Femoroacetabular Impingement: A Review of Current Concepts

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ABSTRACT

Femoroacetabular impingement is becoming an increasingly more common diagnosis in the orthopaedic community for hip pain in the younger population. Variations in the femoral head and acetabulum can lead to a sequelae of changes to the cartilage that can lead to osteoarthritis. Diagnosis is made through a combination of patient history, physical examination, and diagnostic imaging. Plain radiographs are a very useful tool for evaluating the bony anatomy, while CT scan and MRI have roles for surgical planning and more definitive diagnosis. Most patients should trial physical therapy prior to consideration for any arthroscopic or open procedures. Long-term outcome studies are being performed to determine if surgical intervention has any impact on quality of life and development of osteoarthritis.

KEYWORDS: CAM, Pincer, hip arthroscopy, labrum

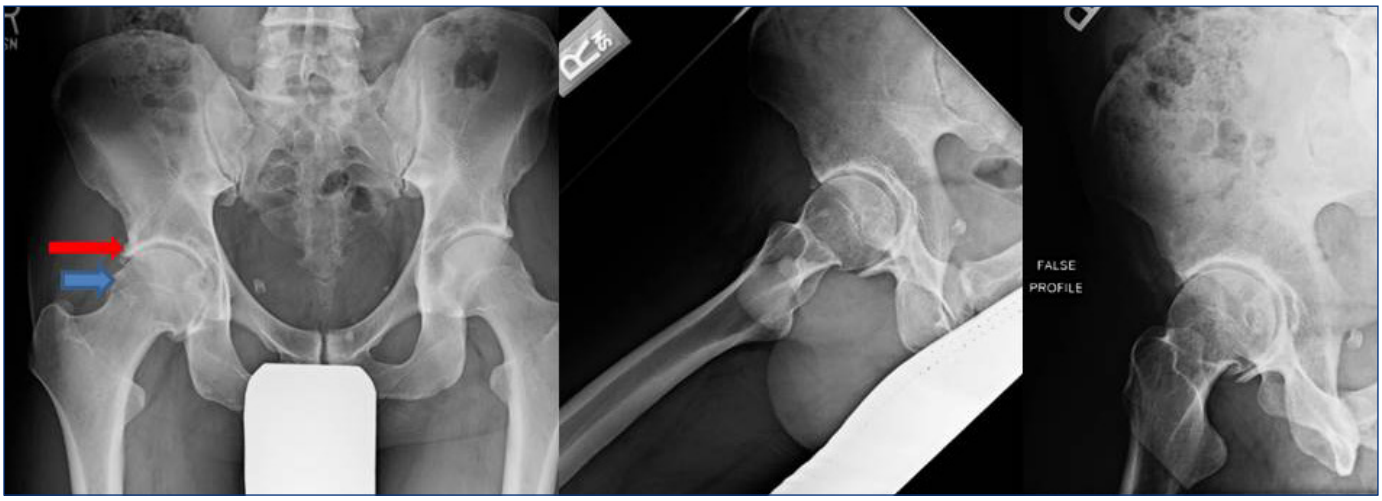
INTRODUCTION

As the population ages, primary care providers are increasingly encountering patients with hip pain. However, the differential ranges widely from muscle strains, various arthritides, vascular compromise to urological or gynecological disorders. Osteoarthritis in particular was thought to be a disease of the elderly but in past decade femoroacetabular impingement (FAI) has become increasing recognized in the younger population as a possible predisposing factor for osteoarthritis.[1] FAI describes a condition of hip pain due to an abnormal femoral head (ball) and/or acetabulum (socket). This association was first described by Ganz et al., in 2003 via inspection of hundreds of surgical hips and analysis of hip motion.[2] While understanding a cause of hip pain and increasing the diagnosis of FAI, as of 2006 it was reported that patients with hip pain went undiagnosed for on average 21 months and saw on average 3.3 providers.[3]

CAM AND PINCER LESIONS

The etiologies of FAI include CAM lesions, pincer lesions and mixed type lesions (**Figure 1).** CAM lesions are bony protrusions on the femoral head-neck junction resulting in impingement with range of motion. Consequently, during hip flexion, this defect causes shearing of the cartilage and labrum and also results in severely reduced internal rotation for the patient. The CAM lesion leads to a repetitive trauma to the anterolateral edge of the acetabulum leading to delamination of the cartilage and failure of the acetabular labrum.[4] Combination of CAM and pincer lesions can also occur which actually is the most common presentation.[4]

Figure 1. Plain Radiographs of a Combined CAM and Pincer Lesion – AP, Frog-lateral, and False Profile views of a skeletally mature individual showing a CAM lesion at the femoral head/neck junction (blue arrow) as well as an acetabular Pincer lesion (red arrow).



The etiology of FAI is generally unknown but one widely recognized cause of CAM lesions is slipped capital femoral epiphysis (SCFE).[4,5] Byrd has written that the "pistol grip" deformity may be due to premature eccentric closure of the capital physic in adolescence leading to the femoral head being a nonspherical shape, in particular with more physical activity a partial physeal arrest can occur.[4] Other proposed relationships include genetic predisposition, occupation or childhood athletics.[1,6,7] For example, studies have quantified the prevalence of CAM lesions ranging between 50-68% in adolescents and young adults 12 to 26 years old who played high level soccer or football and have further shown a 2 or 3 to 1 male to female ratio in CAM lesions.[8-12]

Interestingly, CAM lesions have been documented in asymptomatic adults. One study in 2011 by Jung et al., examined 755 hip radiographs and found asymptomatic CAM lesions in 5.5% and 14% of women and men, respectively.[13] Another study determined a 14% prevalence within their cohort.[14] Thus, CAM lesions could be incidental findings on imaging which do not necessarily require further work-up in asymptomatic patients.

While CAM lesions are defects of the femoral head, pincer lesions are defects of the acetabulum. Pincer lesions are due to either retroversion of the acetabulum or a bony overgrowth causing the anterolateral rim to cause trauma to the labrum during hip flexion.[1,4,6] The prevalence of pincer lesions in general is less than CAM lesions with studies showing in young adults 18–30 year olds 10 to 26% in soccer players[9] and as high as 66% in football players.[11]

Unlike the association of CAM lesions with males, pincer lesions have an equal male to female distribution.[15] The third etiological classification of FAI is when patients have both CAM and pincer lesions which is termed mixed type. The prevalence is of mixed type approximately 50%,[9] but probably higher.

Figure 2. C-Sign – Patients when describing the discomfort in the hip will often cup the hand and place the palm over the greater trochanter with fingers angled towards the groin.

HISTORY AND PHYSICAL EXAMINATION FINDINGS

Patient with hip pain due to FAI have several features of the history that are classic. FAI is due to chronic microtrauma to the cartilage and labrum and thus patients complain of chronic pain that is gradually worsening. Athletic patients may even recall a distant traumatic event or describe themselves as less flexible compared to teammates.[4] Often patients complain of deep medial groin pain radiating to the anterolateral region of the thigh which is termed the "C-sign" (**Figure 2**).[4,7,16] This is formed by cupping the hand and placing palm over the greater trochanter with fingers angled towards the groin.

The "restaurant sign" is when patients describe inability to sit for prolonged periods and must shift their weight or walk around to alleviate the symptoms. As predicted, these symptoms often manifest themselves worst at restaurants. Patients also describe clicks or locking with sharp stabbing pains that are worsened with pivoting, or turning towards the affected side.[4,16]

Physical exam can further confirm your suspicion of FAI. While there is a wide variety in how providers examine hips, certain exam maneuvers are classic for FAI. It is important to be cognizant that physical exam of athletes may not produce enough force on the hip to reproduce symptoms and the hip exam can be uncomfortable thus examining both hips is essential.[4,16] The most sensitive test for FAI is flexion, adduction, internal rotation (FADIR) also known as a positive impingement sign.[16] Understanding the pathophysiology explains this exam maneuver given that flexion causes a CAM or pincer lesion to come into conflict with the labrum or chondro-labral junction which results in limited internal rotation of the hip. Patients may have limited internal rotation in the setting of a CAM lesion without any labrum injury.[8]

Maximal flexion of the hip is generally uncomfortable. A Stinchfield test or resisted hip flexion may be positive. The log roll test is the most specific test for hip joint pathology because it minimizes stress on surrounding structures, but is the least sensitive.[4] It is important to note that secondary lesions such as trochanteric bursitis or muscle spasms may be more obvious to the examiner and thus FAI must be carefully evaluated.[4] Athletic pubalgia (AP) is another condition that can present similarly to FAI.[4,17] While AP and FAI are often seen in athletes, FAI and AP symptoms are reproducible with passive and resisted exam maneuvers, respectively.[4,17] Specifically, AP symptoms are seen with resisted hip flexion or adduction. When history and physical exam are suggestive of FAI, imaging studies can confirm the diagnosis.

IMAGING

Initial studies should include plain film radiographs of the pelvis in standing anteroposterior view, frog lateral of both sides and some also prefer a Dunn or modified Dunn view.[1,4,18] This allows comparison of both sides and placed

Figure 3. Alpha (α) Angle – Plain frog leg lateral x-ray measurement to evaluate the CAM lesion. The normal α angle is between 55 to 60 degrees or less. The x-ray α angle measurement is 77.2°. The angle is measured by drawing a best-fit circle around the femoral head and then by drawing a line that runs through the center of the neck and head. A second line is then drawn to a point where the superior surface of the head-neck junction first is no longer in the circle.

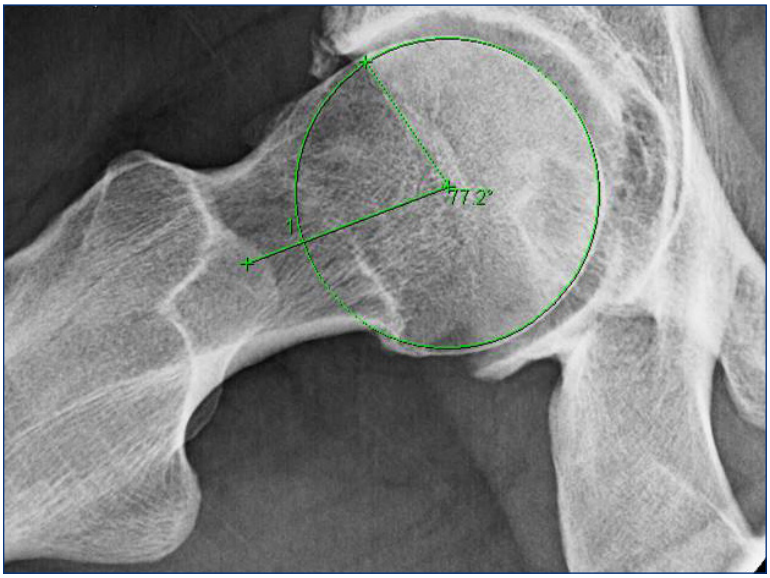


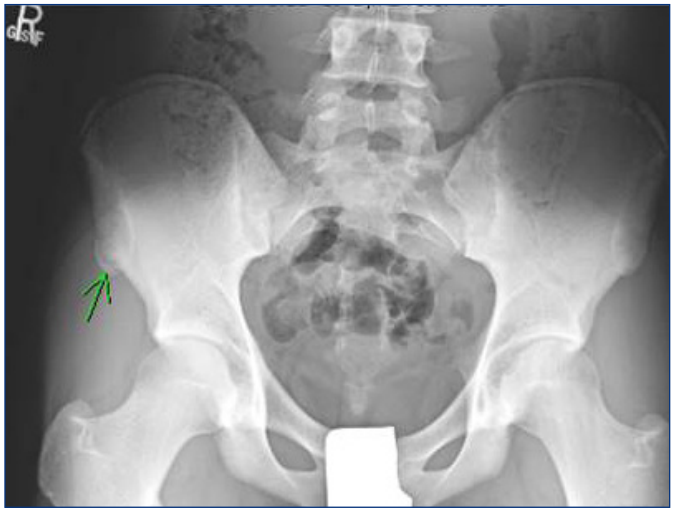
Figure 4. Crossover Sign – The Crossover Sign evaluates for acetabular retroversion. If a line drawn along the anterior wall of the acetabulum (black line) crosses the line of the posterior wall (white line), this indicates a positive crossover sign. Acetabular retroversion is very often associated with a deficient posterior wall of the acetabulum.

in the context of clinical exam. Modified Dunn view is recommended which is imaging of hip flexed 45° and abducted 20° which is sensitive for femoral head lesions[16] compared to the classic Dunn view where the hip is flexed to 90° and abducted to 20°. It is important to mention that physicians often miss radiographic findings of FAI unless they have increased suspicion of such a diagnosis.[1] These specific morphological findings include tilt deformity (CAM lesion), acetabular overcoverage (pincer lesion), crossover sign (acetabular retroversion), bone spurs or joint space narrowing (osteoarthritis).[1,4]

The common series of plain x-rays ordered for adequate work-up for FAI is the AP and a lateral view.[19] The AP view is better for identifying pincer lesions, while the lateral view is better at visualizing a CAM deformity. Lateral views ordered can be a cross-table, frog-leg, or Dunn view at 90 deg. and 45 deg. Flexion.[19] Caviagnac et al., 2012, showed that the frog-leg 45/45/30 view had the highest alpha angle measured and was valuable for diagnosing CAM lesions.[19] Konan et al. compared the alpha angles on CT and XR and found higher alpha angles on CT scan.[20] We prefer a false profile view in our series to evaluate for acetabular dysplasia by measuring a center-edge angle as well as to visualize the CAM lesion.

The alpha (α) angle is used to determine if a CAM lesion is present (**Figure 3**). Typically an α angle of 55 to 60 degrees or less normal. The α angle is measured by drawing a best fit circle around the femoral head and then a line that runs through the center of the neck and head. A second line is then drawn to a point where the superior surface of the head-neck junction first is no longer in the circle.[8]

Figure 5. Anterior Superior Iliac Spine (ASIS) Avulsion Fracture – AP radiograph of a skeletally immature individual with an ASIS avulsion fracture as indicated by the arrow.



The "pistol grip" deformity seen in CAM lesions can be well visualized on an AP radiograph.[4] The Crossover sign refers to over-coverage of the anterior acetabulum due to acetabular retroversion (**Figure 4**).[4] Global over-coverage can lead to multiple areas of impingement due to acetabular profunda or protrusion and is seen with an increased center-edge angle on many views.[4]

The presence of an os acetabula or an unfused apophysis from the rectus femoris origin can be seen on an AP x-ray. Fractures of the anterior superior iliac spine (ASIS) (**Figure 5**)

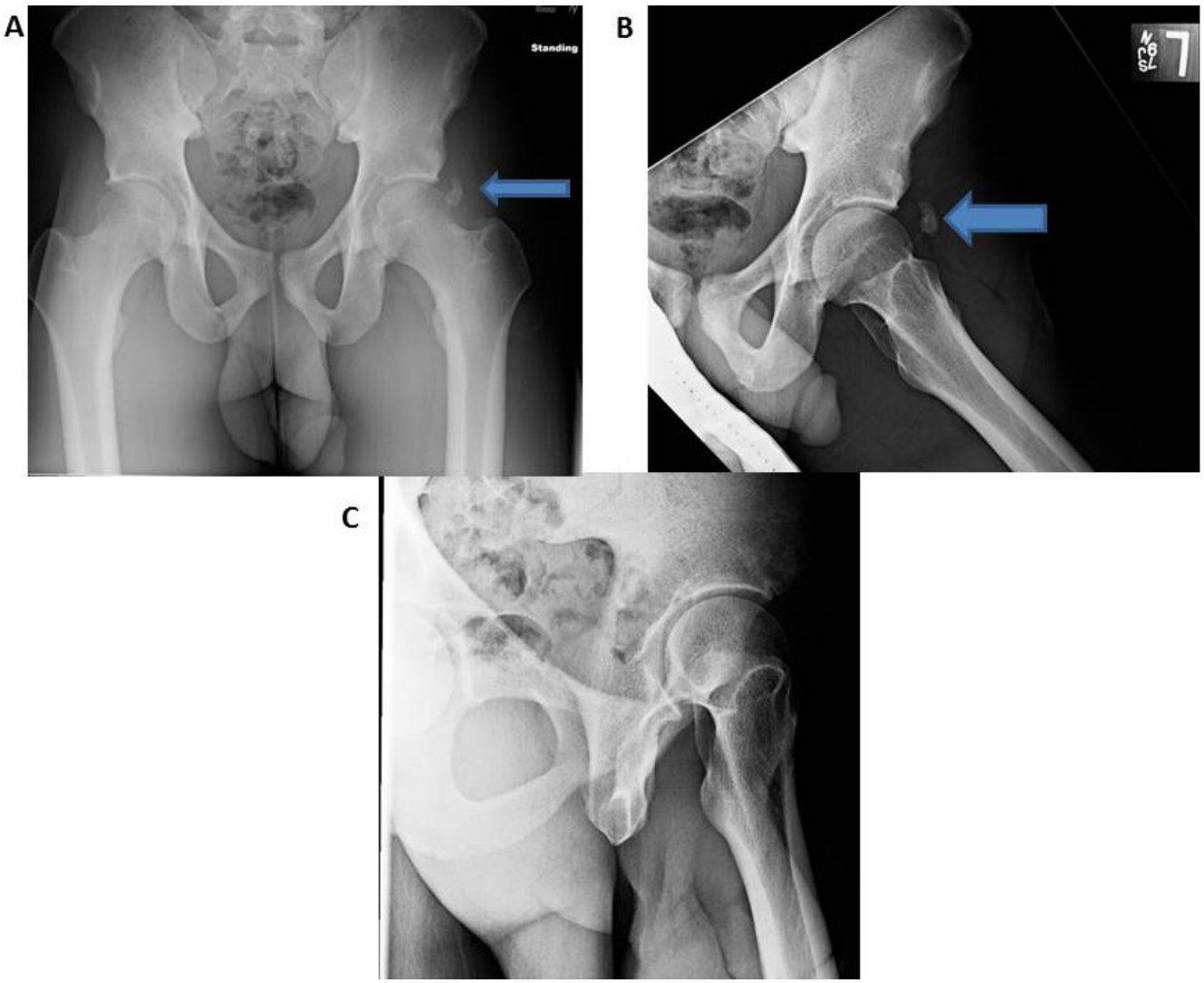
and fractures of the anterior inferior iliac spine (AIIS) (**Figure 6**) can be seen on x-ray as well. AIIS avulsion fractures can lead to impingement as well if the bony fragment becomes incarcerated. A CT scan may be helpful for determining the location of the bone and is the best for showing overall bony architecture and structure.[4] CT scans and CT scans with 3D reconstruction can also be helpful for further evaluating the size of the CAM lesion.

MRI arthrogram is best suited for evaluating labrum or cartilage pathology as it is more than 90% sensitive.[16] The arthrogram component is essential with the current magnet properties of most MRI machines. Lower resolution images from open MRI scanners and smaller magnets do not have great visualization of most lesions in the hip.[4] The magnet for the study should be at a minimum a 1.5-T magnet with surface coils.[4] We prefer a 3-T magnet and we typically do not require any contrast for the study. We recommend discussing the patient with the radiologist prior to ordering the MRI study. During the MRI arthrogram, the local anesthetic injection also helps to confirm if intra-articular pathology is the cause of the joint pain because patients typically have less pain after the injection.[4]

NON-OPERATIVE

While FAI is a result of anatomical deformities of the hip joint, non-operative treatment can offer relief to the patient. Analgesics, physical therapy, activity modification and intra-articular glucocorticoid injections are the mainstay of conservative treatment. Physical therapy focuses on strengthening core muscles and avoidance of motions that cause excessive hip flexion such as squatting or low chairs.[1,4,7] Importantly, there is no data to support one physical therapy intervention over another in terms of symptom improvement or altering the natural course of this disease.[7] Intra-articular injections are both diagnostic and therapeutic

Figure 6. Anterior Inferior Iliac Spine (AIIS) Avulsion Fracture – Radiographs of an adolescent individual with an AIIS avulsion fracture as indicated by the arrow. A is the AP view, B is the frog-leg lateral view, and C is the false profile view.



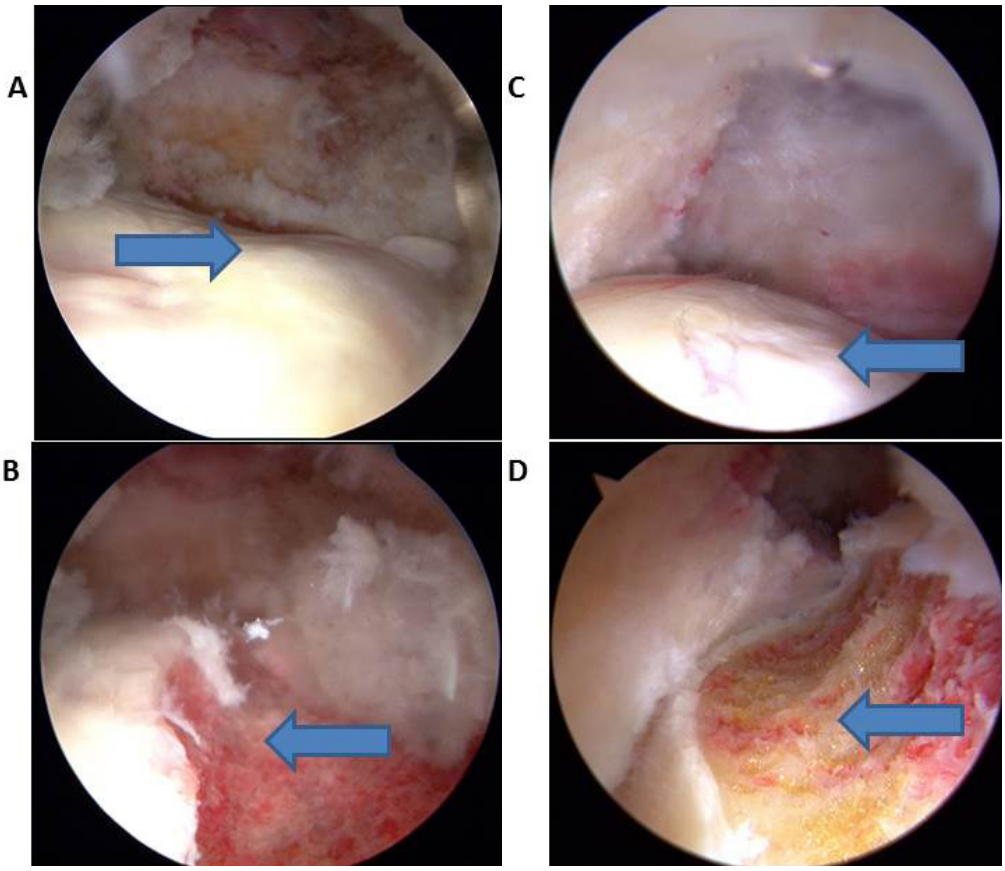


Figure 7. Pre- and Post-Arthroscopic Images of CAM Lesion Debridement at the Femoral Head/Neck Junction (Osteochondroplasty) – Images A & B show pre- and post-CAM debridement in Patient #1. Images C & D show pre- and post-CAM debridement in Patient #2. The arrows point to the area of the CAM lesion both pre- and post-CAM debridement. The comparison between patients shows how the CAM lesion can vary in size between patients.

in that if the injection relieves the pain, then it suggests the pathology is within the hip joint which can be done with an office-based ultrasound machine or at a radiology suite.[1,4,16] Referral to an orthopaedic surgeon is recommended if pain is unresolved with these conservative measures.[16]

SURGICAL TREATMENT

There are a variety of surgical interventions used to treat FAI ranging from the least invasive arthroscopy to the most invasive open surgical dislocation. Regardless of the technique, the goals of operative management are to alleviate pain, improve hip function and mobility and preserve the integrity of the hip joint.[7,16] Arthroscopy is a minimally invasive technique to examine the hip joint and evaluate the extent of injury. It can be used to debride and repair the labrum, chondral surfaces, address the bony deformity in Perthes disease or slipped capital femoral epiphysis (SCFE), and various arthritides (**Figure 7**).[21] The risks include neurovascular injury, specifically pudendal or perineal nerve palsies from traction and lateral femoral cutaneous or sciatic nerve from portal insertion, deep vein thrombosis and rarely femoral neck fracture or avascular necrosis of the femoral head.[16,22,23] However, favorable results have been reported with this method.[7,21,22,24-27] One study performed in 2011 by Byrd et al., prospectively followed their patients and reported on the results of the first 100 consecutive patients to achieve two-year follow-up. They reported 79% of their patients had good or excellent results and all nerve palsies were transient and resolved without further complication.[22] Arthritis was found to be a negative predictor of favorable outcomes which suggests early treatment of FAI is prudent to promote favorable recovery.[1,4,22,24]

FAI can also be treated with an open surgical dissection which has the benefit of full visualization or the joint is often used to fix torn labrum, resect the acetabular rim (pincer lesion) or reshape the femoral head-neck (osteochondroplasty).[7,23] However, this technique employs hip dislocation which risks injury to the femoral head blood supply and the potential for avascular necrosis of the femoral head. Some surgeons utilize a "mini-open" procedure where intra-articular pathology is treated arthroscopically and CAM lesions are resected via small anterior exposure. This method has shown to be effective at improving FAI and return to activity.[4,28] As expected, the side effects of this method are a combination of those previously mentioned of arthroscopic and open surgical technique. Overall, all of these procedures are effective at treating FAI but faster recovery and better improvement in symptoms have been reported in arthroscopic procedures while the highest complication rate has been reported in mini-open.[4,7,24,25] Arthroscopic decompression can result in improved radiographic α-angle and improved internal rotation.[29]

CONCLUSION

When encountering a patient complaining of hip pain, a thorough history and physical is essential to raise suspicion of FAI. Referral to an orthopaedic surgeon is warranted if

conservative treatments do not alleviate pain. While counseling patients about long-term outcomes can vary based on the underlying hip pathology a general follow-up is three months physical therapy with graduated three-month return to full activity as tolerated.[4] The average time to return to sports ranged from three to nine months.[4] FAI is a relatively new diagnosis that is undergoing rapid changes in terms of diagnosis, treatment and outcomes. With a keen clinical eye, early intervention can best improve outcomes in these patients.

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Disclosures

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