# Imaging Review of Groin Pain in Elite Athletes: An Anatomic Approach to Imaging Findings

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**OBJECTIVE.** Groin pain in elite athletes is a common yet challenging diagnostic and management dilemma for the sports clinician, accounting for a significant proportion of athletic injuries. It is often debilitating and, if severe enough, may compromise an athlete's career. Traditionally, groin pain has been poorly understood by radiologists.

**CONCLUSION.** A major reason groin pain has been misunderstood is the complexity of the anatomy of this region, which this article discusses in detail in an effort to inform the reader.

**Keywords:** adductor longus, athletes, groin, hernia, MRI, osteitis pubis, rectus abdominis

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Groin pain in elite athletes is a common yet challenging diagnostic and management dilemma for the sports clinician. Overall, groin pain accounts for approximately 5–18% [1, 2] of all athletic injuries, with kicking sports generally producing most of these injuries. For example, nearly one third of soccer players will develop groin pain during the course of their careers [3]. Groin injuries are unfortunately often disabling, necessitating a protracted time out of competition, and may compromise a professional athlete's career. The differential diagnosis is broad and includes traumatic injury to the adductor and rectus abdominis muscles, osteitis pubis, insufficiency fractures of the pelvis, posterior inguinal wall deficiency, and hernias. Diagnostic imaging has the ability to diagnose these conditions and therefore allow appropriate and timely treatment in this clinical setting.

## Anatomy

Although the groin specifically lacks formal and distinct anatomic boundaries, for practical purposes it may be considered to be the area of the body that encompasses both inguinal regions and the pubic symphysis, extending inferiorly to involve the proximal aspect of the adductor compartment of both thighs.

### *Common Origins of the Adductor and Rectus Abdominis Muscles*

Each rectus abdominis muscle arises from the superior aspect of the pubic symphysis, with distinction often able to be made between a lateral and a medial head on both sides (Fig. 1). Inferiorly, the medial head blends with its contralateral fellow; however, superiorly the medial heads diverge and are separated by the linea alba. The rectus abdominis has a sheet-like configuration [4], with at least three intramuscular tendinous intersections, one at the level of the umbilicus, one at the xiphoid tip, and one between these two. Occasionally, a fourth intersection may be present inferior to the umbilicus. However, the intersections do not extend through the full anteroposterior thickness of the muscle but only to the anterior surface of the muscle, where they blend with the anterior rectus sheath. This latter structure covers the entire anterior aspect of each rectus abdominis and attaches onto the periosteum of the pubic bone anterior and adjacent to the rectus abdominis origin. Immediately lying edge-to-edge with the lateral margin of the rectus abdominis is the pectineus muscle, a flat quadrangular muscle that arises from the portion of the pubic bone lateral to the pubic tubercle, the superior pubic crest. The pectineus muscle forms the floor of the femoral triangle that the femoral neurovascular bundle courses over anteriorly, a fact that allows easy identification of this muscle on axial images.

The adductor longus and adductor brevis muscles possess an extensive insertion onto the femur. Combined with the insertion of the gracilis onto the tibia, these three tendons converge superiorly and obtain an origin close to each other on a narrow portion of the pubic body just lateral to the symphysis,

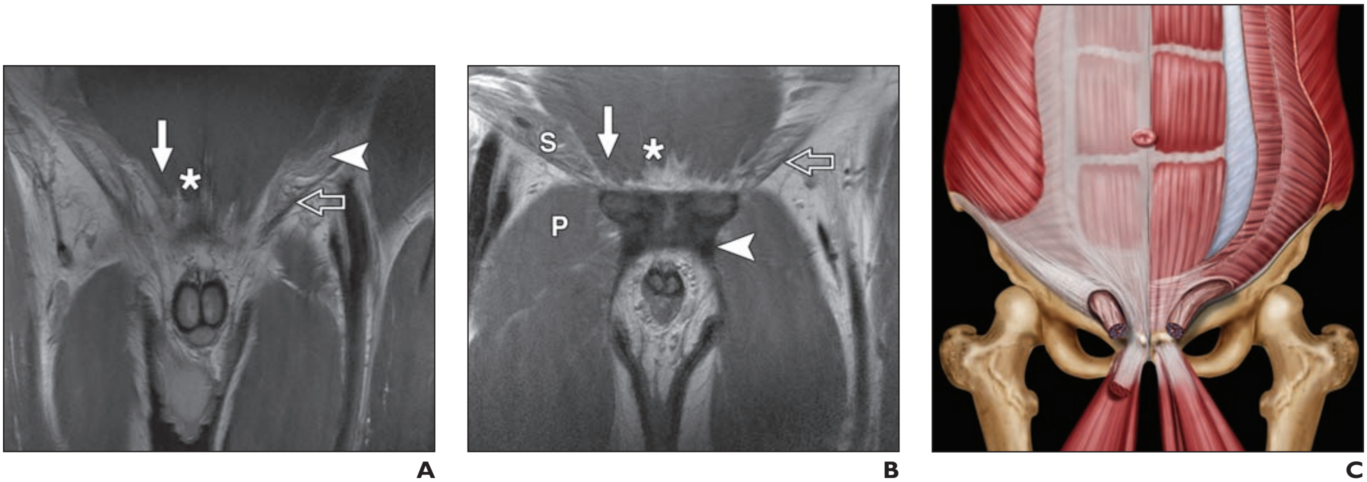



**Fig. 1**—Healthy 28-year-old male athlete.
**A,** Coronal proton density–weighted MR image shows medial (*asterisk*) and lateral (*solid arrow*) heads of rectus abdominis muscle. Also note inguinal ligament (*open arrow*), superior to which spermatic cord courses through inguinal canal (*arrowhead*).
**B,** Coronal proton density–weighted MR image slightly more posterior than **A** shows lateral (*solid arrow*) and medial (*asterisk*) heads of rectus abdominis continue to be visualized. Inguinal ligament (*open arrow*) attaches onto pubic tubercle medially, with contralateral spermatic cord (S) visualized superior to ligament. Note triangular tendon (*arrowhead*) that provides origin for left adductor longus tendon, which is essentially continuous superiorly as tendon of origin for rectus abdominis. Immediately lateral to pubic tubercle, pectineus muscle (P) gains origin from superior pubic ramus, which is slightly posterior and thus not seen on this image.
**C,** Diagrammatic representation of relationship between abdominal musculature and adductor longus muscle. On left of image, external oblique muscle is most superficial layer, inferiorly forming external oblique fascia. This structure splits medially to form external (superficial) inguinal ring through which cut end of spermatic cord exits canal. Anterior rectus sheath covers rectus abdominis muscle on this side, and adductor longus inferiorly has been cut away. On right side of image, external oblique muscle and fascia have been removed to reveal internal oblique and deeper transversus abdominis muscles. These two muscles at level of inguinal ligament laterally form internal (deep) inguinal ring, through which spermatic cord enters inguinal canal. These two structures medially form "conjoint tendon," which is posterior inguinal wall, and blend with anterior rectus sheath (not shown on this side) and, in essence, attach anterior rectus sheath to rectus abdominis as depicted.

where they concentrate the forces that they transmit from the lower limb. Differentiating between the tendons of these muscles at their origin is difficult; it is only further inferiorly that they are adequately discerned (Fig. 2). The adductor longus tendon has its origin almost directly in line with the origin of the more superiorly placed tendon of the rectus abdominis, with the superficial fibers of these two tendons in direct continuity, coursing over the pubic crest (Fig. 3). The tendon of the adductor longus, however, can always be identified by its characteristic triangular configuration, a constant finding in all imaging planes; it meets the opposite adductor longus. These two structures on coronal imaging become continuous (and thus continuous with both rectus abdominis muscles), resulting in a "moustache" appearance (Fig. 1B). The anterior aspect of the adductor longus origin is usually entirely tendinous, with an accessory muscular origin found laterally in one fourth of cases [5]. Deep in relation to its tendon, a broad muscular origin of the adductor longus exists in all cases. The adductor longus arises from periosteum free bone [6], with the collagen fibers of the tendon in direct continuation with the pubis, which pass through a poorly vascularized, but richly neuron-innervated, transitional zone of calcified cartilage [7]. This finding is thought to predispose the adductor longus to injury. Farther posteriorly and slightly laterally lies the origin of the adductor brevis. The adductor brevis muscle is best identified on the more distal axial images in the proximal thigh and is then traced further proximally, where its separate origin may be discerned as a predominantly muscular origin posterior to the triangular moustache appearance of the adductor longus tendon. Of critical importance, some of the medial fibers of the adductor longus and adductor brevis tendons attach directly onto the symphyseal capsular tissues and intraarticular disk [8].

### *Pubic Symphysis*

The pubic symphysis is a complex nonsynovial amphiarthrodial articulation composed of a 4-mm-thick central fibrocartilaginous disk [9] interposed between the medial aspects of both pubic bones, which are in turn covered by hyaline cartilage. A minimal amount of fluid exists within the joint and a small primary cleft, the latter developing in the disk during skeletal maturation. The joint capsule is reinforced by the superior, inferior, anterior, and posterior pubic ligaments; however, the inferior pubic (arcuate) ligament is of the greatest functional significance [10].

Because the symphysis is flat and longitudinally orientated, it is most susceptible to shear stress in the vertical plane [11] during the normal gait cycle when each limb alternates in bearing the weight of the body, shifting the load to the other limb via the pelvis. Horizontal compressive forces imparted by the action of the transversely orientated fibers of the internal oblique and transverse abdominis muscles [11] combine to result in apposition of the pubic rami and hence stabilize the joint [12]. With excessive exercise though, the repeated action of the transversus abdominis may result in excessive compression and therefore disruption of the pubic symphysis, its disk, and surrounding structures. Delayed or insufficient contraction of the transversus abdominis muscle has been associated with groin pain [12], likely as a consequence of loss of its stabilizing role.

### *Inguinal Canal*

The inguinal canal is an oblique tunnel traversed by the spermatic cord, the floor of which is formed by the inferior rolled-up margin of the external oblique aponeurosis, known as the inguinal ligament (Figs. 1C

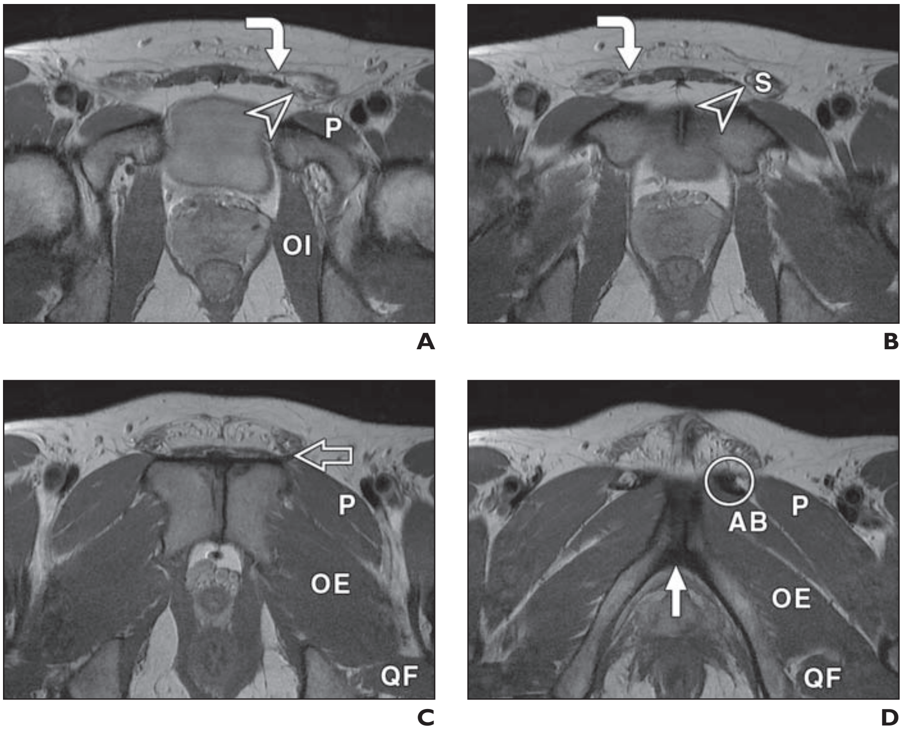



**Fig. 2**—Series of axial proton density–weighted MR images in asymptomatic 28-year-old male athlete depict anatomy pertinent to assessment of groin pain.
**A,** Note anterior (*arrow*) and posterior (*arrowhead*) walls of inguinal canal, as well as pectineus (P) and obturator internus (OI) muscles.
**B,** Further inferiorly, anterior (*arrow*) and posterior (*arrowhead*) walls of inguinal canal are again noted, and spermatic cord (S) is best visualized on this image. Observe how posterior inguinal wall, composed of the two closely apposed internal oblique and transversus abdominis muscles, appears to merge with rectus abdominis, best seen on left side of image.
**C,** On next image inferiorly, linear hypointense structure (*arrow*) represents inguinal ligament, which is inferior margin of external oblique aponeurosis. Note its attachment onto pubic tubercle. P = pectineus, OE = obturator externus, QF = quadratus femoris.
**D,** On final image, adductor longus tendon (*circle*) is shown, deep in relation to which lies belly of adductor brevis (AB). Inferior pubic (arcuate) ligament (*arrow*) is important stabilizer of pubic symphysis. P = pectineus, OE = obturator externus, QF = quadratus femoris.

**Fig. 3**—Sagittal image from reformatted MDCT image in 21-year-old male soccer player shows continuity of rectus abdominis tendon superiorly (*arrow*) with adductor longus tendon inferiorly (*asterisk*).

and 3). Laterally, the external oblique muscle attaches to the iliac crest, where it is strong. The medial fibers of the external oblique muscle are thin and aponeurotic, forming the anterior inguinal wall and splitting medially into two fascicles at its insertion onto the pubic tubercle to form the external (superficial) inguinal ring, which allows passage of the spermatic cord. The posterior inguinal wall is laterally formed by the weak transversalis fascia, which possesses a defect, the internal (deep) inguinal ring. Medially, however, the posterior inguinal wall is reinforced by the lowermost muscular fibers of the internal oblique and transversus abdominis muscles. Hence, when the anterior and posterior walls contract, a valvelike mechanism occurs, increasing craniocaudal tilt and tightening the inguinal canal, thereby preventing herniation of abdominal viscera during raised intraabdominal pressure. The classically taught notion that the internal oblique and transversus abdominis muscles are fused structures (the so-called conjoint tendon) is in reality not the case. These muscles are separate structures that actually insert predominantly onto the anterior rectus sheath, as opposed to primarily onto the pubic tubercle [13] (Fig. 1C).

## Applied Anatomy and Biomechanics

The significance of this anatomic framework serves as the basis for understanding the many causes of athletic groin pain. The tendons of origin of the adductor longus and rectus abdominis form a single continuous structure, appropriately termed the "common adductor–rectus abdominis" origin [14]. The common adductor–rectus abdominis origin forms a critical anatomic and biomechanical axis, acting as dynamic stabilizers of the pubic symphysis. Any disorder of either the common adductor–rectus abdominis origin or the pubic symphysis, as may occur with athletes exposed to repetitive microtrauma, predisposes the other to failure. Typically, the adductor longus fails first, resulting in an overwhelmingly increased load on the smaller rectus abdominis tendon. Ultimately, when these two fail, the poor osseous congruity of the symphysis provides little resistance to instability. Furthermore, traumatic injury of the common adductor–rectus abdominis origin may also disrupt the attachment of the posterior wall of the inguinal canal onto the anterior rectus sheath, resulting in posterior inguinal wall deficiency and, ultimately, direct inguinal hernia formation.

## Imaging Approach and Technique

Visualizing the musculoaponeurotic supports of the groin is vital and generally warrants a multitechnique approach. Radiographic assessment of the pelvis, although often normal, allows evaluation of symphyseal alignment and screening of the hips, sacroiliac joints, and lower lumbar spine for any disorders, which if detected, may initiate more advanced imaging of the relevant region. Focal osseous lesions of the pelvis as well as arthropathy may be detected. If pubic instability is suspected, dynamic "flamingo" views [15] may be performed.

Any radiographic abnormality may then be imaged with either CT or MRI. With the advent of MDCT, the benefits of multiplanar reformatting have obviated reverse-angle gantry images through the symphysis, which

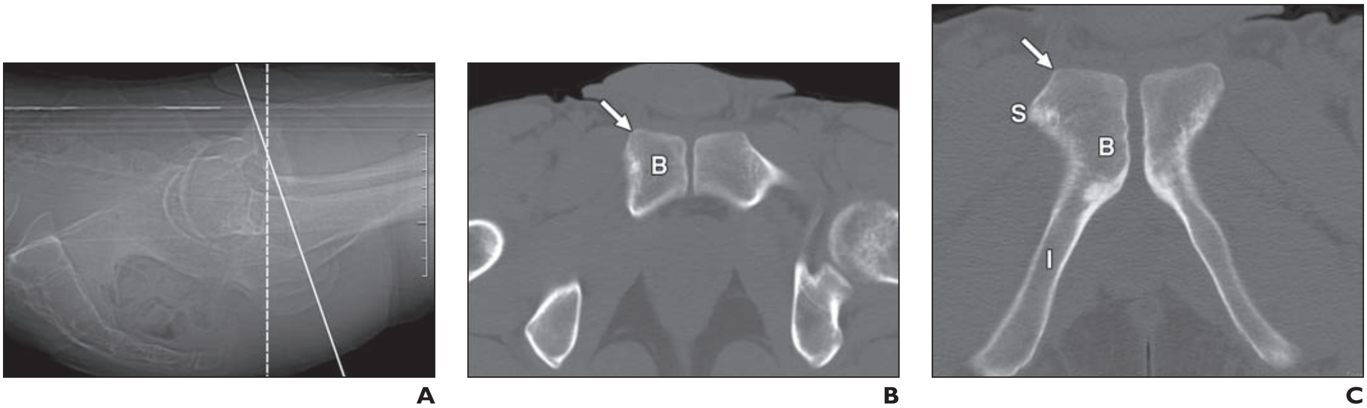



**Fig. 4**—26-year-old man with normal anatomy.
**A,** Lateral scout view on CT shows two options for imaging pubic symphysis in axial plane, either along true anatomic plane (*dashed line*) or obliquely, in plane with pubic symphysis (*solid line*).
**B** and **C,** Figures **B** and **C** will result, respectively, and serve as basis for planning coronal images. Note pubic tubercle (*arrow*), pubic body (B), and superior (S, **C**) and inferior (I, **C**) pubic rami.



were commonly acquired during the helical CT era. Images reformatted in the oblique axial plane elongate the symphysis and are prescribed from the sagittal scout view (Fig. 4), thereby allowing accurate assessment of the subchondral bone plate, the main advantage of CT. Specifically, CT aids in the detection of erosions and cysts. MRI may also be obtained in these planes and has the added advantage of showing abnormalities of the surrounding muscles and tendons, effusions of the symphysis, extrusion of the intraarticular disk, and bone marrow edema. Proton-density imaging in the axial and coronal planes is used to depict the anatomy, with a fluid-sensitive sequence such as a STIR or a T2-weighted fat-saturated sequence, used to show any abnormalities. In place of the coronal proton-density sequence, a T1-weighted sequence is used by many institutions to assess bone marrow for fractures or focal osseous lesions. A field of view of 18 cm is usually adequate. Bone marrow edema may also be assessed with nuclear medicine imaging; however, the superior anatomic resolution of MRI has largely superseded this technique. Although abnormalities of the inguinal canal may be seen on CT and MRI, this area is best assessed with dynamic sonography. Sonographic assessment of the groin is challenging even to the most experienced musculoskeletal sonologist, requiring considerable experience and a detailed knowledge of sonographic anatomy. A combination of CT, sonography, or fluoroscopy may be used for intervention.

The imaging approach is largely dictated by the clinical findings, experience, and the request of the referring clinician. Radiography of the pelvis followed by MRI is reasonable and commonplace. If the lumbar spine or the hip is also suspected as a possible cause of groin pain, then MRI of multiple regions may be performed at one session. Using a wide coronal field of view may act as a screening tool of the hip and may initiate further dedicated imaging. In the event of normal radiography and MRI, sonography may be used. Sonography has the ability to assess the common adductor–rectus abdominis origin in detail and can also exclude a hernia or inguinal wall deficiency with great confidence, as well as having the advantage of correlating any imaging finding with the athlete's symptoms.

## Differential Diagnoses and Imaging Findings

Groin pain in athletes is typically mechanical in nature, which if severe enough results in pubic bone overload. Overload of the pubic bone may be caused by a single acute traumatic event, repetitive microtrauma, or a combination of the two. A clinically relevant list of differential diagnoses can therefore be devised simply by considering the anatomic structures present (as discussed) and the manifestations of trauma (single or repetitive). Note that because the differential diagnoses represent a continuum of injury to different structures, any combination of these entities may coexist.

### *Common Adductor–Rectus Abdominis Dysfunction*

Although the frequency of injury to individual groin structures varies and is sport-specific, the most common injury usually involves the adductor muscles, particularly the adductor longus. The prevalence of adductor longus injuries ranges from 44% to 60% [14, 15–18]; they have been previously known as the “pubic-bone adductor syndrome” [19], “adductor syndrome” [20], “adductor dysfunction” [21], and “gracilis syndrome” [21]. Risk factors for injury include a history of strain and low levels of sport-specific preseason training [22]. Isolated injury to the rectus abdominis origin occurs in 27% of cases [14] (Fig. 5), with combined common adductor–rectus abdominis origin injury occurring in 15–30% of cases [14, 23].

Radiographs of common adductor–rectus abdominis dysfunction are generally normal; however, the earliest manifestation of abnormality is enthesopathy of its origin. This

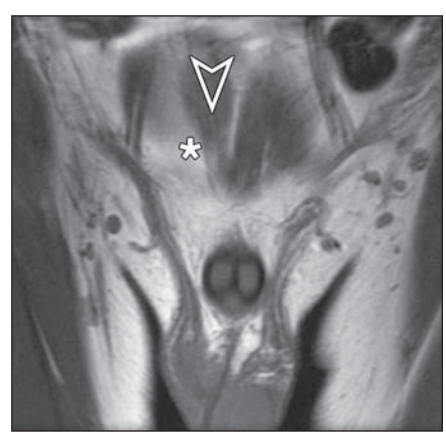


**Fig. 5**—Coronal T1-weighted image of groin in 26-year-old male professional football player shows chronic full-thickness disruption of lateral head of right rectus abdominis muscle (*asterisk*) with ill definition, decreased bulk, and early fatty replacement of medial head (*arrowhead*). Note normal contralateral left rectus abdominis muscle.

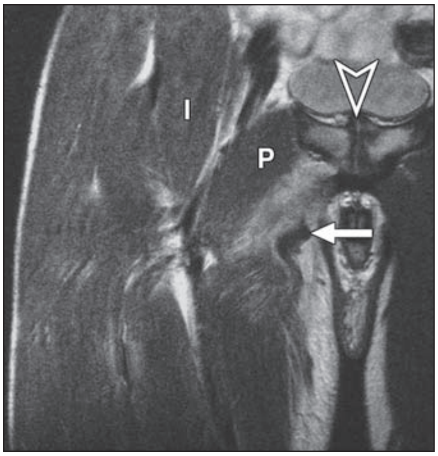



**Fig. 6**—Coronal proton density–weighted image through right groin in 22-year-old male soccer player with acute severe groin pain and loss of adduction shows full-thickness tear of adductor longus tendon from its origin with distal retraction (*arrow*). Tear occurs on background of preexisting pubic overload, where chronic changes of osseous spurring and capsular hypertrophy of superior aspect of pubic symphysis (*arrowhead*) are noted. P = pectineus, I = iliopsoas.

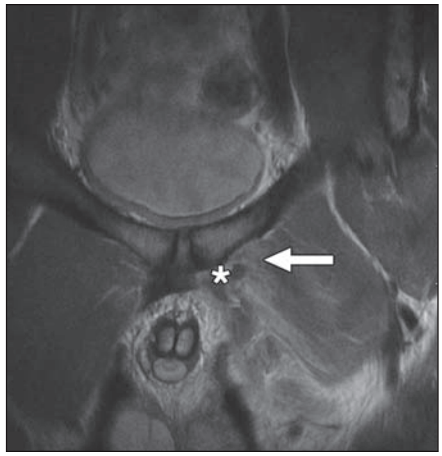


**Fig. 7**—Coronal proton density–weighted image of 30-year-old male athlete shows absence of left adductor longus tendon (*asterisk*), which is consistent with full-thickness disruption and simultaneous partial-thickness tear of medial aspect of pectineus muscle (*arrow*) as it arises from superior pubic ramus.

**Fig. 8**—Coronal proton density–weighted image of 33-year-old male recreational triathlete shows partial-thickness tear isolated to right pectineus muscle (*arrow*).

appears as ill definition of the cortical bone at the origin of either muscle, which, if severe enough, may form a distinct erosion. Attempts at healing compounded by ongoing athletic activity may account for a mixed lytic–sclerotic appearance. However, the condition is distinguished from osteitis pubis (discussed in the following text), which is characterized by the presence of erosions centered at the subchondral bone on either side of the symphysis. Because rectus abdominis and adductor dysfunction is frequently a precursor to osteitis pubis [24], the two conditions often coexist [25]. A single acute traumatic event may result in osseous avulsion of the origin of both muscles; however, this is a rare finding.

Erosions may also be shown sonographically as areas of interruption of the smooth hyperechoic line of the cortex of either the superior or the inferior pubic ramus, in keeping with either rectus abdominis or adductor muscle involvement, respectively. Careful pressure with the probe further increases the specificity of the examination should the patient complain of pain in this region. Further to this, areas of decreased echogenicity of the rectus abdominis or adductor tendon origin may be noted, which is the hallmark sonographic finding of tendinosis. With increasing severity of tendinosis, the tendon increases in size. Because this is often a subjective finding, frequently imaging this area is vital to obtaining adequate operator experience. Discrete anechoic clefts are consistent with partial-thickness tears. The diagnosis of a full-thickness tear with retraction of either the rectus abdominis or the adductor origin is often made difficult by the presence of hematoma, the echogenicity of which is variable and dependent on its age. However, careful investigation will invariably show a recoiled tendon as well as changes of preexisting tendinosis.

Acute tears may also involve the proximal musculotendinous junction of the adductor muscles, again most commonly the adductor longus. The adductor longus muscle is located several centimeters distal to the tendon on the anterior border of the muscle and is detected as an area of altered decreased echogenicity, typical for a grade 1 strain. Focal intramuscular fluid clefts are consistent with a grade 2 strain and may extend to the myofascial boundary, usually anteriorly, resulting in hematoma tracking along the subcutaneous fat plane. Complete transection of the muscle at the musculotendinous junction (grade 3 strain) is rare. Acute tears may also involve the rectus abdominis and are classically seen in tennis players [26], where asymmetric hypertrophy of the rectus abdominis muscle contralateral to the serving arm occurs. However, acute tears are also seen in kicking sports, often contralateral to the preferred kicking leg. This injury most commonly involves the posterior (deeper) fibers of the muscle, and its occurrence at this site is likely due to the relative weakness of the muscle at this point because the anterior fibers are reinforced by the tendinous inscription that extends to the anterior rectus sheath [27]. Because of its superficial nature, the rectus abdominis origin is well depicted with sonography, which has a high sensitivity for the detection of subtle abnormalities, particularly tears and tendinosis [27, 28]. The overlying pyramidalis at the level of the rectus abdominis tendon should not be confused for a mass. Its typical sonographic myofibrillar echotexture and position are diagnostic. Overall, sonography is a useful adjunctive technique [17, 28, 29] in evaluating the groin and may also be used for performing imaging-guided intervention [30], such as autologous blood injection [31] of the common adductor–rectus abdominis origin for the treatment of tendinosis or partial-thickness tears. Both sonography [32] and CT [33] may be used for imaging-guided obturator nerve root block for the treatment of recalcitrant adductor spasm.

The MRI findings of common adductor–rectus abdominis dysfunction closely mirror the sonographic findings discussed previously. Tendinosis is manifest as diffuse increased signal intensity of the common adductor–rectus abdominis tendon, with partial-thickness tears manifesting as focal areas of fluid signal intensity. Although IV gadolinium is rarely used, enhancement after its administration at

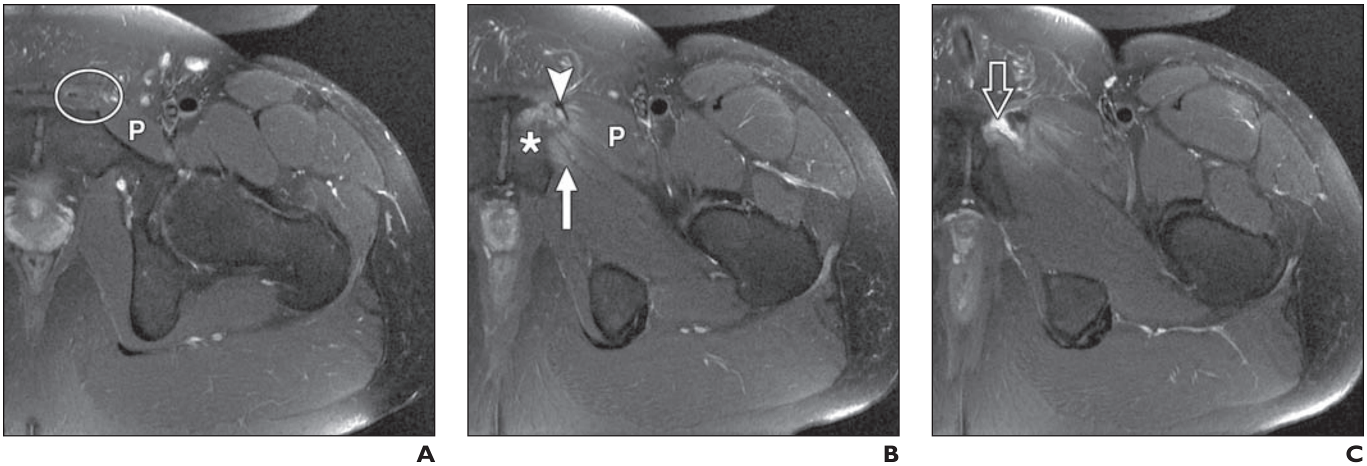



**Fig. 9**—Axial T2-weighted fat-saturated sequences through left groin in 28-year-old male recreational soccer player.
**A,** Image shows subtle edema at lateral head of rectus abdominis muscle (*circle*) consistent with partial strain. P = pectineus.
**B** and **C,** Further distally (**B**), bone marrow edema involves pubic body (*asterisk*, **B**), with partial disruption of medial aspect of origin of pectineus (P) as well as obturator externus (*solid arrow*, **B**) muscles. Hypointense focus medial to pectineus represents common adductor origin complex (*arrowhead*), which is confirmed further distally (**C**) to have avulsed anteriorly from pubis, with fluid undermining its osseous attachment (*open arrow,* **C**).

the proximal enthesis and anterior pubic region correlates strongly with the clinically symptomatic side [34]. If severe enough, an acute injury may result in full-thickness disruption of the adductor longus and secondary retraction of the tendon distally (Fig. 6), resulting in loss of the moustache appearance of the common adductor origin (Fig. 7). Muscle strains (grade 1 or 2) occur most commonly at the anteriorly located musculotendinous junction of the adductor longus; however, strains may also affect other surrounding muscles in isolation, such as the pectineus muscle (Fig. 8). If an episode of trauma is severe enough, multiple muscles may be injured (Fig. 9).

The treatment of common adductor–rectus abdominis dysfunction is usually conservative, initially with a period of rest, followed by progressive strengthening of the common adductor–rectus abdominis muscle axis as well as a program focused on improving core muscle stability. Surgery is rarely used, being reserved for full-thickness tears or in a setting in which conservative measures have failed.

*Osteitis Pubis*

First described in 1923 [35], osteitis pubis is a self-limiting, although often protracted, condition of the pubic symphysis secondary to repetitive microtrauma that induces inflammatory mediated [36] inappropriate osteoclastic activity [37], ultimately resulting in osseous resorption [38]. The hallmark finding on clinical examination is pubic or perineal pain produced on resisted hip adduction. Any abnormality of the hip limiting its range of motion results in increased demands on the pelvis and therefore the symphysis, thus predisposing the athlete to osteitis pubis [39].

**Fig. 10**—Anteroposterior radiograph of pelvis with left leg raised (flamingo view) in 27-year-old female recreational athlete shows widening of pubic symphysis and slight superior migration of left pubic bone when compared with right.

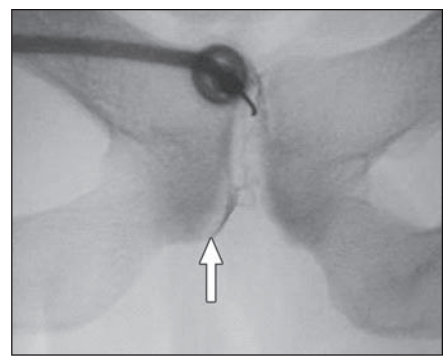
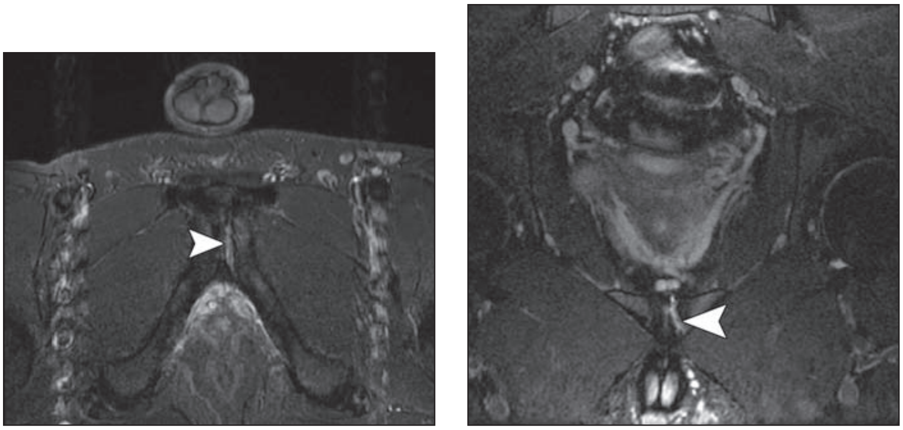


**Fig. 11**—Spot film from fluoroscopically guided injection of pubic symphysis in 23-year-old male soccer player with severe groin pain shows primary central cleft and contrast material extending inferolaterally on right side (*arrow*), away from joint, in keeping with “secondary cleft” sign.

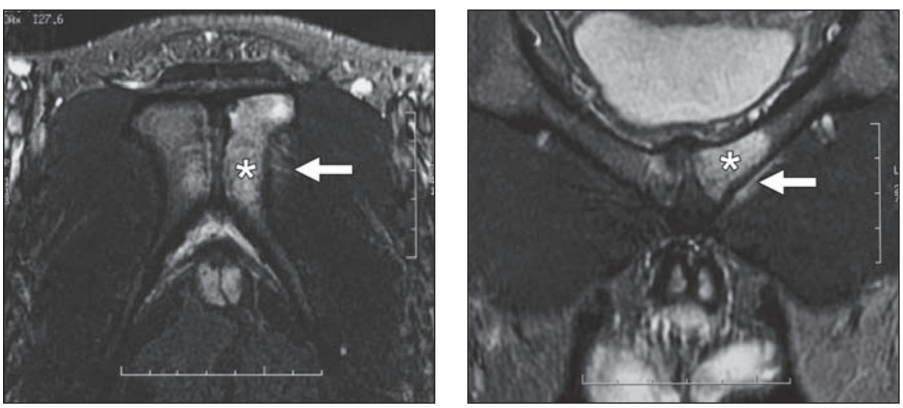
Because the condition must be long-standing and of sufficient severity to be detected radiographically, relying on changes to appear on radiographs in order to diagnose osteitis pubis may result in delay of treatment and is inappropriate in the setting of injury to an elite athlete. Radiographic changes include irregularity of the subchondral bone plate, erosions, fragmentation, and areas of alternating osteopenia and sclerosis. If severe enough, the resorptive process may result in joint space widening (> 7 mm). With time, the symphysis may undergo accelerated degenerative changes, known as premature symphyseal degeneration; however, this condition is usually asymptomatic [33] and seen toward the end of an athlete’s career or after retirement.

Stress radiographs may be performed to detect instability using the flamingo views [15] (Fig. 10). The lower level of the pubic symphysis is a more reliable indicator than the upper level [40] as a reference in the measurement of vertical symphyseal instability. A craniocaudal discrepancy greater than 2 mm of the adjacent inferior pubic margins is diagnostic. Radiologically guided symphyseal cleft injection, or symphyseography, may be performed with either fluoroscopy or CT. Symphyseography is used as a



A B

**Fig. 12**—28-year-old male soccer player with intractable groin pain.
**A** and **B,** Axial (**A**) and coronal (**B**) T2-weighted fat-saturated MR images through groin show fluid (*arrowhead*) in symphysis and extending beyond confines of joint on left side, consistent with "secondary cleft" sign.



A B

**Fig. 13**—18-year-old male football player with pubic bone marrow edema.
**A** and **B,** Axial (**A**) and coronal (**B**) T2-weighted fat-saturated sequences through groin show presence of asymmetric pubic bone marrow edema, left-side predominant (*asterisk*), and edema at origin of left pectineus muscle (*arrow*).

diagnostic procedure akin to diskography; however, symphyseography is also used as a therapeutic procedure. Normal symphyseal cleft injection of contrast material occurs when minimal contrast material is injected, meeting a firm end point of resistance and showing the primary cleft of the symphysis without extravasation beyond the articular margins. Correlation with the patient's symptoms is paramount to determine whether injection of the contrast agent reproduces their pain, because many athletes may present for investigation before any radiographic changes are evident. Extraarticular extravasation of fluid is always abnormal.

The contrast agent usually tracks inferiorly, paralleling the medial contour of the inferior pubic ramus, and undermines the origin of the adductor longus and adductor brevis. Because the contrast extravasation is continuous with the primary cleft of the intraarticular disk, this finding is referred to as the "secondary cleft" sign (Fig. 11) and is indicative of chronic microavulsion injury of the tendon fibers [8, 9, 23] and possibly the inferior pubic ligament [41]. The secondary cleft has a high correlation with the side of reported pain and may also be shown on MRI [41] (Fig. 12). Rarely, although not previously described, the cleft may extend superiorly ("superior secondary cleft"), undermining the origin of rectus abdominis and, if severe enough, the pectineus, usually in continuity with the inferiorly positioned secondary cleft. The CT findings of osteitis pubis mirror the radiographic manifestation but may be detected earlier because of the cross-sectional nature of CT.

Pubic bone marrow edema, the earliest manifestation of osteitis pubis, is superbly shown on MRI as an area of subchondral marrow hyperintensity on fluid-sensitive sequences [42] (Fig. 13). Bone marrow edema is an important finding because it is associated with an increased likelihood of clinically detectable focal pubic tenderness [43], positive provocative clinical tests [44], and preseason training restriction [45]. If osteitis pubis is allowed to progress with ongoing athletic activity, subchondral cysts and erosions characteristic of the resorptive process may occur (Fig. 14). The hypointense subchondral bone plate may become irregular or completely disappear, resulting in symphyseal irregularity, joint widening, and an effusion [33]. Because MRI is performed with the patient at rest, evaluating for secondary signs of instability is important, such as symphyseal disk extrusion and capsular or ligamentous hypertrophy. An elite athlete presenting with symphyseal instability on non-weight-bearing MRI is rare. With repeated impaction, an element of osteolysis may coexist [46–49] and result in superimposed insufficiency fracture formation. Premature degeneration of the pubic symphysis is associated with thickening and hypertrophy of the surrounding joint capsule and ligaments; this finding is most commonly seen superiorly [50] (Fig. 15). The symphyseal joint space decreases (Fig. 16) and eventually ankylosis may occur, with hypointensity of the bone marrow on all pulse sequences consistent with fibrosis and sclerosis. In the adolescent athlete, the presence of bone marrow edema should be interpreted with caution because moderate to severe bone marrow edema may be asymptomatic [51] and related to skeletal

**Fig. 14**—Oblique coronal (tilted gantry) CT image through pubic symphysis of 17-year-old male football player shows changes of subchondral cyst formation, erosions, and ill-defined osseous margins, particularly on right side (*arrowhead*), all compatible with erosive osteitis pubis.

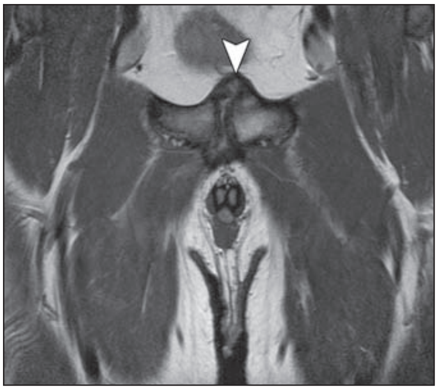


**Fig. 15**—Coronal proton density–weighted image of pubic symphysis in 32-year-old male football player shows osseous spurring and capsular hypertrophy, particularly superiorly (*arrowhead*), consistent with premature symphyseal degeneration.

**Fig. 16**—Oblique axial (tilted gantry) CT image in 35-year-old retired professional football player with chronic groin pain shows subchondral sclerosis, irregularity, and decrease in joint space height, which are compatible with premature symphyseal degeneration.

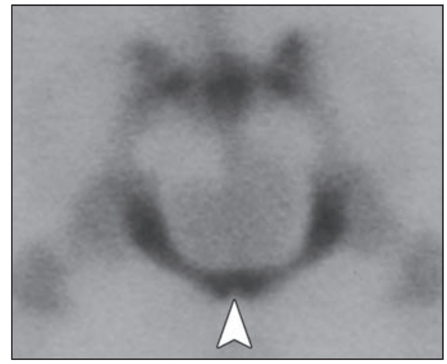


**Fig. 17**—Delayed phase nuclear medicine technetium-99m methylene diphosphonate (MDP) bone scintigraphy (axial view) in 25-year-old male soccer player shows increased uptake on either side of pubic symphysis (*arrowhead*), compatible with osteitis pubis.

maturation. Scintigraphic uptake on $^{99m}$Tc-methylene diphosphonate (MDP) scanning on delayed images is compatible with increased bone turnover and corresponds with areas of bone marrow edema seen on MRI [52] (Fig. 17).

The treatment of osteitis pubis, as for common adductor–rectus abdominis dysfunction, initially involves a trial of rest and rehabilitation. If rehabilitation fails, then corticosteroid injection into the symphysis, using either CT, fluoroscopy, or sonography, is a useful adjunct to conservative treatment [53] in the hope of hastening the convalescence interval [54, 55]. The best success rates are achieved in athletes presenting with acute symptoms (< 2 weeks) as opposed to those in the subacute to chronic phase (> 16 weeks) [54]. However, injection of steroids is contraindicated in the setting of clinical or radiologic suspected instability. IV bisphosphonates [56] may occasionally be used to treat the osteolytic component of the osteitis pubis. Surgery is reserved for severe cases, particularly if instability is present, and includes débridement, trapezoidal wedge resection of the symphysis [35], or arthrodesis.

### *Hernia and Inguinal Wall Deficiency*

Inguinal hernias account for 24–51% of athletes [57, 58] who present with groin pain and, although these hernias are clearly an important cause of athletic groin pain, the imaging findings of hernias are beyond the scope of this review and are discussed elsewhere [59, 60].

Acquired inguinal wall deficiency is an overuse phenomenon occurring in approximately 15% [14] of athletes with groin pain and is, in essence, traumatic attenuation and weakness of the inguinal canal not of sufficient severity to result in discrete hernia formation [61]. Unfortunately, acquired inguinal wall deficiency has been previously known by a myriad of names, such as Gilmore's groin [1], groin disruption [62], pubalgia [63], sportsman's hernia [64, 65], prehernia complex [14], incipient hernia [66], symphysis syndrome [67], and inguinal canal disruption [68]. It is best conceptualized simplistically, involving either the anterior inguinal wall (external oblique muscle and aponeurosis), the posterior inguinal wall (transversus abdominis and internal oblique muscles), or both.

### *Anterior Inguinal Wall Deficiency*

Classically known as the "Gilmore groin" [69], anterior inguinal wall deficiency is the consequence of degeneration and partial tearing of the external oblique aponeurosis, resulting in dehiscence between the inguinal ligament and ultimately causing dilatation of the superficial inguinal ring [70]. Almost all (98%) patients are male [71], with tenderness to physical examination located precisely at the superficial inguinal ring. Pain occurs with increased intraabdominal pressure, kicking, sprinting, and externally rotating the hip to that side. A significant proportion (40%) complain of tenderness in the adductor region that is distinguished from osteitis pubis by the absence of tenderness over the pubic symphysis, ramus, or tubercle, with the pain located lateral to the lateral border of the rectus abdominis. Patients respond to surgical restoration of the inguinal anatomy by open pelvic floor [69], laparoscopic hernia [72], or transabdominal preperitoneal repair [73–76]. The latter two techniques result in a quicker return to competition (2–3 weeks) [77]. When occurring with entrapment of the ilioinguinal nerve, the condition has also been dubbed "hockey groin syndrome" [78]. Entrapment of the terminal branches of the iliohypogastric nerve [79] may also occur. Understandably, because of the very thin fascial nature of the external oblique aponeurosis, imaging findings are rarely seen, with hyperintensity of the superficial inguinal ring, as seen on MRI, the only manifestation (Fig. 18). Therefore, anterior inguinal wall deficiency is a clinical diagnosis and a radiologic diagnosis of exclusion.

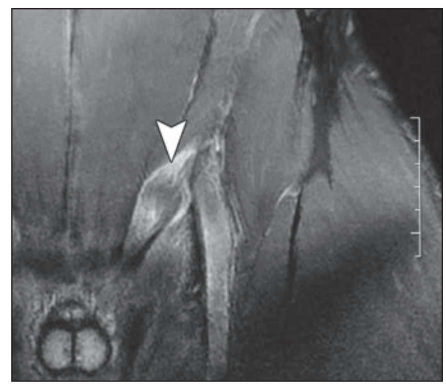


**Fig. 18**—Coronal T2-weighted fat-saturated image through anterior abdominal wall of elite 28-year-old male Australian-rules football player shows area of increased hyperintensity of left external inguinal ring, consistent with traumatic disruption of most medial fibers of external oblique aponeurosis (*arrowhead*) and thus in keeping with acute disruption of anterior inguinal wall.

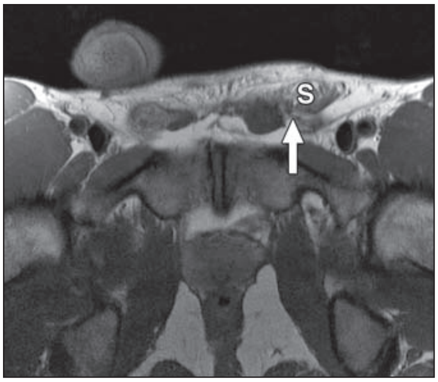



**Fig. 19**—Axial proton density–weighted image in 26-year-old male recreational soccer player with left-sided groin pain shows anterior bulging of posterior inguinal wall on left side (*arrow*), consistent with posterior inguinal wall deficiency. This results in more anteriorly positioned spermatic cord (S) when compared with right side.

### *Posterior Inguinal Wall Deficiency*

Repeated traumatic attenuation of the posterior inguinal wall may result in degeneration and weakness [80] of the transversus abdominis and internal oblique muscles. Split tears beyond the resolution of imaging usually occur medially [81], just lateral to the rectus abdominis muscle and posterior to the superficial inguinal ring. With further injury and inadequate healing, the posterior inguinal wall weakens, resulting in increased mobility, which in turn exerts mass effect on the spermatic cord during straining. This may then result in symptoms and may initially be mistaken for a small hernia. If the weakness of the posterior inguinal wall progresses because of ongoing injury, complete disruption will occur and thus direct inguinal hernia formation with the protrusion of peritoneal contents. Because the posterior inguinal wall attaches onto the anterior sheath of rectus abdominis muscle, posterior inguinal wall deficiency is often seen in association with rectus abdominis abnormalities.

Posterior inguinal wall deficiency is best assessed on dynamic sonography [82]. The athlete is asked to strain with the probe placed over the medial aspect of the inguinal region, initially imaged along the plane of the inguinal canal, and then rescanned 90° to this. The test is positive if abnormal ballooning of the posterior inguinal wall exists, resulting in elevation of the pampiniform plexus of the spermatic cord, and corresponds to the presenting complaint. Asymptomatic incompetence of the wall is common, particularly in young athletes; however, it is eight times more likely to be symptomatic if shown on both sides and with increasing age [82]. Although the posterior inguinal wall may be normal at rest, dynamic MRI shows similar changes as noted sonographically—namely, asymmetric focal protrusion without herniation of the inguinal wall when compared with the contralateral side [83] (Fig. 19). The advantage of MRI is that it allows direct visual comparison of the contralateral side; however, findings should be interpreted with caution because of the possibility of bilateral abnormalities. Treatment is the same as for anterior inguinal wall deficiency.

### *Other Differential Diagnoses*

*Referred pain*—Always remember that groin pain may be referred from other regions, such as compression of upper lumbar nerves, and thus further imaging may be necessary if no local abnormality is shown. Abnormalities arising from the hip may also cause groin pain, such as premature osteoarthritis, stress fractures, femoroacetabular impingement, acetabular labral tears, and intraarticular bodies. Tendinosis and tears of nearby muscles, such as the rectus femoris, sartorius, and tensor fascia lata [84], may present primarily with groin pain. The possibility of an inflammatory arthropathy—particularly a seronegative arthropathy with associated enthesopathy—and less commonly, a focal osseous lesion of the pelvis, must also be considered. For this reason, many athletes with groin pain may present for imaging of the groin and hip. Often direct MR arthrography of the hip is performed, for which a long-acting anesthetic agent such as bupivacaine is injected. The patient is instructed to keep a pain diary to assist the clinician in determining the significance of an MR abnormality of the hip and its possible contribution to groin pain. This is of particular use in the setting when abnormality is detected in both imaged regions.

*Nerve entrapment syndromes*—A plethora of nerves course through the groin region and may be entrapped; these include the ilioinguinal, iliohypogastric, femoral, genitofemoral [85], and obturator [86] nerves. The diagnosis for these conditions is usually based on the clinical findings, with imaging infrequently being used [87].

## Conclusion

The radiologist plays a pivotal role in the assessment of athletes with groin pain because the best outcomes are achieved by adopting a multidisciplinary team approach. It is entirely appropriate that a multitechnique approach is commonly used. The anatomy of the groin consists of a complex array of musculoaponeurotic supporting structures that may be either primarily or secondarily affected as a consequence of pubic bone overload. A knowledge of the anatomic framework of the structures present and familiarity with the imaging manifestations of repetitive microtrauma or a single acute traumatic event allow either an accurate diagnosis to be made or a relevant list of differential diagnoses to be formulated.

## References


1. Gilmore J. Groin pain in the soccer athlete: fact, fiction, and treatment. *Clin Sports Med* 1998; 17:787–793
2. Syme G, Wilson J, Mackenzie K, Macleod D. Groin pain in athletes. *Lancet* 1999; 353:1444
3. Smodlaka VN. Groin pain in soccer players. *Phys Sports Med* 1980; 8:57–61
4. Rizk NN. A new description of the anterior abdominal wall in man and mammals. *J Anat* 1980; 131(Pt 3):373–385
5. Tuite DJ, Finegan PJ, Saliaris AP, Renstrom PA, Donne B, O'Brien M. Anatomy of the proximal musculotendinous junction of the adductor longus muscle. *Knee Surg Sports Traumatol Arthrosc* 1998; 6:134–137
6. Rosenklint A, Andersen RB. Tenosteochondrosis of the pubis. *Acta Rheumatol Scand* 1969; 15: 262–270
7. Adams RJ, Chandler FA. Osteitis pubis of traumatic etiology. *J Bone Joint Surg Am* 1953; 35-A: 685–696
8. Robinson P, Salehi F, Grainger A, et al. Cadaveric and MRI study of the musculotendinous contributions to the capsule of the symphysis pubis. *AJR* 2007; 188:1306; [web]W440–W445
9. Ippolito E, Postacchini F. Rupture and disinsertion of the proximal attachment of the adductor longus tendon: case report with histochemical and ultrastructural study. *Ital J Orthop Traumatol* 1981; 7:79–85
10. Gamble JG, Simmons SC, Freedman M. The symphysis pubis: anatomic and pathologic considerations. *Clin Orthop Relat Res* 1983; 203: 261–272
11. Snijders CJ, Vleeming A, Stoeckart R. Transfer of lumbosacral load to iliac bones and legs. Part I: Biomechanics of self-bracing of the sacroiliac joints and its significance for treatment and exercise. *Clin Biomech* 1993; 8:285–294
12. Cowan SM, Schache AG, Brukner P, et al. Delayed onset of transversus abdominis in long-standing groin pain. *Med Sci Sports Exerc* 2004; 36:2040–2045

13. Condon RE. Reassessment of groin anatomy during the evolution of preperitoneal hernia repair. *Am J Surg* 1996; 172:5–8
14. Gibbon WW. Groin pain in athletes. *Lancet* 1999; 353:1444–1445
15. Walheim GG, Selvik G. Mobility of the pubic symphysis: in vivo measurements with an electromechanic method and a roentgen stereophotogrammetric method. *Clin Orthop Relat Res* 1984; 191:129–135
16. Renstrom P, Peterson L. Groin injuries in athletes. *Br J Sports Med* 1980; 14:30–36
17. Karlsson J, Sward L, Kalebo P, Thomee R. Chronic groin injuries in athletes: recommendations for treatment and rehabilitation. *Sports Med* 1994; 17: 141–148
18. Attarian DE. Isolated acute hip adductor brevis strain. *J South Orthop Assoc* 2000; 9:213–215
19. Riedeberger J, Luschnitz E, Bauchspiess B. The pubic bone-adductor–syndrome in football players [in German]. *Zentralbl Chir* 1967; 92:2656– 2660
20. Morrenhof JW, Fievez AWFM. The adductor syndrome and the functional anatomy of the adductors. *Acta Orthop Scand* 1985; 56:542
21. Wiley JJ. Traumatic osteitis pubis: the gracilis syndrome. *Am J Sports Med* 1983; 11:360–363
22. Emery CA, Meeuwisse WH. Risk factors for groin injuries in hockey. *Med Sci Sports Exerc* 2001; 33:1423–1433
23. Martens MA, Hansen L, Mulier JC. Adductor tendinitis and musculus rectus abdominis tendopathy. *Am J Sports Med* 1987; 15:353–356
24. Cunningham PM, Brenna D, O'Connell M, MacMahon P, O'Neill P, Eustace S. Patterns of bone and soft-tissue injury at the symphysis pubis in soccer players: observations at MRI. *AJR* 2007; 188:864; [web]W291–W296
25. Schneider R, Kaye J, Ghelman B. Adductor avulsive injuries near the symphysis pubis. *Radiology* 1976; 120:567–569
26. Balduini FC. Abdominal and groin injuries in tennis. *Clin Sports Med* 1988; 7:349–357
27. Connell DA, Ali KE, Javid M, Bell P, Batt M, Kemp S. Sonography and MRI of rectus abdominis muscle strain in elite tennis players. *AJR* 2006; 187:1457–1461
28. Kalebo P, Karlsson J, Sward L, Peterson L. Ultrasonography of chronic tendon injuries in the groin. *Am J Sports Med* 1992; 20:634–639
29. Goh LA, Chhem KR, Wang SC, Tho KS. Ultrasonographic features of an adductor longus tear: case report. *Can Assoc Radiol J* 2001; 52:252–254
30. Ashby EC. Chronic obscure groin pain is commonly caused by enthesopathy: 'tennis elbow' of the groin. *Br J Surg* 1994; 81:1632–1634
31. Connell DA, Ali KE, Ahmad M, Lambert S, Corbett S, Curtis M. Ultrasound-guided autologous blood injection for tennis elbow. *Skeletal Radiol* 2006; 35:371–377
32. Fujiwara Y, Sato Y, Kitayama M, Shibata Y, Komatsu T, Hirota K. Obturator nerve block using ultrasound guidance. *Anesth Analg* 2007; 105: 888–889
33. House CV, Ali KE, Bradshaw C, Connell DA. CT-guided obturator nerve root block via the posterior approach. *Skeletal Radiol* 2006; 35:227–232
34. Robinson P, Barron DA, Parsons W, Grainger AJ, Schilders EM, O'Connor PJ. Adductor-related groin pain in athletes: correlation of MR imaging with clinical findings. *Skeletal Radiol* 2004; 33: 451–457
35. Legeu MB, Rochet WL. Les cellulites perivescicales et pelviennes après certaines cystostomies ou prostatectomies sus-pubiennes. *J Urol Med Chir* 1923; 15:1–11
36. Grace JN, Sim FH, Shives TC, Coventry MB. Wedge resection of the symphysis pubis for the treatment of osteitis pubis. *J Bone Joint Surg Am* 1989; 71:358–364
37. McCarthy B, Dorfman HD. Pubic osteolysis: a benign lesion of the pelvis closely mimicking a malignant neoplasm. *Clin Orthop Relat Res* 1990; (251):300–307
38. Levine AH, Pais MJ, Schwartz EE. Posttraumatic osteolysis of the distal clavicle with emphasis on early radiographic changes. *AJR* 1976; 127:781–784
39. Verrall GM, Hamilton IA, Slavotinek JP, et al. Hip joint range of motion reduction in sports-related chronic groin injury diagnosed as pubic bone stress injury. *J Sci Med Sport* 2005; 8:77–84
40. Sequeira W. Diseases of the pubic symphysis. *Semin Arthritis Rheum* 1986; 16:11–21
41. Brennan D, O'Connell MJ, Ryan M, et al. Secondary cleft sign as a marker of injury in athletes with groin pain: MR image appearance and interpretation. *Radiology* 2005; 235:162–167
42. Morelli V, Espinoza L. Groin injuries and groin pain in athletes: part 2. *Prim Care* 2005; 32: 185–200
43. Verrall GM, Slavotinek JP, Fon GT. Incidence of pubic bone marrow oedema in Australian rules football players: relation to groin pain. *Br J Sports Med* 2001; 35:28–33
44. Verrall GM, Slavotinek JP, Barnes PG, Fon GT. Description of pain provocation tests used for the diagnosis of sports-related chronic groin pain: relationship of tests to define clinical (pain and tenderness) and MRI (pubic bone marrow oedema) criteria. *Scand J Med Sci Sports* 2005; 15:36–42
45. Slavotinek JP, Verrall GM, Fon GT, Sage MR. Groin pain in footballers: the association between preseason clinical and pubic bone magnetic resonance imaging findings and athlete outcome. *Am J Sports Med* 2005; 33:894–899
46. Harris NH, Murray RO. Lesions of the symphysis in athletes. *BMJ* 1974; 4:211–214
47. Goergen TG, Resnick D, Riley RR. Post-traumatic abnormalities of the pubic bone simulating malignancy. *Radiology* 1978; 126:85–86
48. Hall FM, Goldberg RP, Kasdon EJ, Glick H. Post-traumatic osteolysis of the pubic bone simulating a malignant lesion. *J Bone Joint Surg Am* 1984; 66:121–126
49. McGuigan LE, Edmonds JP, Painter DM. Pubic osteolysis. *J Bone Joint Surg Am* 1984; 66:127– 129
50. Ekberg O, Kesek P, Besjakov J. Herniography and magnetic resonance imaging in athletes with chronic groin pain. *Sports Med Arthroscop Rev* 1997; 5:274–279
51. Lovell G, Galloway H, Hopkins W, Harvey A. Osteitis pubis and assessment of bone marrow edema at the pubic symphysis with MRI in an elite junior man soccer squad. *Clin J Sport Med* 2006; 16: 117–122
52. Briggs RC, Kolbjornsen PH, Southall RC. Osteitis pubis, Tc-99m MDP and professional hockey players. *Clin Nucl Med* 1992; 17:861–863
53. O'Connell MJ, Powell T, McCaffrey NM, O'Connell D, Eustace SJ. Symphyseal cleft injection in the diagnosis and treatment of osteitis pubis in athletes. *AJR* 2002; 179:955–959
54. Koch RA, Jackson DW. Pubic symphysitis in runners: a report of two cases. *Am J Sports Med* 1981; 9:62–63
55. Holt MA, Keene JS, Graf BK, Helwig DC. Treatment of osteitis pubis in athletes: results of corticosteroid injections. *Am J Sports Med* 1995; 23: 601–606
56. Maksymowych WP, Aaron SL, Russell AS. Treatment of refractory symphysitis pubis with intravenous pamidronate. *J Rheumatol* 2001; 28:2754–2757
57. Cohen RH, Turkenburg JL, van Dalen A. Herniography in 79 patients with unexplained pain in the groin: a retrospective study. *Eur J Radiol* 1990; 11:184–187
58. Smedberg SG, Broome AE, Elmer O, Gullmo A. Herniography in the diagnosis of obscure groin pain. *Acta Chir Scand* 1985; 151:663–667
59. Shadbolt CL, Heinze SB, Dietrich RB. Imaging of groin masses: inguinal anatomy and pathologic conditions revisited. *RadioGraphics* 200l; 21[spec no]:S261–S271
60. Jamadar DA, Jacobson JA, Morag Y, et al. Sonography of inguinal region hernias. *AJR* 2006; 187:185–190
61. Smedberg SG, Broome AE, Gullmo A, Roos H. Herniography in athletes with groin pain. *Am J Surg* 1985; 149:378–382
62. Urquhart DA, Packer GJ, McLatchie GR. Return to sport and patient satisfaction levels after surgical treatment for groin disruption. *Sports Exercise and Injury* 1996; 2:37–42
63. Taylor DC, Meyers WC, Moylan JA, Lohnes J,

Bassett FH, Garrett WE Jr. Abdominal musculature abnormalities as a cause of groin pain in athletes: inguinal hernias and pubalgia. *Am J Sports Med* 1991; 19:239–242
64. Hackney RG. The sports hernia: a cause of chronic groin pain. *Br J Sports Med* 1993; 27:58–62
65. Malycha P, Lovell G. Inguinal surgery in athletes with chronic groin pain: the ‘sportsman's’ hernia. *Aust N Z J Surg* 1992; 62:123–125
66. Lovell G. The diagnosis of chronic groin pain in athletes: a review of 189 cases. *Aust J Sci Med Sport* 1995; 27:76–79
67. Biedert RM, Warnke K, Meyer S. Symphysis syndrome in athletes: surgical treatment for chronic lower abdominal, groin, and adductor pain in athletes. *Clin J Sport Med* 2003; 13:278–284
68. MacLeod DA, Gibbon WW. The sportsman's groin. *Br J Surg* 1999; 86:849–850
69. Gilmore OJA. Gilmore's groin: a ten years experience of groin disruption. *Sports Med Soft Tissue Trauma* 1991; 3:5–7
70. Kumar A, Doran J, Batt ME, Nguyen-Van-Tam JS, Beckingham IJ. Results of inguinal canal repair in athletes with sports hernia. *J R Coll Surg Edinb* 2002; 47:561–565
71. MacLeod DA. The sportsman's groin (commentary). *Br J Surg* 1999; 86:1478
72. Ingoldby CJ. Laparoscopic and conventional repair of groin disruption in sportsmen. *Br J Surg* 1997; 84:213–215
73. Evans DS. Hunterian lecture. Laparoscopic transabdominal pre-peritoneal (transabdominal preperitoneal) repair of groin hernia: one surgeon's experience of a developing technique. *Ann R Coll Surg Engl* 2002; 84:393–398
74. Schuricht A, Haut E, Wetzler M. Surgical options in the treatment of sports hernia. *Operative Techniques in Sports Medicine* 2002; 10:224–227
75. Meyers WC, Foley DP, Garrett WE, Lohnes JH, Mandlebaum BR. Management of severe lower abdominal or inguinal pain in high-performance athletes. PAIN (Performing Athletes with Abdominal or Inguinal Neuromuscular Pain Study Group). *Am J Sports Med* 2000; 28:2–8
76. Diaco JF, Diaco DS, Lockhart L. Sports hernia. *Operative Techniques in Sports Medicine* 2005; 13:68–70
77. Genitsaris M, Goulimaris I, Sikas N. Laparoscopic repair of groin pain in athletes. *Am J Sports Med* 2004; 32:1238–1242
78. Irshad K, Feldman LS, Lavoie C, Lacroix VJ, Mulder DS, Brown RA. Operative management of “hockey groin syndrome”: 12 years of experience in National Hockey League players. *Surgery* 2001; 130:759–764
79. Ziprin P, Williams P, Foster ME. External oblique aponeurosis nerve entrapment as a cause of groin pain in the athlete. *Br J Surg* 1999; 86:566–568
80. Lovell G, Malycha P, Pieterse S. Biopsy of the conjoint tendon in athletes with chronic groin pain. *Aus J Sci Med Sport* 1990; 22:102–103
81. Polglase AL, Frydman GM, Farmer KC. Inguinal surgery for debilitating chronic groin pain in athletes. *Med J Aust* 1991; 155:674–677
82. Orchard JW, Read JW, Neophyton J, Garlick D. Groin pain associated with ultrasound finding of inguinal canal posterior wall deficiency in Australian Rules footballers. *Br J Sports Med* 1998; 32: 134–139
83. Albers SL, Spritzer CE, Garrett WE Jr, Meyers WC. MR findings in athletes with pubalgia. *Skeletal Radiol* 2001; 30:270–277
84. Bass CJ, Connell DA. Sonographic findings of tensor fascia lata tendinopathy: another cause of anterior groin pain. *Skeletal Radiol* 2002; 31:143– 148
85. Harvey G, Bell S. Obturator neuropathy: an anatomic perspective. *Clin Orthop Relat Res* 1999; 363:203–211
86. Akita K, Niga S, Yamato Y, Muneta T, Sato T. Anatomic basis of chronic groin pain with special reference to sports hernia. *Surg Radiol Anat* 1999; 21:1–5
87. Bradshaw C, McCrory P. Obturator nerve entrapment. *Clin J Sport Med* 1997; 7:217–219

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