Groin pain of unknown etiology: how MRI can help

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Learning objectives

To review conditions causing groin pain in professional football players and to determine the contribution of MRI in diagnosis and management of this pathological condition.

Background

Groin pain is typically an overuse injury due to excessive athletic activity accounting for approximately 2 to 18% of all sports injuries [1,2,3].

The term groin pain is the preferred label that refers to a spectrum of musculoskeletal injuries that occur in and around the pubic symphysis and that share similar mechanisms of injury and common clinical manifestations [4].

Groin pain in athletes can be acute (secondary to a single event), chronic (secondary to altered biomechanical load and repetitive microtrauma) or a combination of the two [5].

Images obtained with MRI can improve and speed-up a clarification of athletic groin pain diagnosis.

One of the great benefits of utilizing MRI in the assessment of patients with athletic pubalgia is the modalities inherent sensitivity for a wide array of both musculoskeletal and visceral lesions [6].

Findings and procedure details

MR imaging studies in 28 professional football players referred to a team doctor who specializes in sports trauma for diagnoses "groin pain" during a period from July 2014 through May 2016 (2 seasons) were reviewed.

The mean age of the study patients was 29.7 years (range 25-34 years).

MR imaging studies had been performed at radiology department with 1.5T and 3T MR Scanners.
[Siemens Avanto 1.5T (Siemens, Germany), GE Optima MR 450 1.5T (GE Healthcare, USA), GE Discovery MR 750 3T (GE Healthcare, USA)]

The standard protocol includes large FOV (36-40cm) coronal T1-weighted spin-echo, coronal short time inversion-recovery (STIR), and axial and coronal T2- or proton-density weighted fat-suppressed imaging of the pelvis and hip joints.

In players with muscle strain sagittal proton-density-weighted fat-suppressed imaging of the affected hip were then performed addition to coronal and axial T2- or PD-weighted fat-suppressed images.

We acquired a fluid-sensitive T2 fat-suppressed-WI in the coronal and axial plane to detect bone marrow edema in case of present signs of osteitis pubis. Real-time functional imaging of abdominal wall motion were obtained in case of inguinal hernia.

**Image Analysis:**

MR images were reviewed for bone marrow edema in and around the pubic symphysis. Any abdominal wall, inguinal, femoral, or internal hernia was recorded. Tendinous injury involving the rectus abdominis and the adductor tendons (pectineus, adductor longus, adductor brevis, adductor gracilis, and adductor magnus muscles) were analyzed. Tendon findings were divided into tendinopathy (tendon thickness) enthesitis with fluid under the sheath, partial tear, and avulsion.

**Results**

All conditions were separated in 2 groups: acute & chronic groin pain. The first group consisted of traumatic lesions such as muscle strain and tears, tendon injuries, acetabular labral tears and other injuries (39% of pts). The second group with chromic groin pain (61%) consisted of cases of sportsman's inguinal hernias, spermatic cord lipomas, osteitis pubis and also hip joint and spine-related disorders. In 7 players we found combination of acute trauma injury and MR signs of chronic pubic osteitis. Two athletes had a long term consequences of laparoscopic repair where MR revealed the mesh-related etiology of groin pain. All patients with inguinal hernias and muscle avulsions diagnosed by MR were referred to surgery.

**Muscle & tendinous trauma**

The most common cause of acute groin pain are strains of the adductor muscles (adductor longus, magnus, and brevis; gracilis; pectineus; and obturator externus [7].
Muscle injuries constitute a large percentage of all injuries in football. According to Ekstrand et al., 2011 Muscle injuries constituted 31% of all injuries. 23% of all muscle injuries affected the adductors group of the lower limbs. The incidence of groin strains is highest in the intermediate age group and lowest among the younger players [8].

The currently most widely used classification is an MRI-based graduation defining four grades: grade 0 with no pathological findings, grade 1 with a muscle edema only but without tissue damage, grade 2 as partial muscle tear and grade 3 with a complete muscle tear or avulsion [9].

Mueller-Wohlfahrt et al., 2012, provided terminology and classification of muscle injuries in order to facilitate effective communication among medical practitioners and development of systematic treatment strategies. In the consensus meeting, practical and systematic terms were defined and established. In addition, a new comprehensive classification system was developed, which differentiates between four types: functional muscle disorders (type 1: overexertion-related and type 2: neuromuscular muscle disorders) describing disorders without macroscopic evidence of fiber tear and structural muscle injuries (type 3: partial tears and type 4: (sub) total tears/tendinous avulsions) with macroscopic evidence of fiber tear, that is, structural damage. Subclassifications are presented for each type [10].

MRI is recommended for every injury, which is suspicious for structural muscle injury. MRI is helpful in determining whether edema is present, in what pattern, and if there is a structural lesion including its approximate size. Furthermore, MRI is helpful in confirming the site of injury and any tendon involvement [11].

Grade 1 strain on MRI (3A M-W, Minor partial muscle tear) is positive for fiber disruption. Is presented with hyperintense edema, hemorrhage within affected muscle group. Subcutaneous tissue edema and intramuscular fluid. Fig. 1 on page 8

Grade 2 strain (3B M-W, Moderate partial muscle tear) is positive for significant fiber disruption, probably including some retraction with fascial injury and intermuscular hematoma. On MRI the grade 2 strain is presenting with hyperintense hemorrhage with tearing up to 50% of muscle fibers. Interstitial hyperintensity with focal hyperintensity on T1-WI representing hemorrhage in muscle belly and intramuscular fluid. Focal defect shows partial retraction of muscle fibers. Fig. 2 on page 9

Grade 3 strain (4 M-W) is tear involving the subtotal/complete muscle diameter/tendinous injury involving the bone-tendon junction. Possible a wavy tendon morphology and retraction may be present with fascial injury and intermuscular hematoma. On MRI complete tearing with muscle retraction manifestates with hyperintense fluid filled gap [9,10]. Fig. 3 on page 9

Hip joint trauma (capsule injury, Acetabular labral tear)
The articular capsule envelops the hip joint, reinforced by capsular ligaments, attaching proximally to the acetabulum and distally to the femoral neck at the intertrochanteric line. Capsular ligament injuries are best characterized at MR imaging by disruption of ligament fibers and periligamentous edema, most commonly involving the iliofemoral ligament at its insertion on the femur or ischiofemoral ligament related to posterior acetabular lip fracture.

The acetabulum labrum is a fibrocartilaginous structure attached to the acetabular rim which increases the surface area of the hip joint and helps prevent subluxation [12].

The labrum is relatively poorly vascularized, and its anterior-superior aspect is considered to be as most susceptible to injuries, particularly during hyperextension and external rotation [13].

The labrum is normally hypointense in signal with all pulse sequences and has a triangular cross-sectional morphology. Acetabular labral tear is presented with intermediate linear signal or diffuse abnormal signal on T1-WI and hyperintense signal on PD- and T2-WI with FS. The separation of the labrum at its base and diastasis between acetabular articular cartilage and labral attachment may be present [9]. Fig. 4 on page 10

Osteitis pubis

Osteitis pubis is a noninfectious inflammatory process of the pubic symphysis commonly seen in runners and in athletes involved in cutting sports such as football and hockey. Previous trauma, overuse, and vaginal delivery are all risk factors. The mechanism of injury in athletic pubalgia combines two physical phenomena: repetitive motion injury and muscle development asymmetry. Patients often present with groin pain that is activity related.

The goal of the physical exam is to best localize the focal area of pain. Osteitis pubis can be divided into three zones for focal pain: suprapubic, intrapubic, and infrapubic. Suprapubic sources of pain include injuries to the rectus muscle, rectus tendon, conjoint tendon, and the periosteum of the pubic rami. Intrapubic sources of pain stem mainly from injury to the pubic symphysis and its fibrocartilaginous interpubic disk. Infrapubic sources of pain include injury to the gracilis muscle, the adductor longus muscle, the tendinous origins of these muscles, and periosteum of the pubic rami [10].

MRI has become the main imaging modality to both diagnose and confirm resolution of the inflammatory process.

Substantial amounts of bone marrow edema at the pubic symphysis can occur in asymptomatic football players, and it is only weakly related to the development of osteitis
pubis [15]. Therefore, MRI should be used to confirm the clinical suspicions provided by the history and physical exam.

MR imaging reveals para-symphysial hyperintensity on fluid-sensitive sequences, presumably reflecting edema due to increased stress response and areas of trabecular microtrauma [16].

MR images show diffuse marrow edema extending from the subchondral plate and often involving both pubic bodies [17].

In addition, periostitis, articular surface irregularity, erosions, anterior and posterior osteophytes, and subchondral cysts may be seen on MR images [4,18]. Fig. 5 on page 10

**Femoroacetabular Impingement**

Femoroacetabular impingent (FAI) describes a morphological variant seen in approximately 20% of the general population - it is not in itself pathology [19].

Femoroacetabular impingent (FAI) occurs when there is an abnormal configuration between the acetabular rim and proximal femur. It is classified into cam FAI and pincer FAI depending on the presence of either a femoral or an acetabular abnormality respectively [20,21].

There has been also a third type of FAI outlined, where the first two coexist.

In cam-type impingement, an aspherical portion of the femoral head (the cam deformity) leads to abnormal bone contact and joint damage. Athletes in high-impact sports have a higher risk of developing a cam deformity of the femur [22,23].

In pincer-type impingement, abnormal bony contact occurs between the acetabulum and the femur owing to a focal or general acetabular overcoverage. General acetabular overcoverage is caused by an increased acetabular depth, as in coxa profunda and protrusio acetabuli [24].

Hypointense edema and sclerosis on T1-WI of lateral subchondral bone, hyperointense to intermediate signal intensity acetabular subchondral cysts on T2-WI and acetabular rim associated with labral tears and cartilage defect. Labral tears present with hyperintense linear of diffuse signal on T2-WI [9]. Fig. 6 on page 11

**Spine related groin pain**
The groin is innervated by the genitofemoral and ilioinguinal nerves; degeneration of the spinal canal can cause referred pain to the groin. In particular, patients with herniated discs (most commonly in the L4-L5 or L5-S1 levels) have been known to report groin pain [25].

These discs can cause compression on transversing sacral nerve roots (S1-S3). Additionally, herniation at the L1/L2 levels is rarer but can cause characteristic symptoms of groin pain, manifesting as buttock pain and anterolateral thigh pain [10, 26].

Similar to degeneration and herniation, nerve root may be mechanically trapped due to spondylolisthesis and/or lumbar stenosis [10]. Fig. 7 on page 11

Inguinal hernias

Inguinal hernias are the most common, accounting for 70-75 % of all hernias [27].

The vast majority of inguinal related groin pain in high performance athletes is not an inguinal hernia per se, the complaints are mostly due to weakness of the posterior wall of inguinal canal. Therefore the dynamic MR imaging techniques allow direct visualization during provocative maneuvers such as Valsalva, which may help detect subtle hernias [4].

Occult hernias, which include direct and indirect hernias, can present with a story consistent with that of a groin hernia but without the physical exam findings to support the diagnosis [10,28]. Fig. 8 on page 12

As for occult hernia detection, MRI has been shown to have a sensitivity and specificity figures of 94.5 and 96.3 % [29].

Spermatic cord lipoma

An occult inguinal hernia is a true hernia of the myopectineal orifice that is indicated by symptoms of groin pain,

worsened by activity, but not clinically apparent on physical exam or basic imaging. Occult hernia can be a cord lipoma or indirect hernia sac that tracks along the spermatic cord within the inguinal canal creating compression on the ilioinguinal or genitofemoral nerves. Lipoma of the spermatic cord and round ligament is understood as an extension of the preperitoneal fat, and not as a true benign neoplasm, in the majority of the anatomical and surgical literature [10]/ Fig. 9 on page 12

These lipomas do occur with significant incidence, and they can cause hernia-type symptoms even without the presence of a true inguinal hernia [30].
Mesh related groin pain after hernia repair

The incidence of chronic pain or discomfort after inguinal hernia repair is much higher than previously thought, and studies suggest it could be higher than 50% [10, 31]. The sutures, fixation devices, and mesh may play a significant role. When mesh is used, it can significantly contribute to the development of chronic groin pain through an inflammatory response between the mesh and surrounding tissue. The inflammatory reaction can cause nearby nerves to become entrapped in the mesh directly or cause traction injury to nerves as tissues become scarred and contract. Fig. 10 on page 13

In some patients, mesh may be relatively inert, whereas in others it may migrate, fold, or erode through local structures [10].

Images for this section:

![Image](image-url)

**Fig. 1:** Grade 1 strain: Mild partial tear of right m.pectineus. T2-weighted fat suppressed image shows minor partial muscle tear presented with linear hyperintense signal (turquoise arrow - fiber disruption); a purple arrow shows perifascial fluid.
Fig. 2: Grade 2 strain: Right adductor magnus tear. Coronal and transversal T2-weighted fat suppressed images of the pelvis show hyperintense edema within affected muscle group (blue and green arrows).

Fig. 3: Grade 3 strain: Left muscle pectineus tear. Coronal and sagittal T2-weighted fat-suppressed images of the pelvis demonstrates the typical appearance of total disruption
(turquoise arrow) with intramuscular edema (purple arrow) with hematoma (pink arrow) and retraction.

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**Fig. 4:** Capsule injury and acetabular labral tear. Coronal PD weighted fat suppressed sequence# a yellow arrow shows cysts in the enthesis of iliofemoral ligament due to its precedence injurie; a blue arrow shows an acute acetabular labral tear presenting with hyperintense signal in the base of the labrum.

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**Fig. 5:** Osteitis pubis. Coronal and axial T2-weighted fat-suppressed images show marrow edema that extends throughout pubic body into the superior pubic ramus (purple arrow).

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**Fig. 6:** Femoroacetabular impingent. Coronal T2-weighted fat-suppressed image shows hyperintense edema of acetabular rim associated with labral tears (blue arrow) and subchondral cysts (yellow arrow).

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**Fig. 7:** Spine related groin pain. Sagittal T2-weighted image of lumbar spine shows entrapped L5 root; a red arrow shows subarticular (foramenal) disc protrusion combined
with degeneration of the facet joints; axial T2-weighted image of L5-S1 segment: right-sided subarticular (foramenal) disc protrusion (green arrow) with compression of right L5 root.

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**Fig. 8:** Inguinal hernia. Axial T2-weighted image of pelvis. Red arrow: Inguinal hernia. Green arrow: normal appearance of left inguinal region.

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Fig. 9: Spermatic cord lipoma. Coronal T2-weighted images. An arrow shows a spermatic cord lipoma.

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**Fig. 10:** Spermatic cord edema after mesh repair of inguinal hernia. Transversal T2 weighted fat suppressed images show edema of right spermatic cord (turquoise arrow) in player with mesh related groin pain after laparoscopic repair of inguinal hernia with mesh. Transversal T1WI: hypointesity of spermatic cord (pink arrow).

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Conclusion

MR plays a pivotal role in definition of source of groin pain and its etiology in high performance athletes, either would it be acute injury or chronic pain as well.

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