HIP IMPINGEMENT SYNDROMES

– Written by Haron Obaid, Canada

INTRODUCTION

The hip joint is a weight-bearing joint which allows a wide range of motion yet remains stable due to its ball and socket anatomy. Recognising this, the hip joint may encounter mechanical disorders or so-called 'impingement syndromes'. Awareness of different patterns of hip joint impingement is crucial as these conditions may predispose to hip joint osteoarthritis[1] and may be the source of hip pain in a young individual[2].

ANATOMY

Articular surfaces

The articular surfaces are covered by hyaline cartilage over the femoral head and the acetabulum. The acetabular cartilage mimics a horse-shoe shape due to the acetabular fossa which contains fibrofatty tissue and ligamentum teres. The femoral head cartilage spares a small central fossa at the attachment of the ligament teres which is the fovea capitis.

Proximal femur

The anatomy of the proximal femur is complex. The shape of the proximal femur is determined by the femoral head, neck and the lesser and greater trochanters. The lesser trochanter is more inferior to the greater trochanter and the trochanters are separated by the intertrochanteric area. The lesser trochanter forms the bony attachment of the iliopsoas tendon. The greater trochanter, however, has a far more complex, multifaceted anatomy which hosts the bony insertions of multiple muscles such as gluteus medius and minimus, superior and inferior gemelli, obturator internus and externus, quadratus femoris and piriformis. The trochanteric bursa lies between the greater trochanter and the iliotibial tract.

The labrum

The acetabular margins are surrounded by the labrum, which is a fibrocartilagenous structure. The labrum increases the articular surface of the acetabulum and thus increases joint stability. Other functions of the labrum include shock absorption, joint lubrication, proprioception and aiding pressure distribution[3,4].

LABRAL TEARS

Labral tears were first described in 1957 by Peterson et al[5] following irreducible posterior dislocation, however it was not until 1986 that labral tears were described arthroscopically by Suzuki et al[6]. Although labral tears can be post-traumatic in origin, the labrum is often subjected to mechanical impingement due to the contact that can take place between the femur and the acetabulum, leading to labral tears. There are many local or regional causes for hip pain and labral tears are found in 22 to 55% of patients with hip pain[7], although labral tears can also be found in 69% of asymptomatic hip MRI scans[8]. In addition, associated cartilage degeneration is seen in 63% of patients with labral tears. The mechanical impingement can be observed

in sport activities that involve hip pivoting during axial loading such as martial arts, ballet dancing, golf, hockey and soccer. Other causes of labral tears include hip joint osteoarthrosis, joint instability due to capsular laxity, and acetabular dysplasia.

The most common location for the labral tears is anteriorly which is seen in 93% of the cases[9]. In contrast, a sublabral recess or sulcus, which is a normal variant, is present most commonly anteroinferiorly and posteriorly. The sublabral recess/sulcus can be distinguished from a labral tear on MR arthrography in that the recess normally shows smooth surfaces with incomplete cleft. On the other hand, a labral tear has more ragged margins with complete cleavage of the labrum.

HIP IMPINGEMENT SYNDROMES
Femoroacetabular impingement (FAI)

This condition is defined by abnormal contact between the femoral neck[10] and the acetabular labrum, which is subdivided into three main subtypes.

1. Cam-type FAI

This takes place as a result of reduced offset angle between the anterosuperior aspect of the femoral head and neck creating what is called a 'bony bump'[10]. This bony bump can develop congenitally, following slipped capital femoral epiphysis or due to an old subcapital femoral fracture. During flexion-adduction-internal rotation this bony bump comes into contact with the anterosuperior labrum causing labral tears and superior acetabular cartilage damage. This bony bump can be visualised with radiographs (Figures 1 and 4) and MRI and confirmed with measuring the alpha angle. This type is more common in men than women[11].

2. Pincer-type FAI

This condition develops as a result of acetabular over-coverage of the femoral head due to coxa profunda, protrusio acetabuli

Figure 1: A frontal radiograph of the pelvis demonstrating bilateral bony bumps (straight white arrows) at the femoral head-neck junctions in a patient with cam-type femoroacetabular impingement. A herniation pit is seen in the anterosuperior aspect of the right femur (straight black arrow) and an acetabular ossicle (curved white arrow) is seen on the left side.
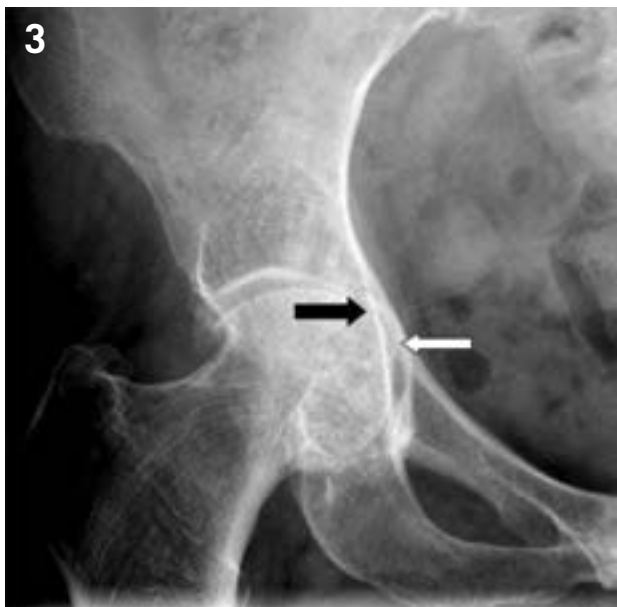
Figure 2: A frontal radiograph of the left hip featuring a coxa profunda which is demonstrated by medialisation of the acetabular fossa line (curved white arrow) in relation to the ilioischial line (straight white arrow).

or acetabular retroversion. Although the labral tears are typically anterosuperior in location, the hyaline cartilage changes are situated posteroinferiorly, constituting what is referred to as 'coup and countercoup' phenomenon. Pincer type FAI is more commonly seen in women than men[11].

3. Mixed pincer and cam FAI

This is the most common type of FAI[12,13], whereby there is an overlap in the bony features of both cam and pincer.

Radiographs are essential primary tests[14], which include frontal radiograph of the pelvis with a Dunn lateral view of the affected hip. The frontal radiograph of the pelvis should be cantered so that the coccyx is 2 cm cranial to, and lined up with, the symphysis pubis. The radiographs should be scrutinised for bony bump (Figures 1 and 4) at the femoral head-neck junction. On Dunn view, the alpha angle can be measured. If alpha angle is >55°, a diagnosis of cam FAI may be made in the appropriate clinical

Figure 3: A frontal radiograph of the right hip demonstrating protrusio acetabuli which is described as medialisation of the medial femoral head line (straight white arrow) in relation to the ilioischial line (straight black arrow).
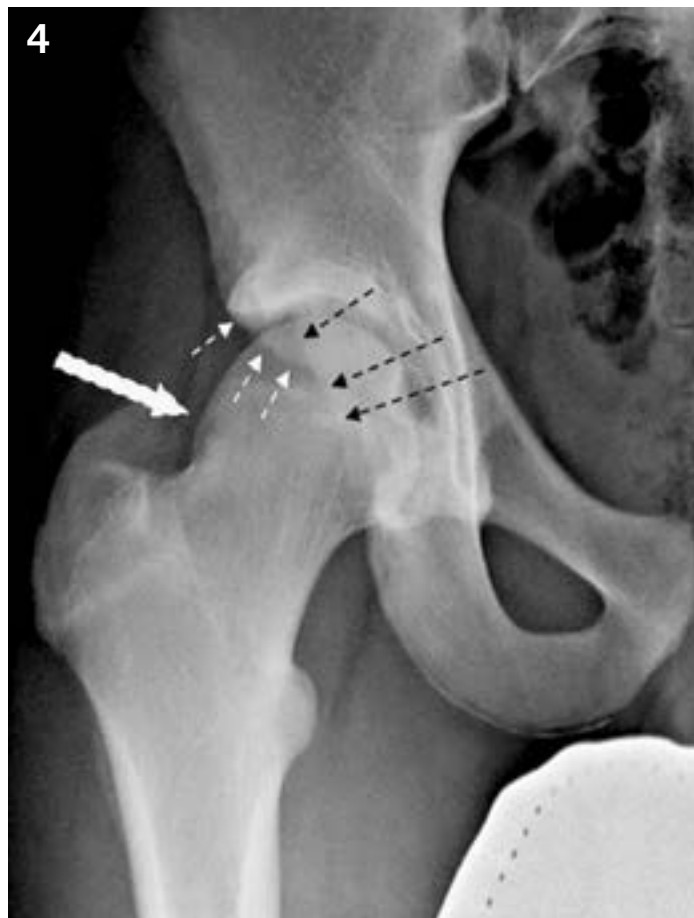
Figure 4: A frontal radiograph of the right hip in patient with mixed cam and pincer impingement demonstrating crossover sign, which is an overlap of the anterior acetabular wall (dashed white arrows) over the posterior acetabular wall (dashed black arrows) in patients with acetabular retroversion. Bony bump at the anterosuperior aspect of the femoral head-neck junction (straight solid white arrow).

settings. The frontal radiograph is useful for assessing the acetabular over-coverage of the femoral head. There are two situations in which acetabular over-coverage can be seen.

1. The first situation is described when there is sinking of the femoral head into the acetabulum as seen in coxa profunda (Figure 2) and protrusio acetabuli (Figure 3). Coxa profunda is diagnosed when the acetabular cavity line is seen medial to the ilioischial line and protrusio acetabuli is demonstrated when the medial femoral head line is medial to the ilioischial line.

2. The second situation is when there is acetabular retroversion which can be seen radiographically as a 'cross-over sign'[14] or 'figure of eight' (Figure 4) in which the anterior acetabular wall crosses over the posterior acetabular wall on the frontal radiographs.

An ossicle adjacent to the superior acetabulum and herniation pit at the femoral head-neck junction (Figure 1) are other radiographic clues for femoroacetabular impingement.

MR imaging plays a key role in assessing labral changes in patients with impingement syndromes. Traditionally this had been achieved with an arthrographic MRI examination (Figure 5), which involves injecting the affected hip with a gadolinium contrast material and scanned with a 1.5T scanner. However, with the advent of 3T and higher scanners, non-arthrographic MRI techniques (Figure 6) became a reality. The advantages of the non-arthrographic technique are mainly being a non-invasive test with no pain or inconvenience to the patient. In addition, there are no radiation, contrast reaction or infection risks associated with it. This technique is also ideal for athletes who are returning to competition after MRI. The MRI examination is able to detect other changes such as cartilage damage, bone marrow oedema, paralabral cyst, synovitis and extra-articular soft tissue.

The recommended MR imaging protocol for MR arthrography could include T1 weighted fat-saturated sequences in three orthogonal planes with a T2 weighted fat-saturated coronal sequence to assess for paralabral cysts. The sequences recommended for the 3T non-arthrographic MRI are coronal and sagittal proton density weighted fat-saturated sequences, axial T1 weighted, sagittal proton density weighted without fat-saturation and radial cuts using proton density weighted sequence.
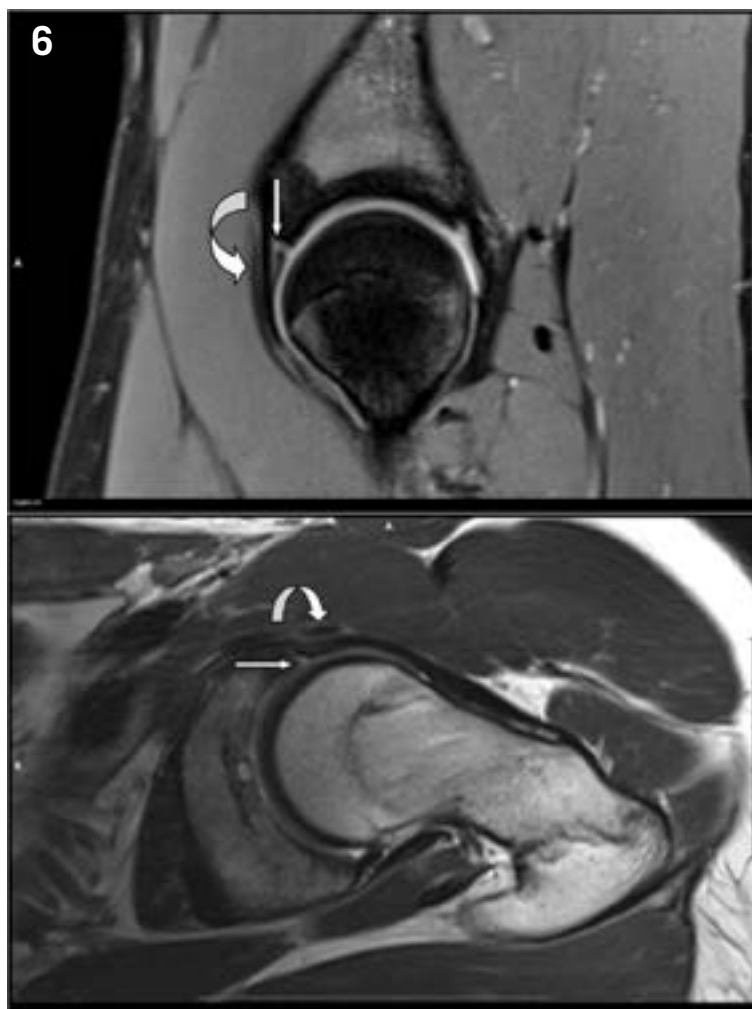
Iliopsoas impingement

The concept of iliopsoas impingement has been described in an arthroscopic study by Domb et al[15] in 2011. The condition was described as inflammatory changes in the iliopsoas tendon with anterior acetabular tears due to compression or traction injury by the iliopsoas tendon (Figure 6). No radiographic features are yet documented with iliopsoas impingement.

A retrospective MR arthrographic study by Blankenbaker et al[16] assessed patients with iliopsoas impingement diagnosed with hip arthroscopy and anterior acetabular tear, and compared them to a control group. The authors reported that there was a statistical association in the iliopsoas impingement group with anterior labral tears compared with controls, however, there was no statistically significant difference between the iliopsoas impingement group and controls regarding the characteristic of the iliopsoas tendon except that in the iliopsoas impingement group, women had a narrower iliopsoas tendon than men within the same
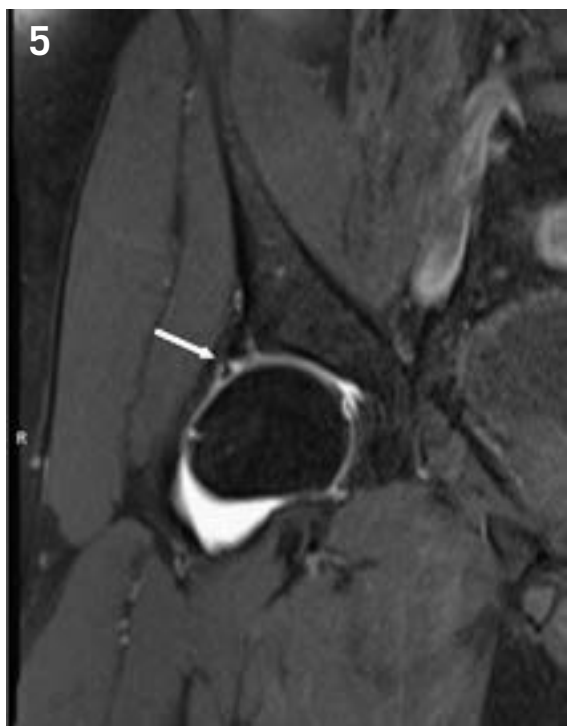
Figure 5: MRI arthrography of the right hip joint demonstrating superior labral tear which is seen as a fluid filled cleft (white arrow) at the articular aspect of the labrum.

Figure 6: 3T MRI (non-arthrographic) of the left hip joint demonstrating a high signal intensity labral tear (straight white arrows) anteriorly at 3 o'clock position in a patient with iliopsoas impingement. Note the close proximity of the iliopsoas tendon (curved white arrows) to the anterior acetabular labrum.

group. This study proposed that anterior acetabular tears on MR arthrography might indicate iliopsoas impingement. There was no assessment of the bony abnormalities of FAI in patients with iliopsoas impingement in this article. In a subsequent study by Aly et al[17] a morphometric MRI analysis of the all patients with 3 o'clock anterior acetabular tears was performed which concluded that no femoroacetabular bony abnormalities were seen in patients with suspected iliopsaos impingement, therefore, iliopsoas impingement is considered a separate disease entity which can be suggested with preoperative imaging.

Iliopsoas impingement versus coxa saltans

It is worth mentioning that iliopsoas impingement should not be confused with internal coxa saltans or iliopsoas impingement that occasionally develops following total hip arthroplasty. Patients with central iliopsoas impingement characteristically present with anterior hip pain, which is aggravated by passive flexion-adduction-internal rotation and resisted straight leg raise. On palpation there is a focal area of tenderness over the usual anatomic location of the iliopsoas tendon. Audible hip snapping is normally absent in patients with central iliopsoas impingement, which distinguishes it from internal coxa saltans. Iliopsaos impingement due to total hip arthroplasty commonly occurs due to an abnormal friction of the iliopsoas tendon against a maligned or over-sized acetabular component.

Coxa saltans is a well-recognised pathologic hip condition that takes place as a result of extra-articular iliopsoas tendon snapping, which is particularly seen in young athletes such as ballet dancers[18]. Patients with internal coxa saltans typically present with a painful anterior hip clicking or popping sensation, which becomes more noticeable with hip extension and internal rotation from flexion-abduction-external rotation. The diagnosis can be confirmed with iliopsoas bursography or dynamic ultrasound scan.

The literature is inconsistent as to whether or not ultrasound guided injection of the iliopsoas bursa or intra-articular injection of the hip joint would help differentiate iliopsoas tendon impingement from other hip impingement syndromes. The treatment is usually surgical which involves tenotomy of the iliopsoas tendon.

> *MR imaging plays a key role in assessing labral changes in patients with impingement syndromes*
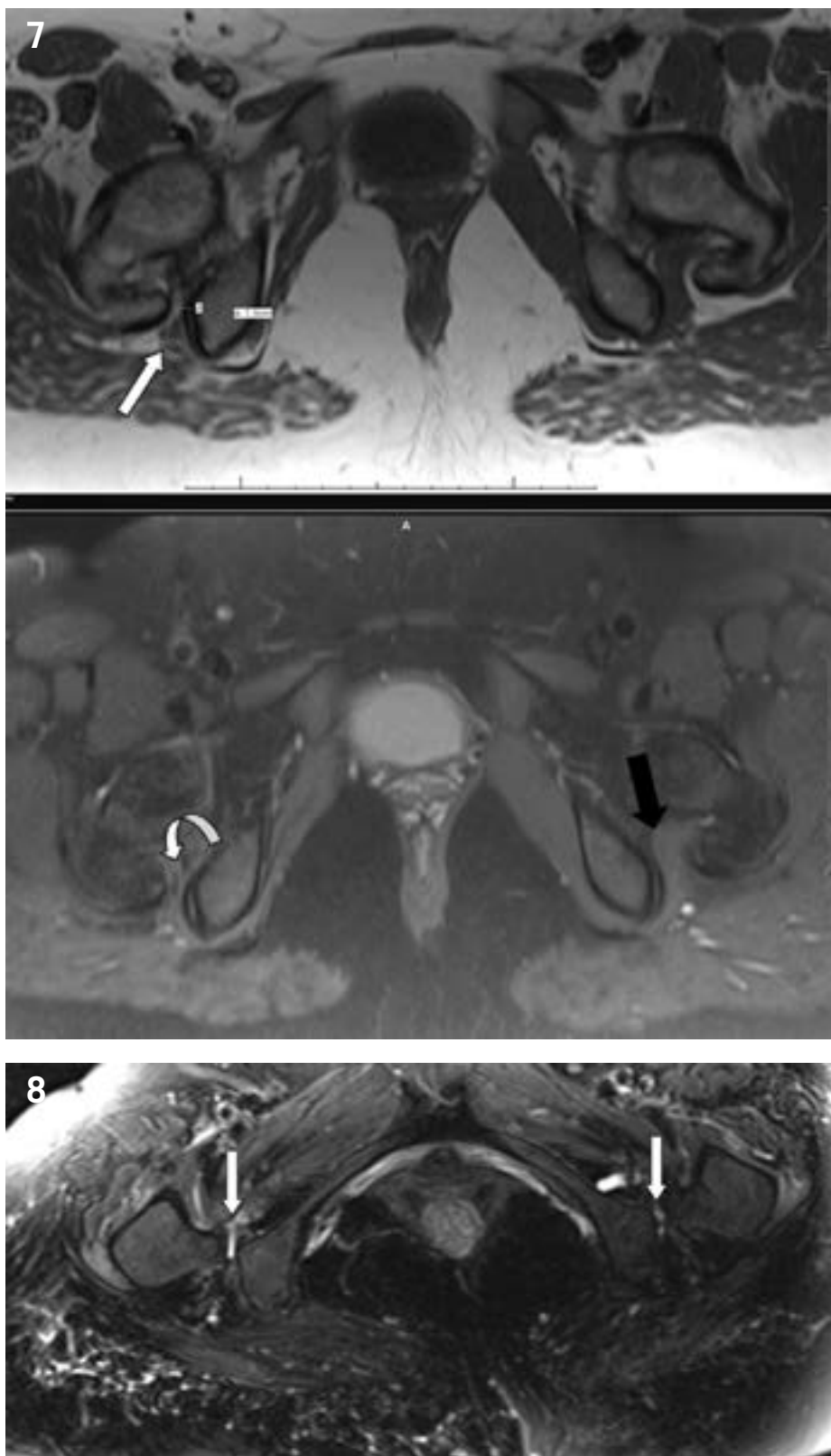
Figure 7: Axial T1 and T2 fat saturated MRI sequences of both hips demonstrating narrowing of the right ischiofemoral distance (7.3 mm) with oedema of the right quadratus femoris muscle (curved white arrow) in patient with right ischiofemoral impingement. Note the close proximity of the right sciatic nerve (straight white arrow) to the site of the impingement. Straight black arrow refers to normal appearing left quadratus femoris muscle.

Figure 8: Axial T2 fat saturated MRI scan of both hips demonstrating bursal fluid formation at the site of the ischiofemoral impingement bilaterally more on the right side (straight white arrows).

Ischiofemoral impingement

This mechanical disorder occurs due to an abnormal contact between the ischium and the lesser trochanter[19], most commonly following total hip replacement or proximal femoral intertrochanteric osteotomy. Nevertheless, this type of impingement can still develop in non-operative patients such as those with severe osteoarthrosis causing protrusion acetabuli (Figure 7) or fracture malunion of the proximal femur. The impingement happens due to narrowed distance between the ischial tuberosity and the lesser trochanter leading to compression of the quadratus femoris muscle, which becomes oedematous in the early stages (Figure 7) but subsequently undergoes fatty replacement. The ischiofemoral distance is considered narrowed when the measurement is less than 13±8 mm (normally 23±8 mm), although the measurement is entirely dependent on the position of the hip when the MRI was performed[20]. This condition is more common in females than males with age range of 30 to 71 years (mean age of 53 years)[20]. Bilateral involvement is seen in nearly one third of cases[20,21].

The labrum has been found to contain pain nerve fibres, which can generate pain if torn.

Figure 9: Frontal and lateral radiographs of the left hip of a soccer player with subspine impingement due to an old avulsion injury of the straight head of the rectus femoris muscle. There is a bony protrusion of the left anterior inferior iliac spines (straight white arrows).

Figure 10: A frontal radiograph of the pelvis demonstrating bilateral bony protrusion of both anterior inferior iliac spines (curved white arrows) in a soccer player with prior bony avulsion injuries at the origins of the straight heads of the rectus femoris muscles.

Patients with ischiofemoral impingement present with hip, groin and gluteal pain which may radiate to the lower leg due to sciatic nerve irritation. In certain cases, bursal inflammatory fluid formation may happen around the iliopsoas tendon at the lesser trochanter (Figure 8). The diagnosis of ischiofemoral impingement can be challenging, as there is no specific clinical test, and therefore imaging is crucial. The treatment of this condition varies from conservative measures such as CT guided cortisone injection to surgical excision of the quadratus femoris or lesser trochanter.

Subspine impingement

This condition can be caused by bony prominence at the anterior inferior iliac spines (AIIS) which can be developmental or perhaps due to previous avulsion injuries or osteotomy. This is also called 'iliac spine impingement' or 'AIIS impingement'. This is commonly seen in male patients with age range of 14 to 30 years. At the anterior inferior iliac spine, the bony origin of the straight head of the rectus femoris muscle takes off, which could lead to bony avulsion of the AIIS apophysis in adolescent soccer players. This may often be referred to as 'sprinter's fracture'. The mechanism of AIIS injury involves rapid, high energy knee flexion followed by hip extension.

This bony protrusion of the AIIS may come into contact with anterior aspect of the femoral neck causing mechanical impingement[22]. Patients normally present with anterior hip or groin pain which is aggravated by hip flexion and focal pain and tenderness when the AIIS is palpated.

With regards to radiographic features of subspine impingement, bony prominence of the anterior inferior iliac spine (Figure 9 and 10) due to an old avulsion fracture and calcification at the origin of the straight head of the rectus femoris are usually very good clues to the diagnosis. The bony prominence of the AIIS has been described previously as the 'pelvic digit' or the 'iliac rib'. CT scan can be used to assess subspine impingement whereby the hip joint is scanned in flexion to visualise the bony contact between the femoral neck and the anterior superior iliac spine. These cases do not usually respond to diagnostic intra-articular local anaesthetic injection.

SUMMARY

There are multiple causes of hip pain including local, regional and referred aetiologies, however labral tears should be considered in patients with mechanical symptoms. The labrum has been found to contain pain nerve fibres, which can generate pain if torn. Labral tears are suspected clinically if the impingement tests are positive. The work up is usually imaging-based, which normally begins with plain radiography and subsequently confirmed with an MRI examination.

References
Available at www.aspetar.com/journal

Haron Obaid M.D., F.R.C.S., F.R.C.R., F.R.C.P.C.
Clinical Associate Prof in Musculoskeletal and Sports Imaging
Royal University Hospital
University of Saskatchewan
Saskatchewan, Canada
Contact: haron.obaid@usask.ca