Femoroacetabular Impingement

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Abstract

Evidence is emerging that subtle morphologic abnormalities around the hip, resulting in femoroacetabular impingement, may be a contributing factor in some instances to osteoarthritis in the young patient. The morphologic abnormalities result in abnormal contact between the femoral neck/head and the acetabular margin, causing tearing of the labrum and avulsion of the underlying cartilage region, continued deterioration, and eventual onset of arthritis. Nonsurgical treatment typically fails to control symptoms. Surgical management involves dislocation of the hip (while preserving the blood supply to the femoral head) and femoroacetabular osteoplasty. Encouraging results have been reported following femoroacetabular osteoplasty and arthroscopic treatment of femoroacetabular impingement.

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J Am Acad Orthop Surg 2007;15:561-570

Osteoarthritis (OA) of the hip may arise as a result of various etiologic factors, including Legg-Calvé-Perthes disease, slipped capital femoral epiphysis, and dysplasia.[1-5] OA of the hip may ensue in young patients with developmental dysplasia of the hip because of the presence of a shallow acetabulum.[2,4,6] The reduced joint contact area in patients with developmental dysplasia of the hip results in eccentric overloading of the anterosuperior joint area.[6-9] Not infrequently, however, orthopaedic surgeons will encounter a young patient (age, 20 to 50 years) without dysplasia who has developed OA of the hip. The widely accepted theory implicating axial overload fails to provide a satisfactory explanation for development of arthritis in these young patients. Hence, there exists a distinct group of patients with OA of the hip for whom no discernible etiologic factors can be found.[10]

It is now recognized that femoroacetabular impingement (FAI) is often the source of hip discomfort in many patients with only subtle abnormalities on plain radiographs.[11-19] The theory implies that in certain patients, the presence of aberrant morphology involving the proximal femur and/or the acetabulum results in abnormal contact between the femoral neck and the acetabular rim during terminal motion of the hip. This abnormal contact in turn leads to the development of lesions in the labrum and the adjacent acetabular cartilage.[15] The early chondral and labral lesions continue to progress and result in degenerative joint disease.[12,15]

Mechanism of Femoroacetabular Impingement

The concept of FAI is not entirely novel. Stulberg et al[3] are credited with introducing the term pistol grip deformity, which described the abnormal morphologic features of the femoral head and neck on anteroposterior (AP) radiographs of patients

Figure 1

Anteroposterior radiograph of the pelvis of a 22-year-old woman who presented with groin pain. Clinical examination strongly suggested femoroacetabular impingement. The radiograph demonstrates bilateral acetabular retroversion as determined by crossover of the anterior and posterior acetabular walls (dotted lines).

with early OA. An abnormal anatomic relationship between the femoral head and neck also was suggested as a possible cause for OA.[3,8,9,20,21] However, impingement was recently popularized as the possible cause of OA in the young patient without dysplasia.[15] Other conditions also may result in an abnormal contact between the proximal femur and the acetabulum; these include prior femoral neck fracture,[11] prior periacetabular osteotomy,[22] acetabular retroversion,[17] and slipped capital femoral epiphysis.[3,20,23,24] In addition, FAI has been observed in patients with residual childhood diseases such as Legg-Calvé-Perthes disease or after surgical interventions such as femoral osteotomy, which has led to reduced clearance of the femoral neck.

Although all of these conditions may result in FAI, most of the patients treated at our institution often lack a clear history for any predisposing conditions. However, evidence is emerging that, in active patients, subtle morphologic aberrations that affect the proximal femur and/or the acetabulum, subjecting the hips to extensive range of motion, are the most common cause of FAI.[15] Typical conditions seen to cause FAI include posttraumatic deformities, coxa profunda (deep socket), protrusio acetabuli, and acetabular retroversion (Figure 1). Retroversion of the acetabulum has been described as a posteriorly orientated acetabular opening with reference to the sagittal plane. On the AP radiograph, crossing of the anterior and posterior wall is seen (Figure 1). The relative anterior overcoverage in this condition results in an abnormal impingement contact between the anterior acetabular rim and the femoral neck.

Types of Femoroacetabular Impingement

Ganz et al[15] described two distinct types of FAI based on the pattern of chondral and labral lesions observed during surgical dislocation of the hip: cam impingement and pincer impingement.

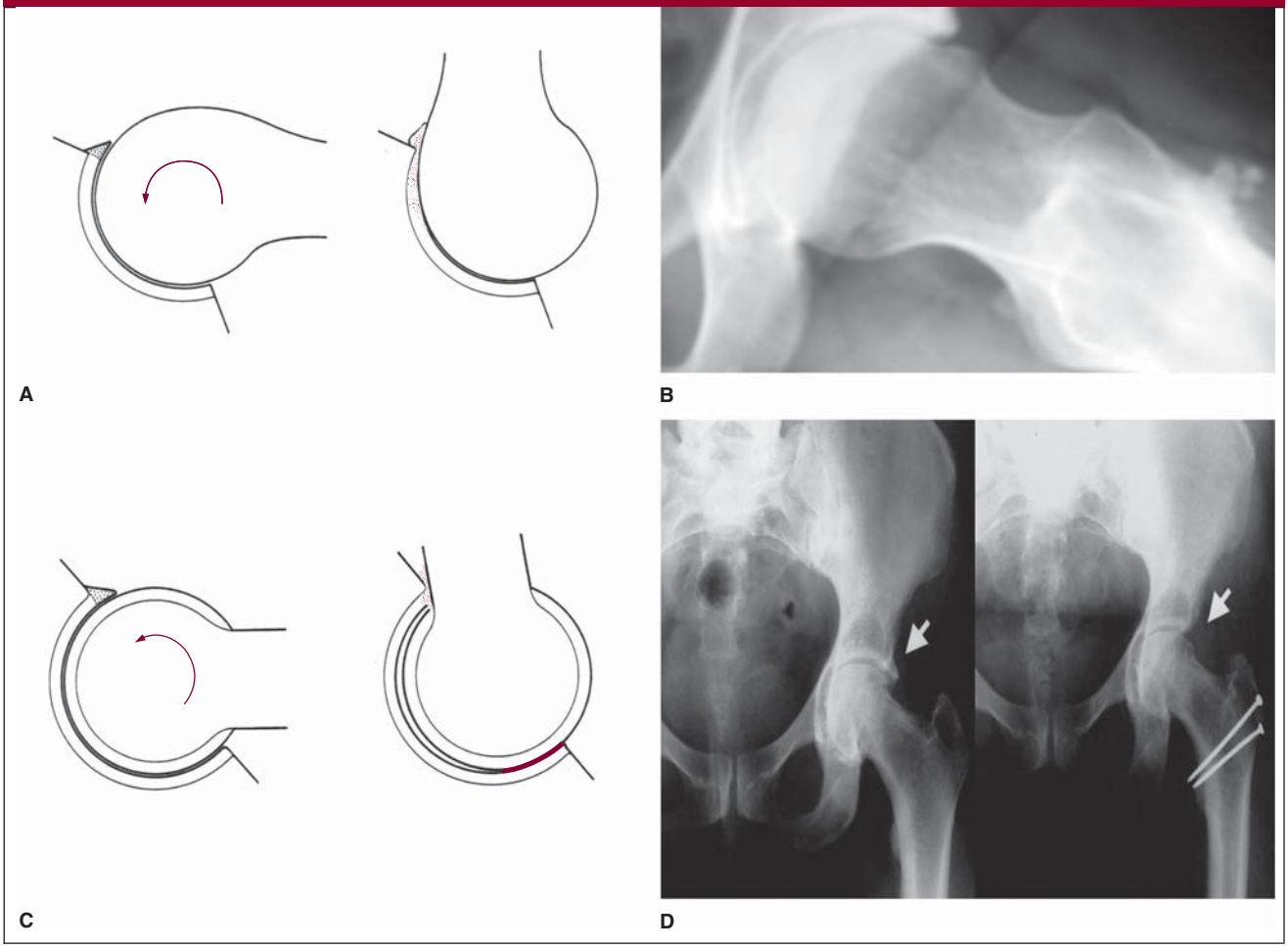
Cam Impingement

Cam impingement occurs when an abnormally shaped (ie, nonspherical) femoral head with increased radius is jammed into the acetabulum during normal motion, especially flexion (Figure 2, A and B). The prominence on the femoral neck is forced into the acetabulum and results in tearing of the labrum and/or its avulsion from the rim. This lesion may extend to involve the acetabular cartilage, separating it from the subchondral bone. The labral and chondral lesion is often observed in the anterosuperior area of the acetabulum.[13-15,19] This condition is encountered more commonly in young, active male patients.

Pincer Impingement

The pincer impingement is the result of abnormal contact between the acetabular rim and the femoral neck (Figure 2, C and D). The femoral head in this situation may be normal, and the abutment is mostly a result of overcoverage of the femoral head in conditions such as coxa profunda[4,25] or acetabular retroversion.[26] The first structure to fail in this situation typically is the acetabular labrum. The lesion in the labrum is often limited to a small area and appears to be benign. However, continued abutment of the femoral neck against the acetabular rim results in degenerative changes in the labrum, such as intra-substance ganglion formation or ossification of the rim. Such degenerative changes may lead to further deepening of the acetabulum and worsening of the overcoverage. With forceful leverage of the head against the inferior part of the acetabulum, the persistent abutment, which often is anterior, can result in chondral injury in the contrecoup region of the posteroinferior acetabulum (Figure 2, C and D). Pincer impingement is commonly seen in middle-aged women who engage in athletic activities.

Figure 2



Cam impingement: **A,** *Left*, The hip is in neutral. The arrow indicates motion. *Right*, Hip motion resulting in flexed impingement on the labrum. **B,** Lateral radiograph demonstrating cam impingement. Pincer impingement: **C,** *Left*, The hip is in neutral. The arrow indicates motion. *Right*, Hip flexed with resultant impingement at the rim. **D,** Preoperative (*left*) and postoperative (*right*) anteroposterior radiographs demonstrating rim ossification that resulted in pincer impingement (arrow). (Panels A and C reproduced with permission from Beck M, Leunig M, Parvizi J, Boutier V, Wyss D, Ganz R: Anterior femoroacetabular impingement: II. Midterm results of surgical treatment. *Clin Orthop Relat Res* 2004;418:67-73.)

Mechanism Leading to Osteoarthritis

The proposed mechanism by which FAI leads to arthritis of the hip is thought to be as follows. The morphologic abnormalities of the femoral head and/or acetabulum result in abnormal contact between the femoral neck/head and the acetabular margin. This leads to tearing of the labrum and avulsion of the underlying cartilage region. The continued abnormal contact results in further deterioration and wear of the cartilage, with eventual onset of arthritis.

Clinical Presentation

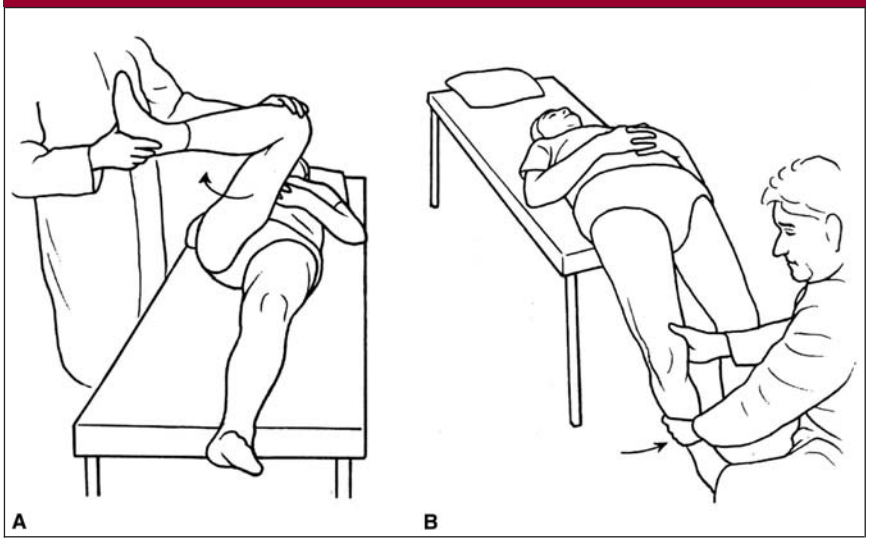
History

FAI usually presents in active young adults with slow onset of groin pain that may start after a minor trauma. During the initial stages of the disease, the pain is intermittent and may be exacerbated by excessive demand on the hip, such as from athletic activities or prolonged walking. The pain also may present after sitting for a prolonged period. In addition, pain may be referred to the knee. Based on the presence of normal hip radiographs, these patients sometimes are subjected to extensive diagnostic work-up and even inappropriate surgical procedures (eg, laparoscopy, laparotomy, knee arthroscopy, lumbar spine decompression, inguinal hernia repair).

Examination

Examination of the hip often reveals limitation of motion, particularly the internal rotation and adduc-

Figure 3



A, Anteroposterior impingement test. The patient is placed supine with the hip in 90° of flexion. Internal rotation of the hip and adduction recreates the symptoms. **B,** Posteroinferior impingement test. The patient slides to the edge of the bed and extends the hip. External rotation of the hip in this position causes pain.

tion in flexion. The impingement test is almost always positive. This test is done with the patient supine; the hip is internally rotated as it is passively flexed to approximately 90° and adducted (Figure 3). Flexion and adduction lead to the approximation of the abnormal contact of the femoral neck and the acetabular rim with recreation of the pain, particularly when there is a chondral lesion.

Occasionally, posteroinferior impingement also may exist. The provocative test to elicit posteroinferior impingement is performed by having the patient lie supine on the edge of the bed and having the legs hang free from the end of the bed in order to produce maximum hip extension. External rotation with the hip in extension that gives rise to severe, deep-seated groin pain is indicative of posteroinferior impingement. A positive impingement test has been correlated with acetabular rim lesions as visualized on specific magnetic resonance imaging (MRI) arthrograms of the hip.[27]

Radiographic Assessment

An orthograde standing true AP radiograph and a lateral radiograph of the hip should be ordered for any patient with suspected FAI. A true AP radiograph is one in which the coccyx points toward the symphysis pubis with a distance of 1 to 2 cm between them; such a radiographic view is critical to assess version of the acetabulum. In patients with FAI, the routine radiographs may appear at first glance to be normal (Figure 4). Careful examination may reveal subtle radiographic abnormalities, including the presence of a bony prominence, usually in the anterolateral head and neck junction of the proximal femur (Figure 4). This prominence leads to reduced offset of the femoral neck and head junction, so that the overall clearance of the femoral neck is decreased.

To visualize the labrum and the acetabular cartilage, we routinely request MRI arthrograms.[28-30] Our protocol includes the use of a high-field scanner (1.5 and, recently, 3.0 Tesla) and a surface coil to improve resolution. For MRI arthrography, we inject between 5 and 20 mL of gadolinium-DTPA (diethylenetriamine penta-acetate) into the hip joint under fluoroscopy. Axial, coronal oblique, sagittal oblique, and radial sequences are obtained. For axial and coronal oblique images, T1-weighted spin-echo sequences (repetition time [TR] = 740 msec, echo time [TE] = 20 msec), as well as FLASH (fast low-angle shot) 2D sequence images (TR/TE = 500/10, flip angle = 90°), are used. For sagittal oblique images, T1-weighted spin-echo images (TR/TE = 774/20) and T2-weighted turbo spin-echo sequences (TR/TE = 4,500/96) are obtained. MRI arthrograms also are capable of detecting or confirming abnormal sphericity of the femoral head, low offset of the neck, herniation pits, or ossification of the acetabular rim, all resulting from impingement (Figure 4). MRI arthrograms are very sensitive and specific for detecting labral and chondral lesions, but they have limitations in detecting undetached chondral separations.[29]

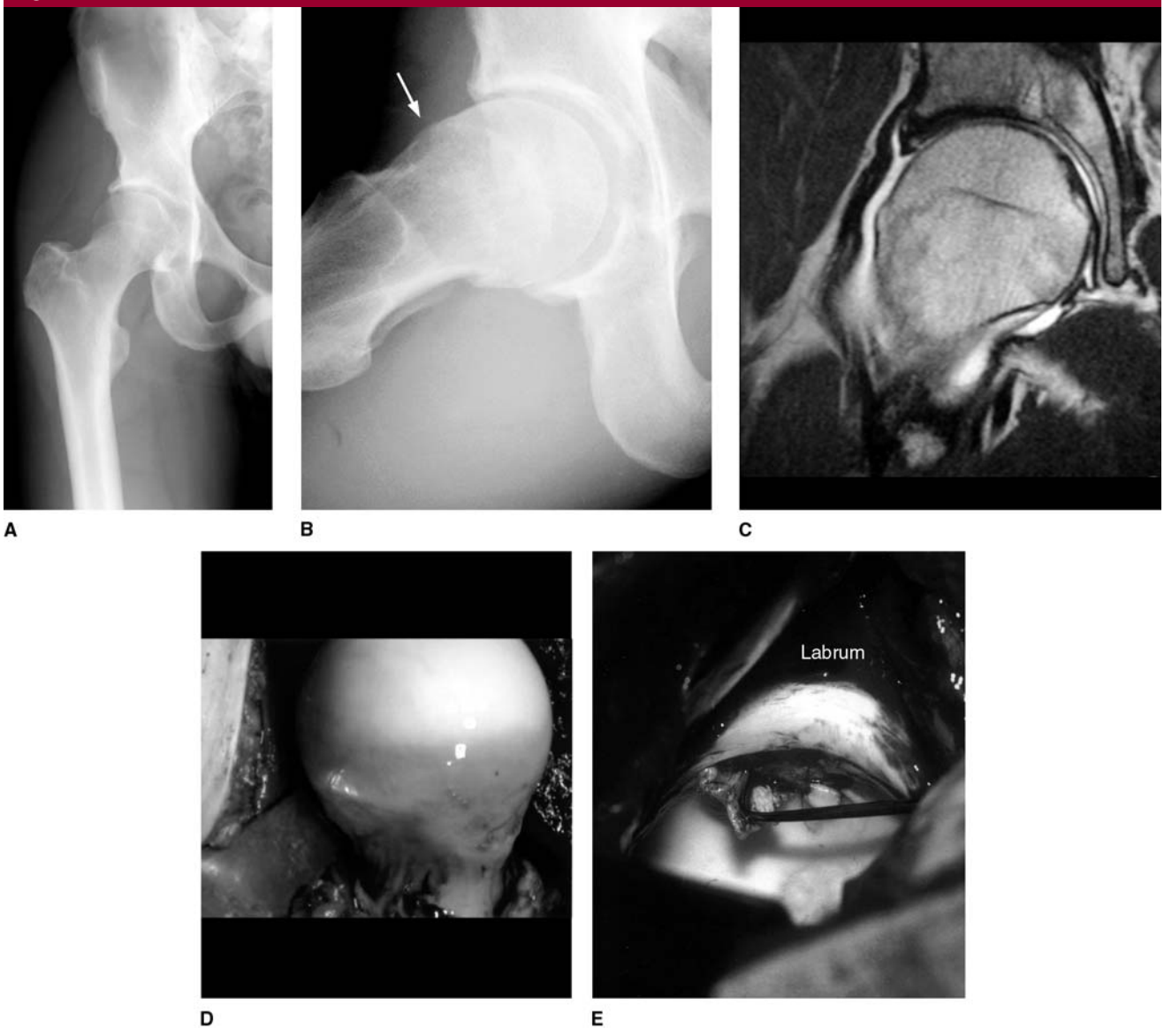
In advanced stages of FAI, the abnormal contour of the femoral head becomes obvious (Figure 5). Careful evaluation of radiographs—checking the femoral neck in patients with FAI— often reveals the presence of herniation pits, which, we postulate, are indicative of impingement. Morphologic changes affecting the acetabulum and/or the proximal femur, such as retroversion, relative anterior overcoverage, coxa profunda, protrusio acetabuli, coxa vara, extreme coxa valga, or occasionally subtle dysplasia, may become apparent only on a careful, systematic examination of the plain AP and lateral proximal femoral radiographs.

Management

Nonsurgical Treatment

Appropriate management of patients with FAI includes an initial trial of nonsurgical treatment, which may include activity modification

Figure 4



Anteroposterior **(A)** and lateral **(B)** radiographs of a 30-year-old man who presented with groin pain and limitation of hip motion. On the lateral radiograph, the prominence in the femoral neck-head junction (arrow) leading to cam impingement is apparent. **C,** MRI arthrogram confirms the nonspherical appearance of the femoral head with reduced neck-head offset. **D,** During surgical dislocation, the femoral head cartilage in the region of impingement appears eburnated and erythematous, with a sizable bony prominence at the neck-head junction. **E,** Evidence of a chondrolabral tear in the anterosuperior region of the acetabulum, which could be displaced.

including restriction of athletic activities, and nonsteroidal anti-inflammatory medications. Physical therapy with an emphasis on improving passive range of motion or stretching is largely counterproductive and exacerbates the symptoms. Nonsurgical management can be temporarily successful because of the general young age of these patients; however, because of the typically high activity level and athletic ambitions of these patients, such treatment usually fails to control the symptoms. Furthermore, continued FAI leads to progression of the destructive process and advancement of labral and chondral lesions. We follow these patients closely and intervene early with surgery to prevent the progression of arthritis.

Surgical Dislocation

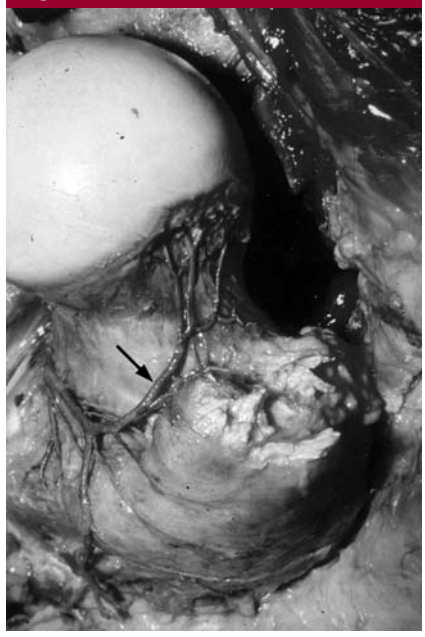
Ganz et al[12] have designed a novel joint-preserving procedure aimed at delivering timely treatment that may decelerate the degenerative pro-

Figure 5

A B

A, Anteroposterior radiograph of the hip in a 21-year-old man demonstrating late-stage femoroacetabular impingement, with a large bony prominence in the femoral head-neck junction of the left hip (arrow). **B,** Anteroposterior radiograph of the left hip following femoral osteoplasty performed via a modified anterior approach.

Figure 6



Intraoperative photograph of anatomic dissection showing the course of the deep branch of the medial femoral circumflex artery (arrow). The artery crosses the obturator externus and runs on the anterior neck to form the retinacular vessels that penetrate the femoral neck. (Reproduced with permission from Lavigne M, Parvizi J, Beck M, Siebenrock KA, Ganz R, Leunig M: Anterior femoroacetabular impingement: I. Techniques of joint preserving surgery. *Clin Orthop Relat Res* 2004;418:61-66.)

cedure initiated by the impingement. The surgical management involves dislocation of the hip, with preservation of the blood supply to the femoral head, and femoroacetabular osteoplasty. An extensive and detailed anatomic study has been performed to elucidate the exact course of blood supply to the femoral head.[31] Better understanding of the anatomic course of critical blood supply to the femoral head has allowed surgical dislocation to be done without causing osteonecrosis of the femoral head.

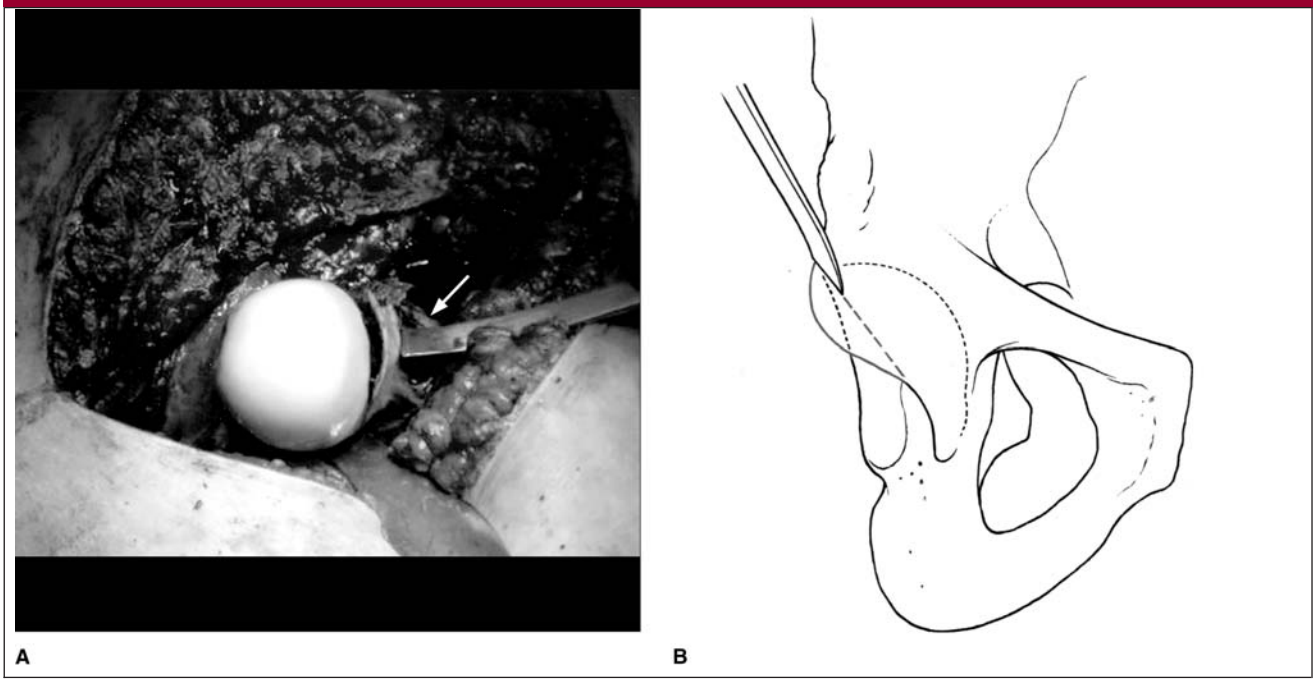
The critical source of blood supply to the femoral head is the deep branch of the medial femoral circumflex artery (MFCA). After crossing the obturator externus muscle posteriorly, the MFCA runs anteriorly toward the short rotators and crosses the femoral neck anteriorly to become the retinacular vessels penetrating the femoral neck[31] (Figure 6). Preservation of the short posterior rotators of the hip ensures that the MFCA is not damaged during surgical dislocation of the hip.

Based on these blood supply studies, a technique for surgical dislocation of the hip was developed.[12] The details have been described.[12,32] Briefly, the technique involves a lateral surgical incision and linear division of the fascia lata to approach the greater trochanter. A trochanteric flip osteotomy is then performed with the site at the lateral border of the piriformis fossa proximally and at the vastus ridge distally. When properly performed, the trochanter segment will have a small attachment of the abductor muscles. The external rotator muscles are preserved during this approach, and the medial femoral circumflex artery is protected by the intact obturator externus muscle.

The osteotomized trochanter is retracted anteriorly in a gentle manner, and the anterior capsule is dissected free of any muscular attachment. A lazy S–shaped capsulotomy is then performed to expose the hip joint. After division of the ligamentum teres, the hip is dislocated. However, before the formal dislocation is accomplished, the FAI is confirmed, and the site of impingement is identified.

Femoral osteoplasty is then performed to remove the prominent area of the femoral neck (Figure 7). This restores the femoral neck clearance to allow an impingement-free physiologic range of motion for the affected hip. The goal is to remove as much of the prominent area as is needed to allow flexion of 120° and

Figure 7



Femoroacetabular osteoplasty. **A,** After surgical dislocation of the hip, the prominence in the femoral head-neck junction is carefully removed while the retinacular vessels penetrating the femoral neck (arrow) are carefully protected. Osteoplasty restores the neck to its normal diameter. Extreme care is exercised to preserve the retinacular vessels penetrating the femoral head in the anterosuperior region of the neck. **B,** The acetabulum also is examined, and any prominence in the acetabular rim is removed. The short dashed lines indicate the normal anatomy; the long dashed line indicates the excessive rim area. (Panel B reproduced with permission from Lavigne M, Parvizi J, Beck M, Sibenrock KA, Ganz R, Leunig M: Anterior femoroacetabular impingement: I. Techniques of joint preserving surgery. *Clin Orthop Relat Res* 2004;418:61-66.)

rotation of 40°. Although infrequent, reorientation of the proximal femur with a flexion-valgus intertrochanteric osteotomy[33] also may be done to reduce FAI in patients with decreased anteversion or varus position of the femoral neck. Relative femoral neck lengthening with trochanteric advancement presents another possibility of increasing clearance.

The acetabulum is routinely inspected. The site and the extent of labral and/or chondral injury are identified. When necessary, the labrum in the anterosuperior region of the rim is then dissected free of the rim and the normal portion of the labrum preserved. The torn labrum is débrided, and osteotomy is performed of the acetabular rim to remove the chondral lesion (Figure 7). Once a stable, intact chondral region is identified, the remaining labrum is reattached using nonabsorbable anchor sutures. The chondral lesion usually extends 0.5 to 1 cm into the acetabulum. Hence, up to 1 cm of acetabular rim may be removed without causing instability of the hip.

The hip is reduced and impingement-free physiologic range of motion is confirmed. The capsule is loosely closed and the soft tissues apposed with interrupted sutures. The trochanteric osteotomy is fixed using two 4.5-mm cortical screws. The screws are placed in the center of the osteotomy and aimed toward the lesser trochanter. We do not use surgical drains.

Hip Arthroscopy

Hip arthroscopy offers a minimally invasive technique for diagnostic as well as therapeutic management of FAI.[34-37] Arthroscopy may be useful in the treatment of labral tears generated by FAI, especially when minimal morphologic abnormality exists. Arthroscopy also may be combined with other surgical techniques without the need for trochanteric osteotomy or intraoperative hip dislocation.[38] Combined arthroscopy with limited open femoral head-neck osteoplasty adequately manages abnormal anatomy and pathophysiology in a nonsurgical manner that is less invasive than other surgical alternatives.[38]

The patient is supine or placed in a lateral decubitus position.[39,40] A fracture table with a well-padded peroneal post is used to distract the surgical extremity. Under fluoroscopic guidance, a spinal needle is inserted into the hip joint. The joint

is inflated with arthroscopic fluid. A guidewire is inserted through the spinal needle, and cannulated trochars are inserted into the hip joint. Care must be taken to avoid scuffing the femoral and acetabular articular cartilage. Typically, two or three portals are used: anterior, anterolateral, and posterolateral. To reduce risk to the peroneal structures, especially the pudendal nerve, and to avoid traction neurapraxia to the femoral and sciatic nerves, the duration of traction should be minimized.[37]

Although hip arthroscopy offers a minimally invasive approach for the treatment of FAI, this technique has many shortcomings, largely related to the difficulty of maneuvering the instruments inside a confined hip joint. First, removal of the bony prominence on the femoral neck, especially when it extends to the posterior neck region, may be difficult, and either over-resection or under-resection may occur because it is difficult to assess the depth of resection. Second, arthroscopic resection of the impinging acetabular rim, in both retroversion and pincer-type impingement cases, cannot be performed because current arthroscopic tools do not allow access to the posterior wall for resection purposes. Stable reattachment of the labrum is also very difficult because one cannot reflect the labrum and débride the underlying surface to provide a proper bed for reattachment. Finally, little can be done to adequately treat the chondral lesion that may be associated with the labral tear. Because of these limitations, hip arthroscopy should be reserved for simple cam-type impingements. Further improvements in the surgical technique and in instrument design may allow wider application of arthroscopic treatment of FAI in the future.

Other Surgical Approaches

Alternative approaches for the treatment of FAI are being explored because of the morbidity associated with surgical hip dislocation—namely, the need for non–weight bearing for an extended period and the potential for trochanteric osteotomy nonunion. A modified Smith-Petersen anterior approach may be used to perform an arthrotomy of the hip. Under direct visualization, the prominence on the femoral neck region can be resected easily and effectively. A detached labrum also can be addressed using this approach. Reattachment of the labrum using anchor sutures also is possible. Traction systems attached to the operating table can be used to subluxate the hip and examine the chondral lesion and resect the lesion, when necessary.

Outcome of Surgical Treatment

Beck et al[41] recently presented the midterm outcome of femoroacetabular osteoplasty in a group of 19 patients. Fourteen men and five women (mean age, 36 years; range, 21 to 52 years) were treated with a surgical hip dislocation and removal of the bony prominence. The follow-up averaged 4.7 years (range, 4 to 5.2 years). Using the Merle-d'Aubigné hip score, 13 hips were rated excellent to good, with the pain score improving from 2.9 to 5.1 points at the latest follow-up. There were no cases of osteonecrosis of the femoral head. Of the 19 patients, 5 had subsequent total hip arthroplasty: 2 patients with grade 2 osteoarthrosis, 2 with grade 1 osteoarthrosis but severe acetabular cartilage damage, and 1 with an untreated ossified labrum. The authors concluded that surgical dislocation with correction of FAI yields good results in patients with early degenerative changes not exceeding grade 1 osteoarthrosis. This procedure is not suitable for patients with advanced degenerative changes and extensive articular cartilage damage.[41]

Encouraging results also have been reported following arthroscopic treatment of FAI. In a study of 158 patients who underwent arthroscopic surgery, most patients reported that 50% of their pain had resolved by 3 months, 75% by 5 months, and 95% by 1 year.[34] These results are comparable to those reported for open surgical dislocation of hip.[38] Recovery from the arthroscopic procedure is expected to be much faster.

Summary and Discussion

FAI is now considered as a potential mechanism leading to OA of the hip in young patients without dysplasia who have a painful hip. This theory is based on extensive clinical observations made by Ganz et al,[15] who have performed surgical dislocation of the hip on nearly one thousand patients suspected of having FAI. Two sets of observations made during surgical dislocation of the hip have furnished the evidence in support of chondral injury leading to labral tear rather than the reverse, that is, that labral lesions contribute to early degenerative hip disease.[19] First, all labral tears or detachments occur at the articular margin and not the capsular margin. Second, chondral injuries without labral tears frequently are seen at the early stages of the impingement process. Solitary labral tears arising from an acute traumatic event are rare. Labral tears not associated with chondral injuries only are observed in patients with early pincer impingement. Labral tears seen during arthroscopic examination of the hip,[19] particularly in the anterosuperior region of the acetabulum, most likely represent FAI. Some of these patients may have symptoms and clinical examination suggestive of a traumatic etiology that is consistent with labral pathology; nevertheless, it is the underlying impingement, however subtle, that leads to labral tear as part of a more extensive injury.

This premise is supported by the observation that most labral tears

seen during hip arthroscopy also are associated with chondral injury.[19] McCarthy et al,[19] reporting on more than 400 hip arthroscopies, noted a highly significant association between the presence of labral lesions and degeneration of the articular surface. In their series, the labral and articular lesions almost always were located in the same region of the acetabulum, and the relative risk of significant chondral lesion approximately doubled in the presence of labral lesions.[19] Approximately two-thirds of their patients with fraying or a tear of the labrum had evidence of chondral damage. It is plausible that some chondral lesions may go undetected during hip arthroscopy; this, in turn, accounts for the higher than expected incidence of isolated labral tears.

Although detailed analysis of the outcome of surgical intervention still is ongoing, the preliminary results indicate that surgical dislocation of the hip and improvement of the head and neck offset is successful in addressing the symptoms arising from the underlying impingement. Surgical intervention is more successful in patients with early FAI.[34] In patients with moderate to severe loss of joint space, the outcome is likely to be less than optimal. Therefore, early diagnosis and timely delivery of care is likely to retard the degenerative process and delay the need for hip arthroplasty.

Surgical care of these patients generally involves removal of the cause of impingement and improvement of femoral neck clearance. Morphologic changes affecting the acetabulum also can predispose the hip to impingement. Acetabular retroversion is one such example. Retroversion of the acetabulum has been described as a posteriorly orientated acetabular opening with reference to the sagittal plane.[26] A retroverted acetabulum may occur as part of more complex acetabular developmental deformities,[14] or it may be seen as an isolated entity.[11] Retroversion results in a prominent anterolateral acetabular edge, thus producing an obstacle for flexion and internal rotation. This situation is worse when the prominent acetabular edge impinges against a proximal femur with a low head and neck offset, as is seen in hips with pistol grip deformity.[18,30]

Symptomatic impingement resulting from underlying acetabular retroversion has been treated successfully with reverse periacetabular osteotomy in a group of 26 patients.[17] FAI, which was alleviated by removing the relative anterior overcoverage, was confirmed in all cases. Labral and chondral lesions in the anterosuperior region of the acetabulum, resulting from the repetitive trauma of impingement, were observed in more than one half of patients; these lesions may explain the association of acetabular retroversion with development of OA.[17]

Other abnormalities, such as coxa profunda and protrusio acetabuli, also can result in pincer impingement by increasing the relative depth of the acetabulum.[4,23,25] The deepening of the socket results in a relative decrease in the length of the femoral neck, a decrease in the neck-to-head ratio, a decrease in femoral neck offset, or an increase in relative circumferential overcoverage of the femoral head. All of these conditions affecting the acetabulum in the presence of a relatively normal proximal femur can lead to abutment of the acetabular rim against the femoral neck and to lesions that are limited to the rim area; deep chondral lesions are rare. Pincer impingement is more common in middle-aged women with morphologic abnormalities of the acetabulum.

This is in contrast with cam impingement, which is more common in young men with morphologic abnormalities involving the femoral head. MRI-based quantitative anatomic study of the femoral head and neck has confirmed that anatomic variations in the proximal femur are responsible for cam impingement.[28] A substantial reduction in the mean femoral anteversion and mean head-neck offset in the anterior aspect of the femoral neck was seen in patients presenting with impingement compared with a group of age- and gender-matched control subjects.[28] Subsequent studies using standardized MRI have confirmed that hips of patients with symptomatic impingement have markedly less concavity at the femoral head-neck junction compared with normal hips.[14,30]

Although long-term results are awaited, surgical treatment of patients with FAI has been encouraging to date. Advancements in the ability of MRI to identify chondral pathology should enhance our understanding of the natural history of FAI. Better understanding of the pathophysiology of impingement as a cause of arthritis of the hip will enable additional therapeutic interventions to be developed. Finally, further refinements of surgical procedures should not only enhance outcome but also allow surgeons to better determine the indications for these impingement procedures.

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Evidence-based Medicine: No level I and II prospective studies were cited. All citations are level III and IV case-control studies.

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