Avulsion injuries of Pelvis: An imaging spectrum

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Learning objectives

1-To recognise the characteristic imaging findings in common avulsion injuries of the pelvis.

2-Understanding the musculotendinous anatomy which aid in accurate diagnosis of these injuries.

3-Demonstration of appropriate imaging techniques.

Background

Avulsion injuries are common in young adults, especially sportsmen and athletes. Avulsion injuries commonly occur at seven sites in the pelvis which include:

1: Ischial tuberosity: Insertion of Hamstring tendons

2: Anterior superior iliac spine: Sartorius and tensor fascia lata

3: Anterior inferior iliac spine: Rectus femoris

4: Superior and inferior pubic rami: Adductor group of muscles

5: Lesser Trochanter: Iliopsoas muscle

6: Greater Trochanter: Glutei , Obturater internus, Gemellus, Piriformis.

7: Iliac crest: Abdominal musculature.

These are often associated with strain or tear of the associated myotendinous junctions and can even be present without definite bony avulsion.

In the largest study evaluating the pelvic injuries, Rossi and Dragoni\textsuperscript{1} found the most common location to be the ischial tuberosity (54%). This was followed by anterior inferior iliac spine (22%), anterior superior iliac spine (19%), superior corner of pubic symphysis (3%), and iliac crest (1%). Soccer (74 cases) and gymnastics (55 cases) had the highest number of avulsion fractures documented.

Metzmaker and Pappas\textsuperscript{2} reviewed 27 cases of avulsion Fracture and found the most common location to be anterior superior iliac spine.
Various pelvic avulsion fractures has been variably classified. The most common location i.e ischial tuberosity avulsion fractures, was classified in 1957 by Martin and Pipkin\textsuperscript{3} into 3 groups:

1- Nondisplaced,

2- Acute avulsion fractures and

3- Old nonunited fractures.

Bart I McKinney et al modified the above classification into 4 subtypes:

Type I: Nondisplaced fractures

Type II: Displacement up to 2 cm

Type III: Displacement > 2cm and

Type IV: Symptomatic nonunion or painful exostosis

**Imaging findings OR Procedure Details**

Pelvic radiographs may demonstrate an avulsed bony fragment in a setting of acute or chronic injury. CT scan is excellent for demonstration of tiny displaced bony fragments and associated muscle injury with or without hematoma.

Ultrasound, although excellent in diagnosing myotendinous strain, partial or complete tear, has its limitations. Its operator dependence and unclear anatomical depiction to surgeons, makes it being utilized as a screening modality.

Magnetic resonance imaging is often used for detailed evaluation of the concerned tendon and muscles. Its role has been well established in diagnosing an avulsed apophysis in the pediatric population. It can give an accurate and detailed assessment of the degree of injury to the involved muscle, myotendinous junction, tendon and underlying bone. Its multiplanar capabilities, excellent soft tissue resolution and no exposure to ionizing radiation makes it the most preferred modality after screening.

**Hamstring tendon:**

Hamstring tendon injuries are very most common in athletes. It is mostly due to sudden contraction during severe exercise. It may be also precipitated by applying sudden muscular load or over stretching.
The hamstring tendons include semimembranosus, semitendinosus and the biceps femoris.

The biceps femoris and semitendinosus arise from a common tendon along the posteromedial aspect of the ischial tuberosity.

Proximal fibers of the semitendinosus tendon along with the long head of biceps femoris arise from the inferomedial impression on the upper aspect of ischial tuberosity as a conjoint tendon.

The semimembranosus tendon arises from the posterolateral aspect of the ischial tuberosity, anterior to the common origin of the biceps femoris and semitendinosus, and has the longest proximal tendon segment.

The hamstrings act to extend the hip.

MRI identifies the location and severity of the injury.

Rectus femoris tendons: Rectus femoris is the most anterior muscle of the Quadriceps group which extends the legs and flexes the thighs. Rectus femoris has two tendinous origins: direct (straight head), which arises from the anterior inferior iliac spine and indirect (reflected head) which arises from the superior acetabular ridge and capsule of the hip joint. The two heads merge to form a conjoined tendon about 2 cm distal to their origin. Injuries to rectus femoris is common in athletes, predominantly in soccer players. Risk factors include recent or remote muscle strain, weak muscle, muscle imbalance, limited flexibility, fatigue muscle, improper warm-up and faulty techniques. Most common injury, especially in the immature apophysis (14-25 years), is the avulsion injury of direct head from AIIS. Other injuries include myotendinous strain or myofascial injury. These patients present clinically with localized pain, swelling and limited range of movement. Acute injury is detected in plain radiographs, especially in oblique pelvic view. MRI is very helpful for identifying minimally displaced or non-displaced avulsions and apophysitis. MRI also detects superior labral and joint capsule injuries which are commonly associated with the injury of the indirect head. These findings help in proper management of rectus femoris injury (conservative or surgical) and final outcome. Ultrasound is also helpful in detecting myotendinous injuries. CT has a role in identifying tiny or subtle bony fracture associated with these avulsion injuries which can be missed in MRI or plain radiographs.

Anterior superior iliac spine (Sartorius and tensor fascia lata):

This is the third most common site of pelvic apophyseal injury in young adults. It gives the origin to Sartorius and some fibers of Tensor fascia lata. Common mechanics of its avulsion is due to sudden strong pull of the Sartorius while the hip is in extension and knee is in flexion, which commonly occurs in sprinters and runners. Patients present
with pain, point tenderness, weakness, swelling and abnormal gait. The findings go undetected in the early radiographs due to either non-displaced fragment or non-ossified apophysis in young adults. Subacute or chronic injury shows abnormal and excessive callous formation at the level of ASIS with wide differentials including inflammatory or neoplastic etiologies in the absence of trauma.

MRI is the modality of choice in detection of early avulsion. It allows direct visualization of the tendon, evaluates the extent of the injury, and other associated findings.

**Greater and Lesser Trochanters:**

The Greater Trochanter has four distinct facets - anterior, lateral, posterior and posterosuperior.

The Gluteus Medius inserts on the lateral and posterosuperior facets, while the Gluteus Minimus attaches to the anterior facet. The two together are also known as the rotator cuff of the hip. Partial tear and tendinosis of their tendons is common in middle aged and elderly persons and is usually associated with bursitis mainly Trochantric, Subgluteus medius and Subgluteus minimus.

The Obturator internus inserts on the medial surface of the Greater trochanter along with the superior and inferior gemili.

The Obturator externus inserts on the posteromedial surface of the Greater trochanter.

The lesser Trochanter is the site of insertion for the Psoas tendon and iliacus muscle. They are responsible for flexion and lateral rotation of the hip joint.

Injury to piriformis, gemellus superior, gemellus inferior, obturator internus tendons are uncommon. Trauma or overuse related avulsion, tendinosis, strain or spasm of piriformis, gemelli - obturator internus muscles are well described and are part of the deep gluteal syndrome entrapping the sciatic nerve.

**Images for this section:**
Fig. 1: Normal axial image for the Hamstring tendons
Fig. 2: Axial PD fat sat image shows mild avulsion injury of right Hamstring tendon yellow arrow.
Fig. 3: Coronal PD fat sat image showa mild Hamstring tendon injury.
**Fig. 6:** Axial T2 FAT SAT image showing grade I injury to the indirect head of right Rectus femoris.
Fig. 4: X-Ray AP of the Hip showing chronic avulsion fracture of right anterior inferior iliac spine and right half of symphysis pubis
**Fig. 5:** CT axial images showing small avulsion injury of left anterior inferior iliac spine
Fig. 7: CT coronal images show dystrophic calcification along the chronic avulsion fracture of rectus femoris from AIIS with dispropotionate osteoarthritic changes in superior aspect of the left hip joint in keeping with associated labral and joint capsule injury.
Fig. 8: MRI hip arthrogram (axial, coronal and sagittal images) shows contrast leak from the hip joint into the rectus tendon tear site in keeping with associated tear of superior labrum and joint capsule with indirect head tear.
Fig. 9: X-Ray AP showing chronic avulsion fracture of the anterior superior iliac spine.
**Fig. 10:** T1 Coronal & axial images showing gluteus minimus muscle and tendon (a) & gluteus medius muscle (b). Greater trochanter (c).
Fig. 11: Axial and sagittal MRI T2 FAT SAT images showing avulsion of the iliopsoas tendon with fracture of the lesser trochanter.
Conclusion

The avulsion fractures of pelvis are common especially in young athletes. Radiographs and CT scan reveal avulsed pieces of bone. MRI is helpful for detailed evaluation of the muscles and tendons. These fractures are increasingly recognised and are assessed in a better and detailed manner with these imaging techniques. Early detection of these injuries is important for appropriate and timely treatment.

References


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