TREATMENT OF ANTERIOR FEMOROACETABULAR IMPINGEMENT WITH COMBINED HIP ARTHROSCOPY AND LIMITED ANTERIOR DECOMPRESSION

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ABSTRACT

Anterior femoroacetabular impingement results from abnormal abutment of the anterolateral femoral head-neck junction with the anterior acetabular-labral complex resulting in pain and progressive hip dysfunction. This under-recognized problem could be the manifestation of acetabular or proximal femoral deformity, and when left untreated leads to the development of osteoarthritis of the hip. Conservative treatment is usually unsuccessful and the optimal surgical treatment for these disorders needs to be determined. We present our technique for treating femoral (cam) impingement which combines hip arthroscopy and a limited open anterior head-neck osteoplasty as a less invasive and more conservative surgical approach, which still adequately addresses the anatomy and pathophysiology of this disease.

INTRODUCTION

Impingement of the femoral neck on the anterior rim of the acetabulum (anterior femoroacetabular impingement) has been described in conjunction with malunited femoral neck fractures,[3] acetabular dysplasia,[12] acetabular retroversion,[32,33] and as a complication of periacetabular osteotomy.[25] Increasingly, it is being recognized as a cause of significant hip pain and disability and is strongly implicated as a cause of secondary osteoarthritis.[5,6,23] In 1999, Ganz and colleagues reported the development of a secondary impingement syndrome as a complication of periacetabular osteotomy.[25] The femoral head-neck junction abutted the anterior rim of the acetabulum leading to pain in five patients after repositioning of the dysplastic acetabulum. Most importantly, successful resolution of anterior impingement symptoms was noted after surgical treatment of the anterior impingement lesion.

Although anterior femoroacetabular impingement was initially described as a complication of surgery and noted to be secondary to several other deformities, it has recently and appropriately been recognized as a disease process unto itself and as a significant cause of hip pain in younger patients.[1,5,23,34,38] Femoroacetabular abutment is classified as either pincer or cam impingement.[5] Pincer-type impingement has been associated with acetabular retroversion,[32] protrusio acetabuli, and coxa profunda[33] due to the relative over-coverage by the anterior rim producing a linear contact between the rim and femoral neck.[5] Cam impingement is the result of decreased head-neck offset with a gradual aspherical contour from the femoral head to the neck anterolaterally with a relative retroversion of the femoral head.[10,34] This results in an increased radius of curvature anteriorly with a triangular shaped extension of bone and articular cartilage onto the femoral neck. This osteochondral lesion impacts the acetabular rim with flexion and internal rotation of the hip.[34] The suspected etiology of this lesion is abnormal physeal development [6,20,28] but it can also occur in slipped capital femoral epiphysis (SCFE),[15,30] Legg-Calve-Perthes disease, and malunited femoral neck fractures.[3]

Interestingly, the histopathological and morphological changes seen in the labrum and cartilage with both cam and pincer impingements are similar to and consistent with chronic degeneration without signs of acute inflammation[9] and an etiology of repetitive microtrauma. Impingement of the femoral head-neck prominence onto the acetabular rim initially leads to hypertrophy of the anterior-superior labrum with intrasubstance degeneration. Over time, delamination of the acetabular cartilage of the superior acetabular rim-labral junction occurs, and degenerative labral tears are produced anteriorly by repetitive compression and sheer forces. As the femoral head levers out of the acetabulum with flexion, a distraction force occurs on the posterior capsular-labral junction resulting in the development of a posterior counter-lesion with small tears noted in the posterior labrum. As severity of the disease progresses, the entire labrum becomes degenerative with further delamination of the acetabular articular cartilage and subsequent wear damage to the anterior portion of the

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Figure 1. Radiograph demonstrating severe arthrosis of the right hip secondary to untreated femoroacetabular impingement in a thirty-eight year old patient. Note the aspherical femoral heads bilaterally.

femoral head. The end result of this process is the development of global hip arthrosis (Figure 1).

Early surgical intervention has been proposed to avert the pathologic sequence of events starting with impingement and resulting in end-stage arthrosis. Specifically, Ganz and colleagues have recommended surgical dislocation of the hip to treat this disorder.[4] The purpose of this report is to describe an alternative, less-invasive surgical strategy for the treatment of early femoroacetabular impingent that combines hip arthroscopy and a limited osteoplasty of the anterior head-neck junction.

CLINICAL AND RADIOGRAPHIC EVALUATION OF ANTERIOR FEMOROACETABULAR IMPINGEMENT

History

Anterior femoroacetabular impingement usually presents in young athletic patients less than 50 years old and involved in activities that require repetitive hip flexion. These patients frequently complain of hip discomfort with sitting and hip flexion activities. The location of the discomfort is predominantly in the groin (anterior inguinal), but can be associated with buttock and lower lumbar discomfort. Anterior femoroacetabular impingement is consistently associated with anterior labral pathology. Therefore, patients may complain of mechanical symptoms (locking, catching, and giving way) indicative of labral tears or articular cartilage delamination lesions. Patients with more severe deformity may also complain of restricted hip motion, specifically limited hip flexion and limited internal rotation in flexion. When interviewing the patient, it is important to elicit any history of previous hip disease or hip surgery, especially SCFE. After characterization of the patient history and symptoms, a careful physical examination is critical.

Figure 2a

Figure 2. Case Example—A 21-year old collegiate wrestler with symptomatic anterior femoroacetabular impingement. AP (a) and frog-leg lateral (b) radiographs demonstrate an aspherical femoral head with deficient head-neck offset anterolaterally. Eighteen-month follow-up frog lateral.

Figure 2b

Figure 2c. MR arthrogram shows hypertrophic degenerative labral tear and aspherical femoral head.

Physical Examination

On physical examination, the patient's gait is either normal or slight limp will be present occasionally. A Trendelenburg test may be positive, especially if the disease is more established. Abductor strength is routinely assessed and commonly reveals slight weakness. Hip motion should be evaluated very carefully. A restriction of hip flexion and hip internal rotation is quite common. Many of these patients have hip flexion limited to 90-100 degrees (normally 120-130 degrees). Internal rotation in 90 degrees of flexion is quite restricted and is usually between 0 and 10 degrees. This restricted internal rotation in hip flexion is due to osseous impingement of the anterolateral femoral head-neck junction with the acetabulum.[27] The anterior impingement test is almost universally positive and should reproduce the symptom of groin pain.[18] Posterior impingement of the hip is assessed with the patient in a prone position. The hip is extended and externally rotated to produce posterior impingement of the head-neck junction with the posteroinferior rim of the acetabulum. Posterior impingement is more common as the disease progresses and a posteroinferior traction osteophyte develops which can produce clinical symptoms of posterior impingement in extension.

Radiographic Evaluation

Radiographic evaluation includes an AP pelvis, false-profile view, frog lateral view, and cross-table lateral view of the hip. The cartilage space of the hip is assessed and any structural abnormalities about the hip are noted. Specifically assess the acetabular version,[19] lateral femoral head coverage,[14] anterior femoral head coverage,[40] inclination of the acetabular articular surface,[39] and the contour and sphericity of the femoral head.[2,7,22,24] Specific attention is directed to the head-neck region. Fullness or a prominence of this region laterally on the AP view is indicative of anterolateral disease (Figure 2a). The frog lateral and cross-table lateral radiographs are used specifically to quantify the femoral head-neck offset along the anterolateral aspect of the head-neck junction (Figure 2b). [2,6,24] The head-neck offset is measured on the cross-table lateral radiograph using a method described by Eijer et al.[2] A line bisecting the longitudinal axis of the femoral neck is drawn; however, this is not necessarily through the center of the femoral head. A parallel line tangent to the anterior femoral neck and a second parallel line tangent to the anterior femoral head are then drawn. The perpendicular distance between these two lines is the measured head-neck offset, with a value less than nine millimeters being abnormal. The offset ratio is determined by the ratio of the head-neck offset distance relative to the diameter of the femoral head, with a value of less than 0.17 being abnormal.[2] In patients with subtle radiographic findings and questionable femoroacetabular impingement, a hip motion exam with fluoroscopy can determine the presence or absence of osseous impingement.

MRI arthrography can provide additional information regarding the integrity of the acetabular labrum, anatomy of the head-neck junction and the degree of acetabular cartilage deterioration (Figure 2c).[11,16,17,29]

Surgical Techniques

The basic principle of surgical treatment of anterior femoroacetabular impingement is to restore sphericity to the femoral head, thereby relieving the impingement, and to also address the pathologic changes in the labrum and articular cartilage. Treatment can be tailored to the specific pattern of the disease. In cases of cam anterior femoroacetabular impingement, the offending lesion is consistently located in the anterolateral aspect of the femoral head-neck junction.[27] This has led to the treatment approach we describe below which addresses this disorder with a less-invasive surgical approach.

The patient is positioned supine on a standard fracture table. We presently prefer general endotracheal anesthesia with muscle relaxation to aid in distraction

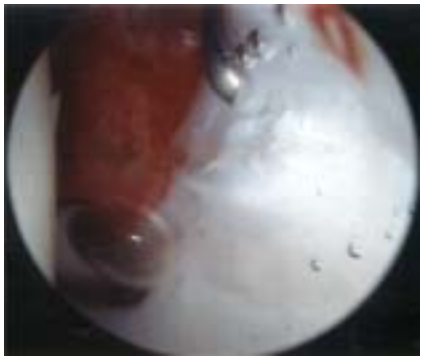


Figure 2d

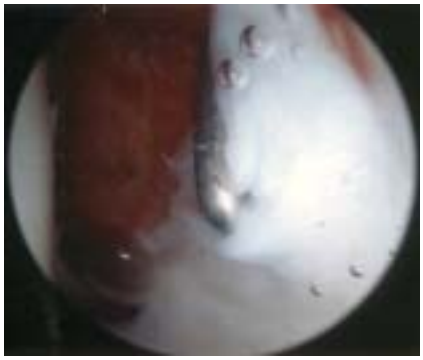


Figure 2e

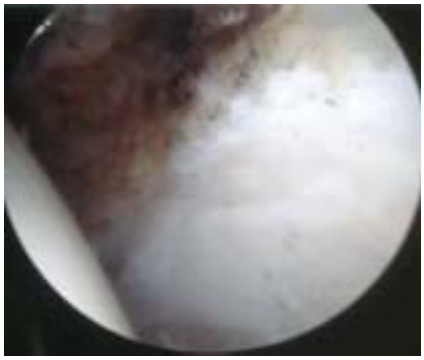
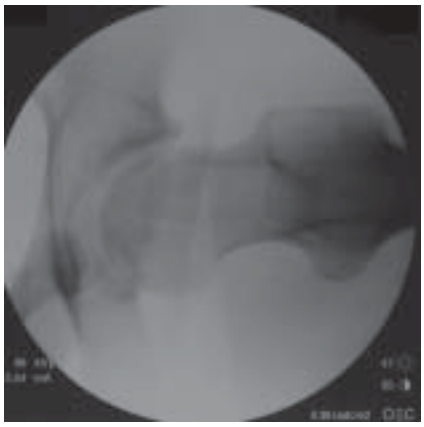


Figure 2f



At arthroscopy, the patient had an anterior labral tear (d), and early articular cartilage delamination (e). These lesions were treated with arthroscopic debridement (f). Intraoperative fluoroscopic views demonstrating the aspherical femoral head (g) and restoration of head-neck offset (h) after anterolateral osteoplasty.

of the joint. The first stage of the operation is a hip arthroscopy to inspect the severity of disease and to address labral and articular cartilage lesions. We perform this with slight hip abduction (5˚) and slight internal rotation of the lower extremity (5˚). The hip is maintained in a neutral position of flexion and extension. The joint is distracted 8-10 mm with fracture table traction. We utilize the anterior, anterolateral and posterolateral portals. These are established with fluoroscopic assistance placing 5.0, 4.5 and 4.0 mm cannulated hip arthroscopy cannulas (Dyonics, Smith&Nephew, Andover, MA) in the respective portals. The joint is systematically evaluated with both a 70-degree and 30-degree angled arthroscope. The articular cartilage of the femoral head, the acetabulum and the acetabular labrum are inspected. In patients with anterior femoroacetabular impingement complex, degenerative tears of the anterior and anterolateral acetabular labrum are common (Figure 2d). These labral lesions are frequently associated with delamination of the adjacent articular cartilage at the transition zone (Figure 2e). In more severe cases, the labral and adjacent articular cartilage disease can extend along the entire anterior and lateral margin of the acetabulum. It is also common to find articular cartilage disease at the articular-labral transition zone posteroinferiorly. In early stages, these posterior changes are mild, and major unstable flaps of articular cartilage are uncommon. Labral disease posteriorly is commonly less extensive and less severe. After careful inspection of the joint, the unstable labrum and articular cartilage disease are treated with conservative debridement (Figure 2f). We employ the combination of a ligament chisel (Vulcan EAS, Oratec Interventions, Menlo Park, CA), full-radius shaver and an aggressive arthroscopic shaver (Linvatech, Largo, FL) to debride unstable flaps of acetabular labrum and associated articular cartilage flaps. Care is taken to resect only unstable regions of the labrum and articular cartilage. Further delamination of the articular margin is possible if aggressive resection is performed. After the anterior labral and chondral debridement is performed, we proceed with a conservative debridement of the posteroinferior acetabular labrum and associated articular cartilage if necessary. After arthroscopic debridement is completed, the joint is irrigated, instruments are removed, and traction is released.

After completion of the hip arthroscopy, the patient remains in the same position and open debridement is performed or the patient is repositioned for a limited, open anterior decompression of the hip. Prior to incision, fluoroscopy images are taken to insure excellent visualization of the proximal femur, specifically the femoral head-neck junction. This is best visualized with a cross-table lateral or a frog-leg lateral view (Figure 2g). Internal rotation in the frog lateral position can better define the anterolateral osteochondral prominence. An 8-10 cm incision is then made, starting just inferior to the anterior superior iliac spine and incorporating the previous anterior arthroscopy portal incision. Dissection is carried through the subcutaneous tissue laterally to dissect directly onto the fascia of the tensor fascia lata muscle. The fascia is incised, and the muscle belly is retracted laterally. The fascia is reflected medially. This medial sleeve of tissue contains the lateral femoral cutaneous nerve which should be protected by placing the fascial incision lateral to the tensor-sartorius interval. The interval between the tensor and sartorius is then developed. The rectus origin is identified, and the direct and reflected heads are released. The rectus is reflected distally and the adipose tissue and iliocapsularis muscle fibers are dissected off the anterior hip capsule. An "I"-shaped capsulotomy is then performed to provide adequate exposure of the anterolateral femoral head-neck junction. Most commonly, an outgrowth of osteochondral tissue is observed along the anterolateral head-neck junction. The offset from the femoral head to the neck in this region is deficient. The normal head-neck offset anteromedially serves as a reference point for resection of the abnormal osteochondral lesion. A half-inch curved osteotome is utilized to perform an osteoplasty at the head-neck junction. The osteotome is directed distally and posteriorly to perform a beveled resection to prevent delamination of the retained femoral head articular cartilage. After the osteoplasty is performed and the head-neck offset has been established anterolaterally, the accuracy of the surgical resection is confirmed with intra-operative fluoroscopy. The frog-leg lateral or cross-table lateral views in neutral and varying degrees of internal rotation are very effective for visualizing the anterolateral head-neck junction (Figure 2h). The hip can also be examined at this time to assess impingement in hip flexion and combined flexion and internal rotation. This is performed while palpating the anterior hip to test for residual impingement. If the anterior acetabular rim is overgrown secondary to labral calcification or osteophyte formation, this is carefully debrided until adequate clearance is achieved. Hip motion should improve at least 5-15 degrees in flexion and at least 5-20 degrees in internal rotation. The goal of the osteoplasty is to remove all prominent anterolateral osteochondral tissue that contributes to an aspherical shape of the femoral head. If sphericity has not been achieved, additional resection of the head-neck junction is performed. Bleeding from the surface of the osteoplasty is controlled with bone wax. The joint is irrigated and the longitudinal and superior transverse arms of the arthrotomy are closed with absorbable sutures. The direct and reflected heads of the rectus tendon are repaired with nonabsorbable suture and the remainder of the wound is closed in standard fashion.

Post-operative Care

Postoperatively, patients are observed overnight in the hospital. Physical therapy is instituted for toe-touch weight bearing with crutches to minimize the risk of femoral neck stress fracture. A pillow is used under the thigh to protect the rectus repair and active flexion is avoided for six weeks. Abductor strengthening is instituted immediately and continued with a home exercise program. Crutches are discontinued at six weeks and activities are resumed gradually as tolerated. Impact activities like running are not encouraged for at least six months. Aspirin 325mg is taken as thromboembolic prophylaxis and indomethacin 75mg sustained release is utilized for heterotophic ossification prophylaxis. Both are taken for six weeks.

DISCUSSION

The contour of the femoral head and neck radiographically has been noted to be a predictor of anterior femoroacetabular impingement.[27] The oval-shaped head, as seen on the AP radiograph, has been described as a pistol-grip deformity.[37] This anterolateral prominence, however, is best recognized on lateral radiographs.[2] The pistol-grip deformity has, over the years, been correlated with idiopathic osteoarthritis.[7] Subclinical slipped capital femoral epiphysis has been suggested as a possible cause of this deformity, and thus, of secondary osteoarthritis.[24,35,36,37] Other authors have disputed this suggestion and attribute the deformity to secondary remodeling of the proximal femur as a result of idiopathic osteoarthritis itself.[8,31] Goodman et al. noted that the post-slip morphology was present at a constant rate in multiple age groups, thus implying that the deformity was primary and not secondary to remodeling from osteoarthritis.[6] It was also suggested in the same study that the deformity might represent an anatomical variant in the shape of the adult femur instead of a consequence of unrecognized childhood disease. Moreover, it was hypothesized that this variant could result in contact between the femoral neck and acetabulum with flex-

ion and internal rotation, leading to the development of osteoarthritis. The contention that the deformity is an anatomic variant rather than the consequence of a subclinical SCFE is further supported by an MRI study showing that the orientation of the capital physeal scar remains in normal position in these patients.[34]

Surgical treatment of femoroacetabular impingement has been described by Ganz and colleagues,[5] who developed an approach that involves dislocation of the hip joint anteriorly with a trochanteric flip osteotomy.[4] This allows for access to the femoral head for debridement, and open debridement of the labrum and acetabular rim, and has been combined with femoral osteotomy, when needed, to address the various causes of femoroacetabular impingement.[1,3,5,13,23,25,38] This surgical approach was reported in 2001 by Ganz for the treatment of multiple hip pathologies and included 164 patients with anterior impingement.[4] Average blood loss was 300ml with an average of eight weeks until osteotomy healing, and four to six additional weeks to regain abductor strength. The overall incidence of heterotopic ossification was 37 percent and there were two transient sciatic nerve palsies. While there were no reported cases of avascular necrosis (AVN) in the initial description of the procedure, laser Doppler flowmetry showed transient changes in head perfusion during the procedure, which returned to baseline after reduction of the joint.[26] The dislocation also requires the rupture or division of the ligamentum teres with loss of its proprioceptive nerve fibers, the consequences of which are currently unknown. In a midterm report of 19 patients with average follow-up of 4.7 years, Beck et al. noted that there was significant improvement in the pain score and the overall Merle d'Aubigne hip score. Five hips were converted to total hip arthroplasty(THA), while the rest were rated with good or excellent results. There were no instances of AVN reported.[1]

Possible surgical treatment options for anterior femoroacetabular impingement include hip dislocation with trochanteric osteotomy, arthroscopy alone, or as we recommend, hip arthroscopy with limited anterior decompression. The inciting mechanical lesion in primary anterior femoroacetabular impingement is consistently located along the anterolateral head-neck junction.[27] In early and mid stages of the disease process, intraarticular pathology is limited to labral degeneration and tears associated with small articular cartilage lesions and delamination around the acetabular rim.[9] These lesions can be addressed appropriately with the arthroscopic portion of the procedure. Advanced chondral lesions have not responded well to open debridement, with a high incidence of progression and subsequent conversion to THA.[1,23] In their original reported

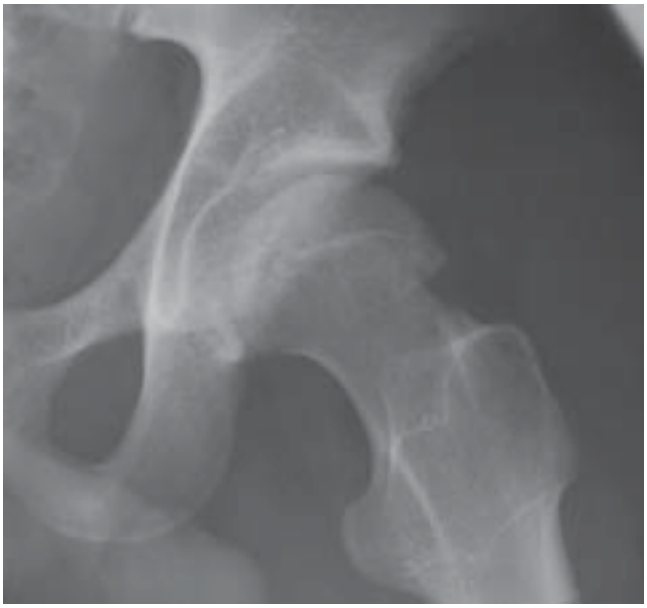


Figure 2i. Demonstrates maintained head-neck offset without progression of degenerative changes.

series of open debridements via hip dislocation, Ganz and colleagues made an intraoperative decision to perform primary THA on patients with advanced chondral lesions.[4]

While we admittedly have no experience with arthroscopic debridement of the bony impingement deformity, our experience with hip arthroscopy[11] has verified the efficacy of arthroscopy for labral pathology. Our current opinion is that debridement of the femoral head-neck junction arthroscopically has certain potential disadvantages including the potential for inadequate exposure of the anterolateral head-neck junction, the potential for bony debris to become entrapped in the joint, and the possibility of inadequate osseous debridement.

We have taken an intermediate approach to treating this disease, which combines the advantages of hip arthroscopy with an open osteoplasty of the femoral head-neck junction. The arthroscopy addresses the labral disease at the acetabular margin and any associated chondral damage. Additionally, posterior labral and articular cartilage disease is accessed and treated arthroscopically. The open osteoplasty is performed via a limited anterior approach through the Smith-Peterson interval. This allows excellent exposure of the anterolateral femoral head-neck junction and the anterior and lateral acetabular rims. This provides adequate exposure for osteoplasty of these anatomic sites. The exposure also allows visualization of the anteromedial head-neck junction, which is an excellent reference point for normal neck contour. This exposure combines the ad-

vantages of a less invasive surgery with a theoretical lower complication rate. Importantly, we do not advocate the use of this procedure for more advanced disease with posterior impingement lesions, or for hips that have circumferential lesions of the femoral head. In these cases, trochanteric osteotomy and surgical dislocation as described by Ganz et al. provides superior exposure to address more extensive disease patterns.[4]

This report presents our current surgical technique for primary cam femoroacetabular impingement and the disease pattern relevant to its development. In our initial cohort of patients treated with this procedure (Clohisy, unpublished data), we have been very satisfied with the rapid recovery and clinical results over the short term (Figure 2i). While our early results with this technique are promising, continued follow-up for mid-term and long-term results is essential to verify the efficacy of this technique.

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