adjacent soft tissue structures. A pelvis MRI including both hips and the intra-abdominal and intrapelvic structures is often inadequate to diagnose subtle pathology of the hip; a dedicated hip MRI with a hip coil and intravenous or intra-articular contrast is required. Magnetic resonance imaging with arthrography facilitates assessment of labral and chondral lesions as well as morphology of the acetabular rim and femoral head-neck junction.[54-56] The necessity of radial sequence imaging to assess labral and cartilage pathology is controversial. The radial sequence imaging protocol establishes an imaging axis along the femoral head-neck axis. Images are obtained around this axis in 15° to 30° intervals. This radial perspective allows precise morphologic assessment of femoral head-neck offset, femoral head sphericity, articular depth, labrum, and articular cartilage.

The normal labrum appears triangular, has sharp margins, and has low signal intensity on T1- and T2-weighted images. On gradient echo (GRE) sequences, it has higher signal intensity similar to fibrous tissue. The normal labrum also has a continuous attachment to the bony rim of the acetabulum, particularly at the superior aspect. There is normally a small hiatus in the labrum near the anterior inferior acetabulum. A degenerated labrum has increased signal on T2-weighted and GRE sequences. Myxoid degeneration is represented by increased volume of the labrum. A tear of the labrum is demonstrated by a linear band of high signal intensity in the labrum or between the labrum and acetabular cartilage. If the tear is long standing, there may be synovial tissue that extrudes between the labrum and acetabular rim, causing a soft tissue ganglion.[54] Thinning of the labrum with ossification starting at the articular side and progressing outward can be seen in chronic pincer FAI. In the late stages, the entire outline of the labrum can be converted to bone. This ossification can be seen on standard radiographs as a beaking of the lateral aspect of the acetabulum or calcifications in the soft tissue adjacent to the acetabulum.[57]

The frequency of acetabular lesions by location from most to least frequent is anterosuperior, posterosuperior, anteroinferior, and posteroinferior.[58] Cartilage pathology is usually adjacent to labral pathology because the labrum is in continuity with the acetabular cartilage. Distinguishing femoral and acetabular cartilage lesions is exceedingly difficult using available MRI techniques. Although MRI with arthrography reliably detects detached labral and cartilage lesions, undetached cartilage separations are poorly identified.[59] Magnetic resonance imaging has been used to assess the overall health of the articular cartilage. T_1-rho, delayed gadolinium-enhanced MRI of cartilage (dGEMRIC), and sodium MRI analyze the collagen and glycosaminoglycan content of cartilage but have not been widely translated to clinical application.

Traditionally, CT scans have not been widely used in the evaluation of FAI except in cases of significant bony deformity. However, the use of new multidimensional postprocessing techniques to create 3-dimensional models of the femur and acetabulum allows for analysis of acetabular version, femoral version, and morphology of the femoral head-neck junction.[60,61] This technique allows dynamic assessment of contact between the femoral neck and acetabulum.[62]

Treatment

Once the definitive diagnosis of FAI has been made, the treatment should be tailored to the patient's symptoms. Many patients with pronounced morphological abnormalities are essentially asymptomatic until their initial presentation with end-stage OA. Furthermore, the role of morphological correction in changing the natural history of the disease is not known. The ultimate outcome likely depends on numerous factors, including patient characteristics such as activity level, degree of cartilage damage, age, and body weight. Over time, the current authors' approach has evolved from a dogmatic approach to surgery as the only approach to a more mature view incorporating the natural healing capability of the hip. The goal of treatment is not to eliminate OA but to minimize current symptoms and decrease pain with the ultimate goal of restoring the joint to health with the potential long-term benefit on the development of arthritis.

Nonoperative treatment is critical in distinguishing the patients in whom the area of damage to the joint may heal from those who may remain symptomatic. Currently, the keys are to avoid the aggravating activity for a time, work on maintaining muscle strength, and judiciously use anti-inflammatory drugs.[63] However, none of these treatments correct the morphological issues. Recently, many institutions, including the current authors', have attempted to treat the labrochondral pathology with autologous platelet-rich plasma.[64] Unfortunately, few data are available on the success rate of nonoperative treatment in this setting. In addition, these new injections are currently viewed as experimental for this indication and are not covered by many insurance carriers. As a result, the emphasis of nonoperative treatment of FAI should be on addressing the symptoms of the disease. The goal would be to return the patient to the asymptomatic state even in the absence of morphological corrections. This includes activity modification, physical therapy, and oral anti-inflammatory drugs.[63] Some authors suggest that excessive focus on stretching and ROM as part of physical therapy may be counterproductive due to the generation of ongoing insult to the articular cartilage and labrum.[65]

Surgical management of FAI is customized based on the morphology of the hip. Typically, the socket and the chondrolabral junction are involved in both types of FAI. In the classical pincer FAI, the labrum may be degenerated or ossified with little damage to the articular cartilage. In cam FAI, the labrum may appear intact but the adjacent cartilage may be delaminated from the acetabular rim.

For pincer FAI, the objective is to eliminate the contact between the acetabular rim and the femoral neck. The specific surgical approach depends on the type of deformity. In cases of localized acetabular overcoverage, most commonly acetabular retroversion, selective trimming of the acetabular rim is performed. The labrum can be debrided, repaired, or reconstructed based on various factors. In cases of more severe deformities such as acetabular retroversion, reorientation of the entire acetabulum with a periacetabular osteotomy may be necessary. In cases with more global overcoverage, such as in coxa profunda or coxa protrusio, the entire rim of the acetabulum may require trimming. The current authors' typical approach for trimming the acetabulum with a relatively intact labrum involves resecting the labrum from the bony rim and articular cartilage with a motorized burr to debride its bony attachment and trimming the bone back to the desired level. Next, the labrum is repaired with suture anchors to the rim at its new position. An analogous procedure is performed if the labrum is reconstructed with allograft tendon or with autologous tissue such as a tubularized fascia lata graft.

For cam FAI, the objective is to eliminate the excessive bone and cartilage at the femoral head-neck junction. This is performed with motorized burrs or osteotomes in open procedures. The goal is to remove the area of asphericity. The radiographic goals are to improve the alpha angle and the femoral head-neck offset.

The location and configuration of labral repair in the hip deserves special consideration based on the role of the native labrum. The hip labrum functions as a fluid seal for the joint and has a minimal role in the weight-bearing support of the hip as seen in the knee meniscus or as a stabilizing structure such as the shoulder labrum. Based on this role as a seal or gasket around the head, it is preferable to repair the hip labrum with a mattress technique so that the free edge can continue to provide this sealing function. This is in contrast to repairs in the shoulder, where the labrum functions as a bumper, where sutures are often wrapped circumferentially around the labrum.

Femoroacetabular impingement has been treated using many different approaches. During the past decade, the approach of surgical dislocation has played an important role in the diagnosis and treatment of this condition. More recently additional approaches have been developed, including hip arthroscopy and anterior mini-arthrotomy.

Surgical Dislocation of the Hip

Ganz et al[2] described the technique of open surgical dislocation of the hip to treat FAI.

Technique. Surgical dislocation of the hip is performed with the patient in the lateral decubitus position with a straight lateral Gibson incision or a slightly more curved posterolateral Kocher-Langenbeck–type skin incision. A longitudinal incision of the iliotibial band is performed in line with the skin incision and extended proximally into the fascia of the gluteus maximus muscle. The gluteus maximus muscle is then split in the same fashion as commonly performed for total hip arthroplasty (THA). Some authors prefer the Gibson approach, which uses the intermuscular interval between the gluteus maximus and gluteus medius muscles.[66] The underlying greater trochanteric bursa is then divided or resected. The leg is internally rotated to approximately 40° by placing the foot and ankle on a well-padded Mayo stand. The posterior aspect of the greater trochanter is then exposed. It is critical to avoid any dissection of excessive manipulation of the piriformis tendon due to the risk of injuring the medial femoral circumflex artery. An oblique line is then drawn with electrocautery from the superior medial aspect of the greater trochanter to exit at the base of the trochanter. It is critical to avoid an excessively medial superior osteotomy due to risk of damage to the medial femoral circumflex artery and the lateral retinacular vessels. The osteotomy should have a maximal thickness of approximately 1.5 cm and is made with an oscillating saw. The goal is to exit from the top of the greater trochanter on the upsloping portion of the medial trochanter. Typically, it is best to leave a small portion of the upslope of the greater trochanter with a few fibers of the gluteus medius attached. This helps to protect the profundus branch of the medial femoral circumflex artery, which becomes intracapsular at the level of the superior gemellus muscle and runs under the piriformis muscle.

Once the greater trochanteric osteotomy is completed, the vastus lateralis is released subperiosteally from the lateral femoral shaft for a distance of 5 to 6 cm. Proximally, the gluteus medius muscle is freed from the bursa beneath it, mobilizing the trochanteric fragment more anteriorly. Next, deeper dissection is performed, developing the interval between the gluteus minimus and the piriformis. The gluteus minimus is adherent to the hip capsule distally and usually requires sharp dissection to be elevated off the capsule. The dissection is carried anteriorly while gradually externally rotating the femur and bringing the foot into the opening of a leg bag. More anteriorly, the gluteus minimus can be released more easily. Release of the origin of the vastus intermedius on the anterior femur may be required to increase the anterior exposure.

Once the entire capsule is exposed, the hip joint is entered through a Z-shaped capsulotomy that protects the retinacular vessels at the inferior part of the superolateral femoral neck. The central limb is in line with the axis of the femoral neck, and the superior rim curves posteriorly and proximally along the posterior rim of the joint. It is critical to protect the hip labrum and femoral head cartilage during the posterior capsulotomy. This can be performed by placing a traction suture in the capsular flap and using a sharp knife from inside-out to ensure that the cartilage and the labrum are not injured. The anteroinferior limb of the hip capsule is then incised. This capsulotomy protects the blood supply of the femoral head but can lead to some bleeding from an excessively distal anterior capsulotomy due to damage to the lateral femoral circumflex artery. Once the capsule is opened, the hip is dislocated. In most cases, the authors have the leg slightly externally rotated with the foot placed just within the entry of the leg bag while using a bone hook around the lesser trochanter and femoral shaft.

Next, a small amount of traction is applied to break the suction seal of the joint. The hip is usually easily subluxated approximately 2 to 3 cm. A curved Jorgenson scissors is then used to gently pass around the femoral head and to cut the ligamentum teres. One must be exceedingly careful during the passage of the scissors to avoid any contact with the femoral head cartilage to avoid iatrogenic damage to the head. Once the ligament is cut, a release is felt and the hip can be fully dislocated. The authors then place the hip back in the joint and take it through a range of motion to examine it for sites of impingement.

The exposure of the acetabulum can occasionally be difficult. It is initially achieved by externally rotating the hip further and putting the foot in the leg back at the front of the operating table. It is important to place a large bump under the operative thigh in the front of the table to avoid the leg's falling into an adducted position toward the floor. By having the thigh horizontal to the ground, the assistant can push back on the knee, allowing for improved exposure of the acetabulum. Next, the authors prefer to obtain circumferential exposure of the acetabulum with small Hohmann retractors. A large, narrow, curved Hohmann retractor can be placed into the acetabular fossa and against the femoral neck to achieve an exposure of the acetabulum.

At this point, attention is turned to the acetabular rim. The rim is addressed for cases of localized overcoverage as seen on the intraoperative impingement check and on preoperative imaging. It can also be addressed in cases of localized rim cartilage delamination. In such cases, the size of the lesion can be decreased by performing a rim trimming. Regardless of the indication, the labrum in the area to be addressed is cut sharply off the bony rim in a bucket-handle configuration. A burr or sharp, curved osteotome is then used to remove the selected area of the bone. The labrum is then repaired with metal, polymer, or resorbable suture anchors. The authors' preference is to use nonmetal anchors so as not to interfere with future MRI scans. As noted previously, it is preferable to perform a mattress-type suture to allow the labrum to maintain its role as a suction seal around the head rather than wrapping sutures circumferentially around the labrum. More recently, in cases with complete absence of the labrum due to ossification, the labrum is reconstructed with allograft tissue or a tubularized segment of the patient's own fascia lata (**Figure 5**).

Next, attention is turned to the femoral head-neck junction. This is performed by removing the deep Hohmann retractor from the acetabulum and allowing the head to come centrally into the wound. Using rotation, all portions of the head can be exposed and treated. The authors use blunt Hohmann retractors to keep the head in view and to lift the proximal femur out of the wound and stabilize it in position. If there is a cam lesion, osteochondroplasty of the head-neck junction is performed using a 10-mm, curved Lambotte osteotome or a high-speed burr. It is critical to take extreme care toward the posterior aspect of the neck, where a soft tissue tuft containing the retinacular vessels is located. After the impingement areas have been addressed, the hip is reduced and examined through the ROM to ensure that no further impingement remains. Typically, one helpful measurement is the degree of internal rotation with the leg in neutral abduction (femur parallel to the floor). Notzli et al[67] showed that the blood supply to the femoral head is maintained even after more than 1 hour of dislocation of the femoral head from the socket. However, care must be taken during closure because an excessively tight capsular repair has been shown to compromise the vascular supply to the femoral head.[68]

The closure involves repair of the capsule with a loose running resorbable suture followed by fixation of the trochanteric osteotomy with two to three 3.5-mm cortical screws or two 4.5-mm cortical screws. Postoperatively, the patient is restricted to toe-touch weight bearing for 6 weeks with hip flexion limited to 90º. Active abduction is prohibited for 6 weeks to avoid stress on the bony repair of the trochanter.

Outcomes. Surgical dislocation of the hip has shown encouraging short- and mid-term results for the treatment of symptomatic FAI. A small, retrospective evaluation of 19 hips with FAI treated by surgical dislocation of the hip demonstrated an improved Merle d'Aubigne hip score at an average 4.7-year follow-up in 13 hips, improved pain scores from 2.9 to 5.1, and no patients with avascular necrosis.[69] Five patients eventually went on to require THA.

A retrospective evaluation of 60 hips with FAI treated with surgical dislocation showed significant improvement in Merle d'Aubigne hip scores.[70] The authors compared 2 groups of patients: those treated with resection of their torn labrum and those treated with primary labral repair. Patients who underwent primary labral reattachment recovered earlier and had superior clinical and radiographic results compared with patients who had undergone resection alone.

During recontouring of the femoral head-neck junction, care must be taken not to overresect this bone. Studies have been performed to help assess a safe amount of femoral head-neck resection. A cadaveric study evaluated an increasing amount of femoral head-neck junction resection (10%, 30%, and 50%) with 15 matched cadaveric hips.[71] The contralateral femoral head-neck junction in each matched pair was left intact to serve as the control. A resection of 30% or more of the femoral head-neck junction significantly decreased the load-bearing capacity of the proximal femur.

Anterior Mini-arthrotomy

Anterior mini-arthrotomy has been proposed as an alternative approach to surgical hip dislocation to treat early anterolateral FAI.[72] This technique offers surgeons the ability to view the anterior portion of the head-neck junction without having to dislocate the joint.

Compared with surgical dislocation of the hip, anterior mini-arthrotomy offers a less invasive alternative for patients with anterolateral FAI. It should be emphasized that this procedure is not indicated for posteroinferior impingement, including coxa profunda, or circumferential pathology.

Technique. Hip arthroscopy may be used to assess the extent of FAI and to treat simple labral and articular cartilage lesions or accessible posteroinferior lesions. With the patient supine on a fracture table, a limited open anterior approach is done through a standard Smith-Petersen interval without need for a trochanteric osteotomy. An osteochondroplasty of the anterolateral femoral head-neck junction is performed, if necessary, and the amount of resection is confirmed fluoroscopically. Anterior calcified labrum and osteophytes from the acetabular rim are debrided, if necessary. The labrum is resected, repaired, or reconstructed. Intraoperatively, the traction is released and the leg is flexed either with the fracture table or by removing the foot from the traction device. The hip flexion should improve by 5° to 15º and internal rotation should improve by 5° to 20º following the acetabuloplasty and osteochondroplasty. Postoperatively, patients are limited to partial weight bearing for 6 weeks.

Outcomes. Laude et al[73] retrospectively evaluated 100 hips after the mini-anterior approach and reported that this

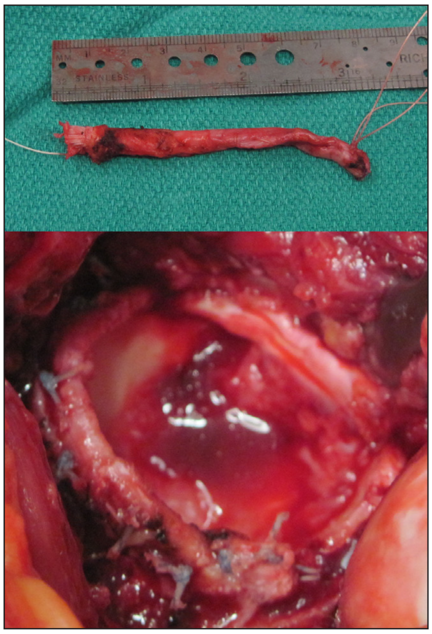

Figure 5: Case involving ossification of the labrum, labral resection, and labral reconstruction with a tubularized segment of the patient's own fascia lata.

technique offered a low complication rate, with only 1 femoral neck fracture and 11 cases of progression of arthritis necessitating conversion to THA. Average nonarthritis hip scores improved significantly at 2 years, from 55 to 84.

A study by Barton and Kim[74] followed 23 patients who underwent the procedure. Over a follow-up period ranging from 12 to 30 months, 5 patients required revision surgery and 3 were lost to follow-up. The other 15 experienced significant increases in Harris Hip Score, from an average of 70 to 84. Complications included transient lateral femoral cutaneous nerve injury and a case of heterotopic ossification.

A recent study reported 16 hips with symptomatic cam FAI that underwent diagnostic arthroscopy combined with an anterior arthrotomy; 13 (81%) of the 16 hips were found to have associated labral tears. At 24-month follow-up after labral repair and osteochondroplasty, patients experienced an improved alpha angle, from an average of 64.5° to 43.3°, as well as an improved femoral head-neck offset, from an average of 1.9 to 9.6 mm.[75]

The mini-anterior approach increases visualization of the femoral head-neck junction and allows for faster recovery times without the morbidity of a surgical dislocation and trochanteric osteotomy. These advantages come at the cost of limited access to posterior pathology and decreased global visualization of the socket and femoral head.

Hip Arthroscopy

Hip arthroscopy was first developed in the early 20th century.[76] Initial attempts at hip arthroscopy were done without traction, which led to limited visualization of the hip and limited space for instrumentation. It was eventually recognized that joint distraction was necessary to achieve adequate visualization of the hip joint.[77] Burman[76] described the importance of extra-long instruments to enter the hip joint, due to the thick overlying soft tissue envelope. He also described the anterolateral portal, still commonly used today. With improved instrumentation and technique, hip arthroscopy has become an increasingly popular procedure. As techniques continue to improve, the indications for hip arthroscopy are being expanded and refined.[77]

Arthroscopic techniques minimize soft tissue injury around the hip and reduce the risk of injury to the medial femoral circumflex artery. Hip arthroscopy can be done on a fracture table or on a standard table with a commercially available traction setup, in either the supine or lateral position. The lateral position has some advantages in obese patients and was historically the more common approach. More recently, the supine approach is becoming more popular due to better access to the anterior joint, where most of the pathology exists.

The benefits of hip arthroscopy over traditional open surgical dislocation are clear. There is less morbidity, faster recovery, less pain, fewer infections, and fewer complications.[7] However, hip arthroscopy cannot address all pathology about the hip. Arthroscopic procedures have a limited role in the treatment of acetabular dysplasia, severe acetabular protrusio, large cartilage defects, and severe acetabular retroversion. For these patients, an open approach may be indicated.

Nevertheless, hip arthroscopy has its own set of unique risks. They include traction injury to the sciatic and femoral nerve, compression neuropraxia of the pudendal nerve and superficial peroneal nerve, injury to the superior gluteal neurovascular bundle, and injury to the lateral femoral cutaneous nerve and femoral neurovascular bundle near the anterior portal.[78] Most of the complications relate to traction on the operative extremity. These complications can be minimized in various ways. Joint distension can decrease the amount of traction necessary to distract the hip joint prior to arthroscopy.[79] It is critical to place the operative extremity in a soft boot. Hard polymer boots are extremely dangerous for causing compression on the foot. In addition, the current authors wrap the foot with a roll of cotton cast padding and gel pads. It is critical not to prepare and drape the patient under traction. Every minute of traction time is critical, and it should be applied only when the surgical incision is about to be made. The authors' approach is to demonstrate that traction can be applied and the hip distracted off traction. Then the traction is applied and the suction seal of the joint is broken. They then release the traction just until the joint is radiographically reduced. Only then is the hip prepared and draped. Others have described a technique where they prepare a small area, place a spinal needle in the joint to break the suction seal, remove the needle, and only then prepare and drape the patient definitively. Another recommended technique is to take traction off during the case, particularly as it approaches 60 minutes of traction time. Intuitively, an increase in the duration of this "traction holiday" should result in improved nerve perfusion. Unfortunately, no animal studies address this question definitively.

Technique. The patient is positioned in the supine position with both legs in well-padded traction boots. Although a fracture table is an effective tool, numerous commercially available portable traction devices have been used. The authors typically use a portable traction system that can be attached to any operating room table. It is imperative to pad the dorsal aspect of the foot and to avoid any hard surfaces against the skin. The surgery is usually performed under general anesthesia with full pharmacological relaxation. Gross traction is applied to both legs to ensure that the patient's groin is in full contact with the perineal post. It is also critical to check the genitalia, particularly in male patients, to avoid direct compression during the traction process. At this point, traction is applied using the fine traction adjustment of the traction table until the hip is distracted approximately 8 to 10 mm. In rare cases such as in chronic spasticity with associated joint contractures, it is difficult or impossible to distract the hip. Once successful distraction is confirmed, the traction is released until the joint is radiographically reduced. The hip is then prepared and draped. It is critical to drape proximal to the anterior superior iliac spine and approximately 30 cm distal to the tip of the greater trochanter to ensure access to all standard and accessory hip portals.

A surgical pause is performed, and traction is reapplied. The traction start time is confirmed with nursing and anesthesia and tracked throughout the case. The anterolateral paratrochanteric portal is established first (**Figure 6**). This is the most commonly used hip portal. It is critical to place the incision just proximal to the greater trochanter and to ensure that the portal tracts aim toward the midpoint between the femoral head and the acetabulum by fluoroscopy. A specialized large-bore, 6-inch spinal needle is used to localize this path. Once the desired position is achieved, the inner stylet is removed and an audible whistle is often heard as air rushes into the distracted joint. In many cases, the hip is further distracted with this air entry. If the hip is distracted more than 10 to 15 mm, some of the traction should be released to avoid undue traction on the sciatic nerve and the risk of compression neuropathies.

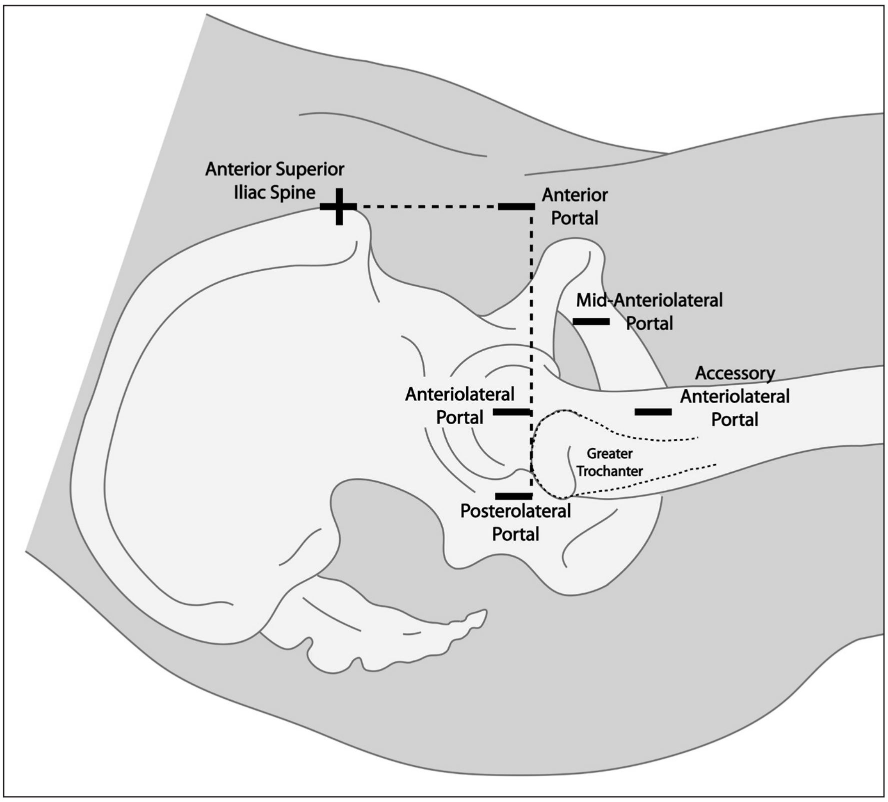

Figure 6: Location of commonly used hip arthroscopy portals.

Next, a guidewire is placed through the spinal needle, a small incision is made, and an arthroscopic cannula is placed. The authors initially perform a dry hip arthroscopy to avoid bubble formation and to confirm that the initial portal is placed in such a way as to allow adequate visualization of the anterior capsule. Next, under direct vision with occasional fluoroscopic assistance, a direct anterior portal is placed (**Figure 6**). Some authors have described placing this portal in line with the anterior superior iliac spine.[78] However, the current authors have found it beneficial to place the anterior portal approximately 4 to 5 cm distal and 4 to 5 cm anterior to the anterior paratrochanteric portal. In this position, the portal is usually at least 2 to 3 cm lateral to the direct distal extension of the anterosuperior iliac spine. They use the spinal needle and enter the joint through the anterior triangle formed by the labrum, femoral head, and periphery of the arthroscope.[78] This portal is at greater risk for damaging branches of the lateral femoral cutaneous nerve. As a result, the authors perform a skin incision followed by blunt dissection using a tonsil clamp. At this point, arthroscopic fluid is introduced using a pump pressure of approximately 40 to 50 mm Hg. A 70° arthroscope is used to perform a diagnostic arthroscopy. If there is evidence of a posterior labral tear or if it is difficult to assess the hip with the first 2 portals described, a posterior paratrochanteric portal is made (**Figure 6**).[78] A flexible radiofrequency device is helpful in removing synovium as necessary to improve visualization, particularly in the early phases of the surgery. A motorized shaver is then introduced, and labral debridement is performed as necessary.

At this point, standard hip arthroscopy is performed as described in previous review articles.[56,80,81] If an acetabuloplasty is required, this is usually performed with a 5.5-mm round burr under fluoroscopic guidance. Although the 4.0-mm burr can be passed through a 5.5-mm cannula, the authors prefer to avoid that size due to a higher tendency to scallop the area being treated and a higher risk of metal debris degeneration. To pass the 5.5-mm burr, the authors disassemble the burr tip and place a switching stick into the joint. The outer sheath of the burr tip is then passed over the switching stick. The switching stick is then removed and replaced by the inner core of the burr tip. The burr handle is then attached to the burr tips in vivo.

This facilitates reaching different areas of the joint with the burr and allows the use of a larger 5.5-mm burr, which does not easily fit through most cannulas. The larger burrs are less likely to generate metal debris in the hip.

Once the acetabuloplasty is completed, the central portion of the joint is inspected by switching to the 30° arthroscope. Ligamentum teres tears, loose bodies, and central osteoarthritis lesions can be visualized. At this point, the labrum can be either debrided, repaired, or reconstructed. Passage of suture anchors is dramatically helped by placement of the initial portals in a slightly more distal position or by the establishment of accessory portals more distally. In addition, the authors use fluoroscopy to confirm the divergence of the suture anchor tract away from the acetabular roof. One must try to place a suture anchor entry site as close to the articular surface as possible while also diverging farther away from the articular surface as the anchor passes more deeply. Once the labral work has been completed, any articular cartilage lesions can be addressed using either a microfracture technique or other cartilage restoration technique.

At this point, traction on the limb is slowly released. The hip is flexed to approximately 45°, and the peripheral compartment is entered with the 70° arthroscope with the use of the anterolateral paratrochanteric skin portal and placement of a spinal needle through the capsule, making contact with the femoral neck (**Figure 6**). An alternative technique uses a longitudinal cut through the capsule, starting at the edge of the acetabulum and proceeding down onto the femoral neck. This should only be performed with the hip flexed sufficiently to completely protect the healthy articular cartilage of the femoral head. A second portal is established more proximally through the skin incision of the direct anterior portal and passing through the anterolateral capsule (**Figure 6**). Part of the zona orbicularis is excised with a shaver to improve visualization and mobility of instruments within the compartment. One can place traction sutures on the edges of the capsule or debride a portion of the capsule to achieve access to the entire anterior femoral neck. Using fluoroscopic guidance, an osteochondroplasty of the femoral neck can be performed as needed. Exposure of the lateral head can be improved by performing a localized capsulotomy in this region and by abducting the limb.

A key objective is to maintain the proximal extent of the osteochondroplasty at approximately 1 cm distal to the edge of the labrum with the hip flexed. A lateral fluoroscopic view of the femoral head-neck junction is obtained by having the hip flexed and "rainbowing" the image intensifier to approximately 45° toward the ground. After the proximal edge of the osteochondroplasty is performed, the recontouring is tapered distally onto the femoral neck. Here it is critical to have adequate release of the zona orbicularis down onto the base of the neck. At the completion of the osteochondroplasty, the arthroscope is left in the peripheral compartment and the hip is slowly flexed to 110° or more to rule out any further contact between the cam lesion and the acetabular edge. With the procedure complete, the hip is brought to 30° of flexion and a guidewire can be placed into the joint along with a spinal needle. The portals are sutured and the joint is filled with the long-acting local anesthetic through the spinal needle. The skin portals are also injected with the local anesthetic. The wounds are dressed in the standard fashion with a generous dressing due to the substantial outflow of arthroscopy fluid in the early postoperative period.

Postoperatively, a careful neurological evaluation is performed. The authors' patients are prescribed a 2-week course of a nonsteroidal anti-inflammatory drug (eg, indocin) to prevent heterotopic bone formation. Prophylaxis for deep venous thrombosis in this setting remains controversial. In cases of osteochondroplasty, the authors keep patients on toe-touch weight bearing for 6 to 8 weeks and prohibit running or vigorous activities for a minimum of 6 months.

Outcomes. Results of arthroscopic treatment for FAI have been favorable; multiple studies have shown improvement in symptoms and return to sport in competitive-level athletes. Philipon et al[82] reported 45 professional athletes undergoing treatment for FAI comprising suture anchor repair, intrasubstance repair, and labral grafting. All 45 patients had improvement in symptoms, and 43 (93%) patients returned to professional play. In another case series of 30 professional hockey players who were unable to play secondary to hip pain and who underwent hip arthroscopic labral repair of FAI, results were favorable, with all 30 having improved modified Harris Hip Scores and being able to return to sport at 3.8 months postoperatively.[83] In a retrospective study of 156 patients who underwent arthroscopic hip surgery for mild FAI, symptoms included somewhat reduced ROM, poor tolerance of prolonged sitting, and inability to participate in sports.[84] For the majority of the patients, pain relief was 50% at 6 to 12 weeks, 75% at 5 months, and 95% at 1 year. Patients no longer needed crutches after 2 to 4 weeks. Arthroscopic management of cam FAI in a prospective study of 200 patients demonstrated an average increase in Harris Hip Score of 20 points, a 0.5% rate of conversion to THA, and a 1.5% complication rate at greater than 1 year of follow-up.[85]

Arthroscopic repair or reconstruction of the labrum appears to be important for more favorable outcomes than labral debridement. A retrospective analysis of 75 patients with labral repair showed better Harris Hip Scores and a greater percentage of good-to-excellent results compared with the results of labral debridement.[86] A case series of 100 hips evaluating the early outcomes after arthroscopic management of FAI demonstrated that the patients who underwent labral repair had a statistically significant decrease in pain score from 6.7 to 1.9, an increase in Harris Hip Score from 61 to 83, and an increase in Short Form 12 quality of life score from 60 to 78.[87]

Arthroscopic osteochondroplasty can lead to morphological correction equivalent to that of open surgical dislocation. Sussmann et al[88] used 8 paired cadaveric pelvises to make this comparison and found no differences between the techniques in terms of volume, depth, or arc of bone resected. A more recent case-control study compared 60 patients: 30 after open surgical dislocation and 30 after arthroscopic evaluation for acetabular rim and femoral head-neck osteochondroplasty.[89] The groups had comparable reductions in alpha angle and anterior femoral head-neck offset.

Conclusion

Femoroacetabular impingement is caused by subtle morphologic abnormalities around the hip. These abnormalities can result in pathologic contact between the femoral head-neck and the acetabular rim causing injury to the articular cartilage and the labrum. Femoroacetabular impingement is recognized as a source of hip pain in young adults and should be included on the differential diagnosis when evaluating patients with hip-related symptoms. Evidence continues to mount that untreated FAI may lead to progression of cartilage injury, eventually resulting in the development of early OA.[8]

Morphologic changes can occur at either the acetabular or the femoral side of the joint and often occur in combination. Common examples of acetabular pathology include acetabular retroversion, coxa profunda, protrusio acetabula, and ossification of the labrum. One or more of these entities are typically responsible for producing pincer-type FAI, which is more common in middle-aged women. Femoral-sided morphologic abnormalities include decreased femoral anteversion, decreased femoral head-neck offset, and other anatomic deformities that result in femoral head asphericity. One or more of these entities typically produce cam-type FAI, which is more common in young men.

The appropriate treatment strategy for FAI should be determined after careful evaluation of the patient's history, physical examination findings, and detailed imaging studies. Conservative management options should be used and may include activity modification, nonsteroidal anti-inflammatory drugs, and intra-articular injections. However, continued FAI can lead to progression of labral and cartilage injury. Therefore, patients should be followed closely, and surgical intervention should be offered if symptoms persist. Surgery must be tailored to address an individual patient's pathology. Some pathology may necessitate an open approach, whereas other pathology may be addressed with arthroscopic techniques. Early results of both open and arthroscopic techniques are encouraging, with most patients reporting 95% reduction in pain and improved function by 1 year.[72,90] The underlying question of whether early treatment of FAI can slow or prevent the development of OA in young patients remains unanswered and is the subject of ongoing investigation.

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