Original Article

Review Of The Current Situation Of The Femroacetabular Impingement

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Abstract

Femoroacetabular impingement (FAI) is a pathological hip condition characterized by abnormal contact between the acetabulum and femoral head–neck junction. This can occur within the normal physiological range of motion as a result of osseous abnormalities. Types of FAI Cam deformities type (Young men are more prone to be diagnosed with cam impingement) describe an abnormal anterosuperior femoral head–neck junction, whereas pincer deformities Type (Middle-aged women are more common to suffer from pincer impingement and could have comorbidities) describe abnormalities in the shape or orientation of the acetabulum, moreover, some patients have both deformities, designated mixed pathology. Diagnosis of FAI by detailed history collect more data as possible about the patient and his/her pain. And can be diagnosed by physical examination e.g (leg length(LLD), range motion (ROM), Comprehensive provocative tests and radiography(X.ray)). Moreover, pelvis MRI (Magnetic resonance imaging) is mainly used for detecting avascular necrosis, bone marrow edema syndrome, and peritrochanteric space disorders. While the magnetic resonance arthrography (MRA) are the preferred modality for the investigation of intra articular hip pathology, as it provides optimal resolution of soft tissue structures as the labrum, cartilage, joint capsule and ligamentumteres. CT scan can be useful in some instance during the differential diagnosis of a painful hip.It is used to assess the contour of the anterior lateral impingement surface in patients with suspected FAI with good results. Treatment of FAI (Non operative management, Operative management, Open surgical hip dislocation, Combined approach (mini-open arthroscopic assisted, and Arthroscopy).

INTRODUCTION

Hip arthroscopy was first described in 1931 by Michael Burman, however, its widespread adoption was only achieved some 60 years later during the 1990s by Ganz when he first described the strong association between FAI and osteoarthritis. (1 ,2)

Femoroacetabular impingement (FAI) is a pathological hip condition characterised by abnormal contact between the acetabulum and femoral head–neck junction. (2) This can occur within the normal physiological range of motion as a result of osseous abnormalities described as either cam or pincer deformities. Cam deformities describe an abnormal anterosuperior femoral head–neck junction, whereas pincer deformities describe abnormalities in the shape or orientation of the acetabulum, moreover, some patients have both deformities, designated mixed pathology. (3)

Repeated abutment of the femoral neck against the acetabular rim can result in injury to the labrum and adjacent cartilage. Over time these focal lesions may progress to more extensive degenerative disease. There is increasing evidence implicating FAI in the development of osteoarthritis (OA).(4)

FAI typically initially present as an insidious onset of anterior groin pain that is exacerbated with rigorous activities such as sports or prolonged walking. Patients may report pain with deep flexion or self-describe the positions that generate impingement. When asked where they are having pain the patient may display a “C” sign in which the patient’s hand is cupped above the greater trochanter with the fingers gripping into the anterior groin Often, the

presentation is vague and requires a high index of suspicion, a thorough physical exam, and proper imaging studies to identify the morphology.(2,5)

On examination, Antalgic or Trendelenberg-gait patterns may be observed. Internal rotation with the hip at 90° of flexion is typically markedly limited. Flexion and abduction are also often limited, although this is a less consistent feature. The hip impingement test is performed with the patient supine with hip and knee flexed to 90°, the hip is progressively rotated from external rotation to internal rotation while moving from abduction to adduction A positive test elicits a sudden, sharp pain in the hip. Patients often report that the manoeuvre recreates their typical symptoms. A positive impingement test has been shown to be present in more than 90% of patients who go on to have FAI confirmed either radiologically or at the time of surgery, in addition it has a high positive predictive value for labral pathology.(6,7)

Once the definitive diagnosis of FAI,has been made, the treatment should be tailored to the patient's symptoms,either non surgical or surgical method. For the nonsurgical treatment the aim is to avoid the aggravatingactivity for a time, work on maintaining muscle strength, and judiciously use anti-inflammatory drugs, howeve none of these treatments correct the morphological issues.(8)

The surgical modalities of treatment of FAI,are1- Surgical Dislocation of the Hip Ganz et al2 described the technique of open surgical dislocation of the hip to treat FAI 2- Anterior Mini-arthrotomy Anterior mini-arthrotomy has been proposed as an alternative approach to surgical hip dislocation to treat early anterolateral FAI.723- hip arthroscopy has became an increasingly popular procedure.As techniques continue to improve, the indications for hip arthroscopy are beingexpanded and refined.77Arthroscopic techniques minimize soft tissue injury around the hip and reduce the risk of injury to the medial femoracircumflex artery with rapid recovery period .(9,10,11)

As the use of hip arthroscopy has rapidly increased in the last decades with improving techniques and indications for surgery,one aspect of hip arthroscopy that remains greatly debated is management of the hip capsule. Because of the anatomic constraints of the hip joint, distraction as well as some forms of capsulotomy is usually needed to perform intra-articular procedures such as acetabuloplasty,femoroplasty, and labral repair. The most common capsular management technique is the interportalcapsulotomy, where the iliofemoral ligament is incisedin-line between the anterolateral portal and the midanterior or direct anterior portals.(12)

Arthroscopic anatomy of the hip joint

The hip has two intra-articular compartments, the central and the peripheral, separated by the acetabular labrum [1]. The central compartment (CC) includes the acetabular fossa, teres ligament, lunate surface, labrum, fovea capitis and the articular surface of the femoral head in the weight-bearing area. The peripheral compartment contains the femoral neck, the nonweight- bearing cartilage of the femoral head, the medial and lateral synovial folds, perilabralrecess or paralabral sulcus, the non-articular surface of the labrum and the articular capsule [2,3].

There are several methods to localize intraarticular lesions in hip arthroscopy. Thetwo most commonly used mapping systems are the "clock face" system and "geographic zone method" [2, 4]
Both systems can also be used for mapping the femoral head, and the reference lines follow the same pattern used in the acetabulum, so the femoral locations will reflect the corresponding acetabular locations. The clock face system also allowsa good correlation with the radial MRI findings[2, 4].

Central Compartment

Acetabular Fossa
The acetabular fossa is located in the inferior region of the acetabulum and is surrounded by the horseshoe-shaped lunate surface. It is the non-articular surface of the acetabulum and iScovered by synovium. The transverse ligament limits the inferior margin of the fossa and is in continuity with the anterior and the posterior labrum.(5)

Ligamentum Teres
The ligamentum teres or ligamentum capitis femoris is an intra-articular ligament that attaches the head of the femur to the acetabulum. It arises in the inferior part of the acetabular fossa and runs inferiorly and anteriorly across the joint space to insert into the fovea capitis of the head of the femur Dynamic hip examination shows that the ligament becomes tense during external rotation of the hip and relaxed on internal rotation. The ligamentum teres may have afunction similar to that of the anterior cruciate ligament in the knee. When considering reconstruction ofthis ligament,

anchors should be placed in areas of the acetabulum that provide the best bone stock for purchase, while minimizing the risk of damage to vital intrapelvic structures [5,6,7].

Fovea Capitis

fovea capitis is a small area devoid of cartilage in the femoral head and is located slightly posterior and inferior to the centre of the femoral head cartilage. The articular cartilage thickness decreases from the centre to the periphery of the femoral head.(2)

Labrum

The acetabular labrum or cotyloid ligament is found on the rim of the bony acetabulum (fig. 5).The labrum is a fibrocartilage with a triangular cross section; it increases the depth and coverage of the acetabulum, thus favoring stability of the hip joint by forming slightly more than a hemisphere. The labrum has three faces: (1) The base or adherent face is the part that inserts onto the rim of the acetabulum.(2) The internal or articular face is continuous with the articular surface of the acetabulum,such that it is occasionally difficult to distinguish on simple arthroscopic vision The external face inserts onto the joint capsule,leaving a free border that can be observed during arthroscopic examination (8-10)

Peripheral Compartment

The peripheral compartment (PC) consists of the unloaded cartilage of the femoral head (FH); the femoral neck with the medial, anterior and posterolateral synovial folds (Weitbrecht's ligaments);the articular capsule with its intrinsic ligaments, including the zona orbicularis (ZO);the non-articular surface of the labrum and the perilabral recess or paralabral sulcus. PC of the hip can be divided routinely into the following areas: anterior neck area, medial neck area, medial head area, anterior head area, lateral head area, lateral neck area and posterior area.(67)

Synovial Folds

Synovial folds are sheetlike structures of synovial and connective tissue that run longitudinally in various zones of the peripheral compartment and serve as important landmarks. The *medial synovial fold*("iliopectineal fold") is located at the antero-medial aspect of the femoral neck but usuallythe antero-medial aspect of the femoral neck but usually is not stuck to it. [13].The anterior synovial fold is adherent to the neck and only recognizable by its single fibres covering the bone of the neck. The lateral synovial fold is located at the junction between the lateral and the posterior femoral neck being a common landmark to the 12:00 position [2]

Capsule

The anatomical structure that most influences the peripheral space is the joint capsule. It is a thick and tense fibrous sleeve extending from the outer neck to the acetabular rim. The inner surface is entirely covered with synovium. Some portions of the capsule have an increased thickness
or are reinforced. Namely, (a) the superolateral part is reinforced by the reflected tendon of the rectus femoris, (b) the anterolateral part by the ilio-femoral ligament (y-shaped ligament of Bigelow),(c) the antero-medial part by the pubofemoral ligament and (d) the posterior capsule by the ischio-femoral ligament. (16,17)

Portals

The are several portals for hip arthroscopy for approaching the central and peripheral compartments sumerized in the following For the peripheral compartment, the proximal anterolateral portal (PAL) and distal anterolateral portal (DAL) are the primary working portals . Their direction is marked on the skin under fluoroscopy before their establishment with their intersection projecting onto the femoral head-neck junction. PAL, as described by Dienst et al. [20], is oriented 45° caudally with the entry point lying at the junction between the medial and the middle third of a line drawn
between GT and ASIS (soft spot). DAL is placed on a curved line running distally from the PAL with the centre of the curve being the greater trochanter .

For central compartment, the anterior (A), anterolateral (AL) and posterolateral (PL) portals are the primary working portals [21]. The AL is established first. It is placed 1 cm proximal and anterior to the tip of the GT and directed parallel to the femoral neck [22]. The superior gluteal nerve is found an average of 4.4 cm above the level of the anterolateral portal [23].The anterior (A) portal is placed at the intersection of a longitudinal line drawn distally from the ASIS and a transverse line across the superior edge of the GT. This portal is orientated 45°cephalic and 30° towards the midline [22].

Aetiolgy and the risk factor of FAIS

1. Intrinsic Factors

There have been specific genes associated with femoroacetabular impingement. The shape of the proximal femur has been correlated with single nucleotide polymorphisms (SNPs) of growth differentiation factor 5 (GDF5), Frizzled transmembrane receptor (FRZB) and deiodinase 2n(D2) [5]. These genes are important in the development of long bones and articular formation. However, Safran et al. found no difference in the SNP frequencies of GDF5 and FRZB compared to the general population in their pilot study[6].

2. Developmental (Activity-Related) Factors

Repetitive physical activity, especially during the developmental years, may predispose to the development of FAI.16 Most published studies exploring this hypothesis have focused on elite athletes because of the high prevalence of FAI in this population.(8,9)This was also performed in youth hockey players finding increased alpha angles following physeal closure. The hockey players with hip pain had even higher alpha angles than asymptomatic players with radiographic signs of impingement [15].

3. Sequelae of Pediatric Hip Disease

a. Slipped Capital Femoral Epiphysis

Childhood and adolescent hip disease may cause FAI.(20,21)Slipped capital femoral epiphysis (SCFE) can alter the shape of the femoral head, which may lead to abnormal contact with the acetabulum and eventual degenerative changes. Fraitzl et al(22) retrospectively identified 73 patients with unilateral mild SCFE (slip angle <30°) treated with K-wire fixation. Sixteen patients with a mean slip angle of approximately 16° had long-term follow-up with an activity score, clinical examination, and AP/cross-table lateralradiographs, including the contralateral hip. The only significant findings were a reduced head-neck offset (16 hips vs 9 hips, $P < 0.02$) and increased prevalence of head-neck junction bony prominence (13 hips vs 9 hips, $P < 0.03$).

b. Legg-Calvé-Perthes Disease

Legg-Calvé-Perthes disease (LCPD) is an idiopathic hip condition, typically affecting children 4 to 12 years of age, in which there is osteonecrosis of the femoral head and progressive deformity. Although LCPD can also lead to the development of clinical FAI, this is likely a different type of impingement than classic cam or pincer impingement. Because of the complexity of the deformities associated with LCPD, the radiographic diagnosis of FAI in these hips is difficult.(25)

4. Sequelae of Femoral Neck Fracture

Malunion following femoral neck fractures in young patients could also result in alteration in femoral head-neck contour and hip mechanicsthe femoral head-neck junction along with labral and acetabular cartilage damage, suggestive of FAI. Corrective osteoplasty was performed on all 8 patients, while 2 required a supplemental intertrochanteric osteotomy to correct residual deformity. Three were pain-free postoperatively, (27)

5. Postsurgical Etiology

Structural anomalies of the acetabulum may be acquired and lead to pincer FAI.(26,27) Forty-six hips in 38 male patients underwent periacetabular osteotomies for hip dysplasia and were followed to determine anydifference in pre- and postoperative signs of FAI.(27)

6. **Anatomical related fractors**:

a. Femoral and acetabular version

Increased femoral anteversion on MRI has been seen in patients with pincer-type FAI compared to cam-type (18.3°–18.7° vs. 10°–11.6°, respectively) [29]. This was also seen in Kraeutler et al.'s prospective study of 440 hips showing femoral version to be an independent predictor of hip internal rotation and cam lesions (alpha angle > 50° on CT) independently associated with decreased hip flexion [30].

b. Spinopelvic influence

The motion of the lumbar spine and pelvis has a close relation with the hips, particularly in the sagittal plane. The trunk has been shown to have a significant influence on mechanical impingement at the hip. Patients with FAI have less spine) and greater hip [24].. Patients with pincer lesions also had lower pelvic incidence than those with cam lesions [32].

Diagnosis of FAI

Detailed History

An accurate diagnosis depend on a careful history of the patient. The physician should collect more data as possible about the patient and his/her pain. Then all data should be matched to have a first suspicious about the disease. In reality it is not so rare to get a nearly definitive diagnosis by simply listening to the patient. The clinician should inquire about duration, location, frequency pattern, and radiation of pain. Intra-articular hip pain usually presents as groin discomfort and may radiate to the medial-anterior thigh.(1)

Pain onset and duration often do not discriminate precisely between hip pathologies unless a traumatic event has occurred. In patients suffering from symptomatic femoroacetabular impinge- ment (FAI), symptoms onset is commonly insidious and activity related(2,3). Only one third of FAI patients refer to a specific initial episode for the beginning of pain Pain occurs predominantly in the anterior groin and in the lateral hip and, for this reason an accurate examination should be carried out for a possible concomitant greater trochanteric pain syndrome (GTPS). (2)

Physical Examination

Clinical examination should confirm the initial suspicious, asses the relevance of the pathology and drive next diagnostic procedures. Furthermore clinical evaluation should check other signs or reproducible symptoms sometime underestimated by the patient.(13)

Gait Analysis

Painful hips are often associated with a slight/mild limp. Trendelenburg's sign is rare and present in severe dysplastic cases or medius gluteus lesion (13). Young patients, even with disabling hip pain, generally do not use cane, crutches or other assistive devices

Leg length

Checking length leg discrepancy (LLD) is an important step of the physical examination. There many pathologies that may result in a shortened limb (Dysplasia, M. Perthes, Epiphysiolysis) and there are some pathologies that are related with LLD (GTPS). We
are checking LLD in FAI patients and first results are showing a LLD or a patient feeling of LLD in many of our patients. Interestingly this feeling is normally accentuated after surgery.(13)

Range of motion (ROM)

Intra-articular pathologies reduces range of motion . Many FAI patients have decreased internal rotation, adduction and flexion. In this patient internal rotation decreases with increasing flexion and adduction. Affected hips typically have an internal rotation in flexion between 9° to 11 and a flexion averaging between 90° to 100° (2,14).

Comprehensive provocative tests

The majority of patients suffering from chondro-labral pathology associated with FAI demonstrates a positive anterior impingement test (FADIR test, Flexion ADduction and Internal Rotation which is considered as the most reliable and consistent physical exam finding. In anterior impingement test the patient is in a supine position and the affected hip is passively flexed beyond 90°. Then the hip is internally rotated while an adduction force is applied. The test is considered positive if reproducing patient typical hip or groin pain (2,4,24).

The Patrick's or FABER test (Flexion, ABduction and External Rotation)has been originally describe to differentiate between sacroiliac from hip pathologies. The FABER test is often positive in FAI patients and reproduce the anterior hip pain. In case of SI joint pathology a posterior pain is referred. (4)Other helpful, but less specific and sensitive tests are the FABER test, the resisted straight leg raise test, the log roll test andthe posterior impingement test (4).In the resisted straight leg raise test the hip joint is actively flexed to approximately 30°, with the knee extended. The examiner apply pressure just above the knee, toward the examination table. The test is positive if reproduce groin pain (11).In the log roll test the patient laying supine with hip e knee relaxed.The examiner rotate internally end externally the affected hip ABuction and External Rotation) the posterior labrum is checked and the patient laying at the edge of the table to allow extension.(26,14)

Diagnostic Procedures

Radiography

X-rays should always be the first diagnostic procedure in detecting hip pathologies. Radiographic evaluation remains one of the most important diagnostic tests for a large number of pathologies. A real standard Antro-Posterior (AP) view , a frog-legview and a cross-table lateral view or a 45° and 90° Dunn view of the affected hip are the best images to have. To get those views right a precise patient positioning and xray tube is mandatory. FAI diagnosis is made by good X-ray views. Further exams arethen needed only to asses the severity of the disease and its surgical indication. (27)

Types of FAI

Pincer Type Middle-aged women are more common to suffer from pincer impingement and could have comorbidities. Over-coverage of hip occurs this type of FAI, which could accelerate osteoarthritis. It leads to a linear contact between the acetabular rim and the femoral head-neck junction, causing scrub of the bone in the contact point. Compared to cam impingement, pincer impingement damages a lesser proportion of cartilage (27,28).

Cam Type Young men are more prone to be diagnosed with cam impingement. Herein, the femur is the cause of impingement, as femur has an aspherical head jammed into the acetabulum. This process decreases femoral head-neck offset, and the larger proportion of cartilage is injured ((29, 30 , 31).Combined Pincer/Cam Type: Most patients have a combination of both cam and pincer. Radiographic Signs and Findings,(31**)**

Magnetic resonance imaging

Pelvis MRI (Magnetic resonance imaging) is mainly used fordetecting avascular necrosis, bone marrow edema syndrome(BMES), peritrochanteric space disorders and other extra-articulardisorders. it's not very useful for a fine intra articular diagnosis. (16,19,18).

While the magnetic resonance arthrography (MRA) are the preferred modality for the investigation of intra articular hip pathology, as it provides optimal resolution of soft tissue structures as the labrum, cartilage, joint capsule and ligamentum teres. The hip anatomical structures are outlined with improved contrast resolution by the contrast solution which extends the joint space and the recess betweenthe labrum and the capsule. Labral tears and labral detachment from the acetabular rim are demonstrated by contrast media solution extending into the labral structure or into the labral base at the labral-chondrolabral junction filling the defects (4,18) (Complete chondral lesions appear filled by contrast media . Small-field MRA has been demonstrated the most reliable study to diagnose labral pathology, showing high sensitivity and specificity (45,46).

Moreover MRA can provide multiplanar images of the hip, allowing the best visualization and mapping of the joint space. MRA is also used for evaluation of the femoral head asphericity by the
alpha-angle measurement in cam femoroacetabular impingement and less for assessment of acetabular retroversion (47).

CT scan

CT scan can be useful in some instance during the differential diagnosis of a painful hip. It has been used with 3D, surface rendering and oblique radial reformation in order to assess the contour of the anterior lateral impingement surface in patients with suspected FAI with good results. Its radiological exposure and low sensitivity for chondral and labrum degeneration makes CT seldom used for this purpose. Furthermore CT scan has a low resolution on soft tissues. CT scan may be useful in particular FAI cases with abnormal deformities as abnormal femoral anteversion and anti torsion angle. 3D CT scan may also be usefull ipreoperative planning during the management of complex deformities (54)

Treatment of Fai

Non operative management

Conservative management of FAI has been described in the literature. Emara et al showed short-term improvement with adapting of activities of daily living to a safe range of motion as to avoid impingement.(1) Asymptomatic patients should be treated with conservative management with follow-up for the development of impingement symptoms. In patients who have mild symptoms, early conservative management can be considered with an emphasis on physical therapy and activity modification.(2)

Operative management

Indication for surgical management for FAI is a complicated issue for surgeons. Literature has shown there is inconsistency regarding indications for surgery.Some commonly cited reasons for proceeding with surgery include failure of non operative management, symptomsand pain for greater than 6 months, series of positivespecial tests, signs of FAI on radiographs, MRI and/orCT scans.(4)
For hip arthroscopy, an absolute contraindication includes joint space narrowing <2 mm. Relative contraindications for surgery include osteoarthritis of the hip, advanced age, ligamentous laxity and morbid obesity. It should be discussed with patients prior to surgery that
due to the diagnosis of FAI, they may develop furtherprogression which could lead to osteoarthritis necessitatinga total hip arthroplasty in the future.(5,6)

Open surgical hip dislocation
Open surgical hip dislocation was the first described surgical treatment of FAI and was once considered the "gold standard".8This approach has shown good results in theliterature. Nwachukwu et al showed in a recent systematic review that patients who underwent open hip dislocation had equivalent medium-term survival rates when compared to hip arthroscopy.(9,10)

Open hip dislocation has advantages when compared to other approaches in that it provides 360° visualization of the femoral head and acetabulum
thus allowing the surgeon to address all pathology associated with FAI and allows for templating of the femoral aspect to allow for precise sphericity.(8)

It is a larger operation when compared to other techniques and has been shown to result in more blood loss, more extensive soft tissue dissection, increased blood loss and longer rehabilitation when compared to mini-open and arthroscopic techniques. It requires a trochanteric osteotomy
which may result in nonunion and hardware pain.(8)
Combined approach (mini-open arthroscopic assisted)

With this technique, the intra-articular pathology associated with FAI is addressed arthroscopically. The cam lesion is then addressed via a mini-open approach thus avoiding the need for a trochanteric osteotomy. This
approach is efficacious in that it has been shown to improve hip scores postoperatively. Laude et al showed an improvement in the non-arthritic hip score (NAHS) by29.1 points.(10)

Arthroscopy
Arthroscopic treatment of FAI provides a less invasive option and has become a very popular surgical option. Griffin et al showed, in a multicenter randomized trial, the patients undergoing hip arthroscopy improved to a greater degree than patients who did physical therapy.(13)
When treating patients arthroscopically, the articular and labral components can be addressed through the central compartment, whereas the cam lesion is typically more peripherally located and can be addressed through the peripheral compartment. Arthroscopic treatment has been shown to be very effective at treating the pathology associated with FAI. Byrd and Jones reported on 200 patients who underwent hip arthroscopy for FAI and found an average increase of 20 points in the Harris hip score.(14)

Hip arthroscopy has been shown in the literature to have a lower complication rate when compared to miniopen and open surgical dislocation.(8,36) Recently, Larson et al showed, in a prospective trial, a complication rate of 8.3% following hip arthroscopy. They noted most common complications included lateral femoral cutaneous nerve neuropraxia, pudendal nerve neuropraxia, chondral injury, labral injury and heterotopic ossification. In their study, they showed the complication rate was higher in female patients and longer surgical and traction times with over60 mins resulting in significantly increased complication rate.(37)

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