IMAGING IN TRAUMA OF THE HIP (REGION)

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Key words:

Hip, trauma, sports

INTRODUCTION

Trauma of the hip can have several causes, including road traffic accident (pedestrian, motorcyclist, cyclist, car driver and passenger), falls, and sport injuries. This means that trauma of the hip is a heterogeneous collection ,including fractures of the hip, acetabular fractures, pubic fractures, luxations, cartilaginous lesions, muscle trauma …

There are several imaging modalities that can be used to examine the injured hip region, including conventional radiology, (spiral) CT, MRI, Ultrasound, but sometimes other modalities such as angiography can be used to come to correct diagnosis and treatment of the patient.

IMAGING

Plain film imaging of the hip almost always starts with conventional imaging including the AP view of the pelvis and the profile view (usually with external rotation, sometimes a true lateral view) of the hip. Sometimes, additional views can be necessary. In acetabular fractures, oblique views (Ala- and obturator foramen view) are necessary to evaluate the fracture. The obturator foramen view also can demonstrate fractures of the pubic rami and avulsions of the tuber ischiadicae, due to trauma of the hamstring insertion. Inlet and outlet views are useful in the detection and evaluation of the pubic rami. There are several other "special" views that can be performed, f.i. in the evaluation of the iliac crest, and the iliac spines, fractures of the greater trochanter, etc…

Flamingo views are views of the symphysis with weightbearing on each leg alternately. These views are used to detect pelvic instability.

Computed tomography (CT) provides cross-sectional imaging of the complex bone and joint surfaces. This gives CT an important role in the assessment of acetabular and hip fractures [i], loose fracture fragments within the hip joint, etc. Spiral arthro- CT with intra-articular injection of iodine and small slices is a very good tool in the evaluation of intra-articular lesions such as labral tears, and cartilage lesions.

Magnetic Resonance imaging (MRI) demonstrates abnormal bone marrow changes and provides a cross sectional view of soft tissue anatomy. Magnetic resonance imaging (MRI) of the hip has proven valuable in the diagnosis of radiographically occult osseous abnormalities and periarticular soft-tissue disorders such as stress fractures, avulsion injuries, musculotendinous abnormalities, and bursitis. Conventional MRI has been less useful in the evaluation of intra-articular lesions, including acetabular labral tears, intra-articular loose bodies, and cartilage lesions. Visualization of intra-articular structures and their abnormalities can be improved by injection of diluted gadolinium, which distends the capsule and leaks into labral tears [ii]. This makes MR-artrography a useful diagnostic tool.

There are a number of scenarios where radiographs alone are insufficient for management and where ultrasound may have a major clinical role to play [iii]. Chronic repetitive trauma can result in localised swellings such as enlarged bursae or ganglia, or produce focal injury to tendons, muscles and even bones that can be demonstrated with ultrasound. In acute trauma, radiographs may be negative or may show signs of joint pathology, but not the associated soft tissue injuries that are frequently present. Haemarthrosis can be detected, thus permitting diagnosis of an intra-articular fracture of osteochondral injury. Tendon or ligament injuries can be demonstrated. Also, ultrasound can show muscle tears or defects in the fasciae.

PATHOLOGY:

Acute bone injuries

Major fractures of the pelvis, hip and femur in young patients are usually the result of high energy trauma. These fractures can be located in the acetabulum, the pelvis and the hip. Fractures of the hip, the intertrochanteric region and the femoral neck are relatively uncommon in the early and middle years of life, but increase sharply in the later years. This increase is a reflection of the forces required to create injury. On the other hand, the majority

of fractures in elderly people results from minimal to moderate trauma, mostly sustained in falls[iv]. Fractures of the neck and intertrochanteric region begin to appear after the age of 45 years and increase continuous thereafter to epidemic proportions.
Hip fractures are further divided in subcapital, basicervical, per-(inter)trochanteric and subtrochanteric fractures.
There are also characteristic fractures after luxation of the hip, the so called pipkin fracture.
A feared complication of intra-capsular fractures of the hip is avascular necrosis or osteonecrosis of the femoral head. In these cases, MR is a very sensitive tool in the detection and evaluation.

Avulsion fractures are due to muscle traction, and can be seen after low energy trauma.
Avulsion injuries can occur at different sites. The apophyses in the pelvis are common sites of acute and chronic avulsion injuries. Avulsion injuries of the pelvic apophyses occur during or just after the adolescent years, as compared with epiphyseal injuries of long bones, which are more frequently observed prior to or during adolescence. Familiarity with the origins and insertions of the major muscles contributing to these avulsions as well as the radiographic patterns of these injuries is helpful in arriving at the definitive diagnosis. Apophyseal avulsions can occur at the ischium (hamstring muscle), anterior superior iliac spine (sartorius), anterior inferior iliac spine (rectus femoris), symphysis pubis (adductor) and lesser trochanter (iliopsoas) [v].

The *ischial tuberosity*, which serves as the origin of the hamstrings muscle group is the most common site of such avulsions. This avulsion is seen between puberty and 25 years of age [vi].
Avulsions of the *anterior superior iliac spine* produced by forceful contractions of the sartorius or tensor facia latae and those of the *anterior inferior iliac spine*, avulsed by the straight head of the rectus femoris muscles are also commonly encountered during athletic activities. Fractures of the anterior superior iliac spine are more common than those of the anterior inferior iliac spine. At both sites, the mechanism of injury is violent extension of the hip. Adductor muscle avulsive injuries occuring at the *symhysis pubis* are also fairly common in young athletes. The radiographic changes at the origin of the muscle could resemble osteomyelitis or a neoplastic proces. Familiarity with the characteristic radiographic appearance of these lesions greatly facilitates the diagnosis. Typically, there is irregularity of the pubis on one side. Healing of an avulsion may result in bony deformity because of

significant displacement of the avulsed fragment or because of exuberant callus formation bridging the gap between the fracture fragments [vii]. On MR imaging, early or minor avulsive changes of the pubis can present with bone marrow oedema.

Acute soft tissue injuries

Acute *tears of various musculotendinous attachments* around the pelvis are common. Musculotendinous injuries are probably the most common form of sports-related injury to the hip and pelvis [viii]. These lesions can occur as the result of blunt direct trauma or secondary to indirect trauma from extensive tension or forceful contraction. Lesions include tendinous avulsion, muscle contusion and myotendinous strain.

Muscle contusions are secondary to direct trauma. Common sites of muscle contusion about the hip include the gluteal region and the proximal thigh (quadriceps). If imaging is performed, ultrasound is a useful tool, but in general, MR imaging with its exquisite soft tissue contrast resolution is superior in the evaluation of traumatic musculotendinous abnormalities. The MR imaging appearance varies according to the severity of the lesion. Diffuse oedematous changes of the muscle are manifested by a feathery MR imaging appearance on STIR and T2 weighted sequences. Intramuscular hematomas can develop with more severe trauma. The MR imaging characteristics of an intramuscular hematoma can be affected by its age, state of hemoglobin oxidation and field strength of the MR imaging system.

Muscle strains are induced by indirect trauma from excessive stretch or tension. They are usually the result of a single major traumatic event. Strain injuries affect the myotendinous junction, the weakest point of the musculotendinous unit [ix]. The two most common strained muscles about the hip joint are the rectus femoris and the hamstrings. Myotendinous strains are clinically as first degree (stretch injury), second degree (partial tear) and third degree (complete rupture). Myotendinous strain can be classified on MR imaging based on the extend of disruption present. First-degree strains imply degree of fiber disruption. There is interstitial oedema and haemorrhage at the myotendinous junction, with extend in the adjacent muscle fascicles. This produces a feathery MR imaging pattern [x]. Second-degree injuries are characterised by partial tear without retraction. A haematoma at the myotendinous junction is frequently observed, as are perifascial fluid collections.

Third-degree strain refers to complete rupture of the myotendinous junction. This diagnosis is usually made on clinical grounds.
As a result of facial tears, *muscle hernia* can occur. These hernias can result in late onset pain and local swelling, and can be detected with ultrasound.

Chronic injuries:
The majority of sports related injuries around the hip result from overuse. A finding of increased density may indicate *bone stress*, and a vague area of sclerosis in the femoral neck is the characteristic radiographic sign of a stress fracture. *Stress fracture* of the femoral neck usually present with groin pain related to exercise. Plain films may be negative for up to 3 weeks after symptoms onset. MRI is a useful tool in the diagnosis of stress fractures.
Stress fractures can be located lateral or medio-caudal in the femoral neck. The medio-caudal is the most frequent one, and is usually stable. The less frequent lateral stress fracture has a greater risk for instability and displacement. Sacral stress fractures can present with pain referred to the hip, and can clinically be mistaken for hip pathology.
Stress fracture of the pelvic rami most common occur in the inferior pubic ramus. These fractures may be associated with osteopenia.

In the immature skeletal, repetitive force at a developing center of ossification may cause a stress reaction which is described as *"apophisitis"*[xi] . Apophisitis is seen on X-ray as apophyseal fragmentation and irregularity. Care should be taken in the diagnosis of apophisitis to prevent normal secondary ossification centres to diagnose as apophysitis.

In the region of the pelvis and hip, three main bursal groups can be involved. The trochanteric burs, the ischiogluteal bursa and the iliopsoas bursa [xii]. *Trochanteric bursitis* can arrise from frictional overload or direct trauma. If the clinical diagnosis is uncertain, ultrasound can help to differentiate trochanteric bursitis from gluteus medius tendinosis.
Ischiogluteal bursitis results from a fall or repetitive trauma. Other causes of buttock pain include hamstring tendinosis, gluteal muscle strain, priformis syndrome, referred pain from the lumbar spine or sacro-iliac joint and apophisitis or avulsion of the ischial tuberosity.

Osteitis pubis can be due to chronic overuse and repetitive trauma in athletes. Radiographic changes include asymmetric erosion and sclerosis at the bony margins of the symphysis and across the anterior surface of the body of pubis.

Slipped femoral capital epiphysis *is most common in boys and usually presents as hip or groin pain in adolescence.*

Dystrophic calcification or ossification can form at sites of previous tendon rupture. Myositis ossificans is a common complication of muscle contusion, associated with myonecrosis and hematoma formation. Following muscle rupture from indirect or direct trauma, haematoma formation may progress to myositis ossificans. This is most commonly seen in the rectus femoris and vastus intermedius. Calcification at the haematoma site is usually visible 7-10 days following trauma and will ultimately progress to heterotopic bone.[xiii]

Acetabular labral tears

Acetabular labral tears have gained recognition as common and clinically important intra-articular lesions that may cause persistent hip pain or disabling mechanical symptoms. Until recently, labral abnormalities were associated with major hip trauma such as posterior dislocation (or chronic degeneratieve joint disease). Currently, it is recognised that symptomatic tearing of the acetabular labrum can result from less severe trauma, such as twisting injuries [xiv]. Injury to the acetabular labrum is a common event that bears some similarity to meniscal tear at the knee. Not all tears that can be demonstrated are symptomatic, but those with symptoms usually present as groin pain. The diagnosis can sometimes be made with ultrasound, but MRI (with arthrography) is the "gold standard" imaging modality to detect and evaluate these lesions[xv]. Acetabular labral tear is not functionally associated with development of hip instability, but may lead to other complications. Labral tear is increasingly recognized as starting point for degenerative joint disease.

Joint dislocation

In major trauma, the hip can dislocate. A typical example is the "dashbord" injury, where a force applied on the flexed hip results in a posterior dislocation of the hip. This is usually

associated with a fracture of the posterior acetabular rim, or with a split of the femoral head (the so called “pipkin fracture”). Conventional imaging can demonstrate the dislocation, but for the associated fracture CT is mandatory. Even MRI can be helpful in demonstrated bone marrow oedema or associated soft tissue injury.

CONCLUSION

There are several traumatic lesions in and around the hip. Many of them are sports related, and can be acute (one forceful traumatic event), or chronic (repetitive trauma). Medical imaging has an important role in the detection and in the evaluation of these lesions. It’s important to mention that hip pain can be due to hip pathology, but also can be referred pain, f.i. from sacral lesions.

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