19 Management of Abdominal Wall Hernias, Sports Hernias, and Athletic Pubalgia

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Groin injuries are a common occurrence in sport, especially in elite-level athletes. Most of these injuries are muscular strains that resolve completely with standard conservative management measures. However, some groin injuries result in a significant loss of playing time and can be a source of persistent pain that limits performance. Over the last 20 years, a subset of athletes with chronic, unremitting groin pain known commonly as "sports hernia" has become increasingly recognized. These injuries present challenging diagnostic and therapeutic management problems for athletic trainers and physicians because of the broad range of diagnostic possibilities, the subtle physical exam findings, and the anatomic complexity of the lower abdominal and groin region. In this chapter, the clinical presentation, diagnostic evaluation, and treatment options for athletes with a possible sports hernia will be reviewed. The differential diagnosis of athletic groin pain will also be discussed since surgeons who treat these athletes must understand the spectrum of injuries in order to make an accurate diagnosis.

Background and Epidemiology

Athletes who play certain sports, such as ice hockey, football, soccer, and baseball are especially vulnerable to groin injury because of the rapid acceleration/deceleration movements and repetitive twisting and turning motions carried out at high speeds. The reported incidence of groin injuries varies by sport and level of play: ranging from 5 to 28% in soccer players [1–3] and 6 to 15% of ice hockey players [4, 5]. In one study, groin injuries accounted for 10–43% of all muscle injuries in elite Scandinavian league hockey players [6, 7]. Another review found that 5–9% of hip/groin injuries were found in high school athletes, compared to 3–11% in Olympic-level athletes and 10–18% in professional soccer players [8]. Though an increasing number of female patients are being diagnosed with sports hernias, the vast majority of patients are male [9]. Unlike most other sports injuries, athletic groin injuries are soft tissue in nature and do not result from direct physical contact.

Risk factors for groin injury have been examined by several groups. Emery and colleagues [10] analyzed injury reports from six NHL seasons from 1991 to 1992 through 1996–1997 involving 7050 players with a subset analysis of the 1995/1996 and 1996/1997 seasons. Six hundred seventeen injuries were reported for an injury rate of 13.3–19 abdominal and groin injuries per 100 players. Not surprisingly, injuries were more common during training camp and early in the season. One-fourth of injuries were abdominal muscle strains, and 56% of reinjuries occurred in same season. The median time lost was seven practice or game sessions (range 0–180), and time loss was greater with abdominal injuries (median 10.6 sessions) than adductor injuries (median 6.6 sessions). Their group subsequently carried out a prospective study of National Hockey League (NHL) players over the 1998–1999 NHL training camp and regular season. Risk factors associated with an increased risk of injury were (1) <18 sports-specific training sessions (e.g., on ice) in the off-season (RR3.4), (2) history of previous groin or abdominal strain (RR 2.9), and (3) veteran player status (veteran > rookie) (RR 5.7) [11].

Reduced adductor strength relative to abductor strength was also found to be associated with a higher rate of groin injury in one study of NHL hockey players [12]. Tyler et al. prospectively study hip strength and flexibility in one NHL

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team and found that players whose preseason adductor strength was <80% of abductor strength were 17 times more likely to sustain an adductor strain. Perhaps more importantly, they showed that an adductor strengthening program reduced the incidence of groin injury from 3.2/1000 to 0.7/1000 player game exposures.

Differential Diagnosis

The causes of groin pain in athletes are numerous and most commonly include muscular strains of the adductors, lower abdominals, and hip flexors. In addition to sports hernia, other conditions that can cause groin pain are osteitis pubis, stress fractures, hip and pelvis injuries, inguinal hernia, and various non-musculoskeletal-related conditions including intra-abdominal pathology. In one recent review, the five most common surgical causes of groin pain in athletes were femoroacetabular impingement, sports hernia/athletic pubalgia, adductor-related pathology, inguinal-related pathology, and labral pathology [8]. A detailed discussion of the clinical presentation and management of these various entities can be found in recent reviews on this subject [13–19].

Stress Fractures: Stress fractures of the pelvis and hip typically are associated with extreme athletic endurance activities such as with long-distance runners and military recruits. The mechanism is thought to be due to the bone breaking down faster than it can remodel and is related to overuse. Women at risk for osteoporosis may be especially vulnerable. Associated factors may include a change in training duration or intensity and change in foot gear or training surface. The most common sites in the groin region are the inferior pubic ramus and femoral neck. An unrecognized stress fracture of the hip can lead to avascular necrosis; therefore, early diagnosis and treatment are essential. Plain X-rays may not reveal a fracture, and as a result, MRI is indicated in suspected cases. Pubic ramus fractures should be treated by rest and other conservative measures and usually resolve within 4–6 weeks. Femoral neck fractures may require orthopedic fixation.

Osteitis Pubis: Osteitis pubis is a condition of unknown etiology that is most likely due to overuse/repetitive trauma and abnormal biomechanics of the pubis. It is most common in runners and soccer players but can also occur in swimmers, soccer, and hockey players. The clinical presentation consists of midline pubic symphysis pain that may be referred to adjacent areas including the adductor region. In one series, 80% had adductor pain, 30% abdominal pain, and 12% hip pain [20]. Radiographic findings in osteitis pubis may include widening of the symphysis, sclerosis along the pubic rami, and edema on MRI. Bone scans typically show increased uptake on both sides of the pubic symphysis (Fig. 19.1). Treatment consists of a reduction in activity, pelvic stretching (especially of adductors), anti-inflammatory medications, and, for acute or refractory cases, a corticosteroid injection into the symphysis. The time frame for return to sport is unpredictable but may take several months in some cases.

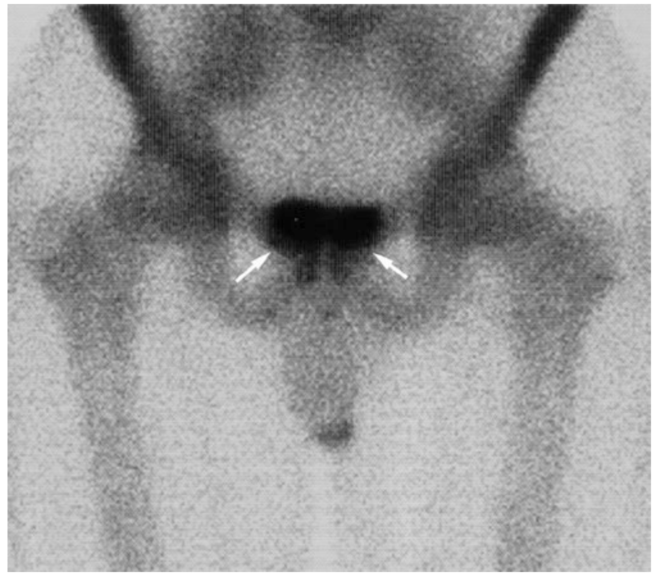

Fig. 19.1 Bone scan that shows increased uptake in both pubic rami (*arrows*) in an athlete with osteitis pubis

Adductor Muscle Group Strains: The adductor group is the most frequent site of sports groin injury and most commonly involves the adductor longus. In one series, adductor longus injuries accounted for 62% of sports groin injuries [1]. A history of a sudden injury and even a pop in the groin are not uncommon. The mechanism involves an eccentric force on the muscle (i.e., sudden stretching when the muscle is contracted). Symptoms and findings are medial thigh or groin pain with associated pain with passive or resisted adduction movements. In acute complete tears, there may be medial thigh ecchymosis and even a palpable defect. Most adductors injuries are strains and not complete tears of the tendon from its attachment to the pubis (Fig. 19.2). In chronic cases, these injuries may overlap or coexist in their clinical presentation with sports hernia and osteitis pubis. Imaging with MRI is indicated to define the extent of the injury in severe cases or those that do not resolve with conservative management. Treatment may vary according to the location and chronicity of the injury but initially should consist of rest, ice, and compression. Once symptoms subside, management should consist of progressive range of motion exercises followed by balance training/graduated strengthening and finally sports-specific functional activities. Time to return to play may vary from a few days to several weeks depending on the severity of the injury. However, some athletes have been able to return to play from even complete adductor longus tears within 5–6 weeks of injury [21].

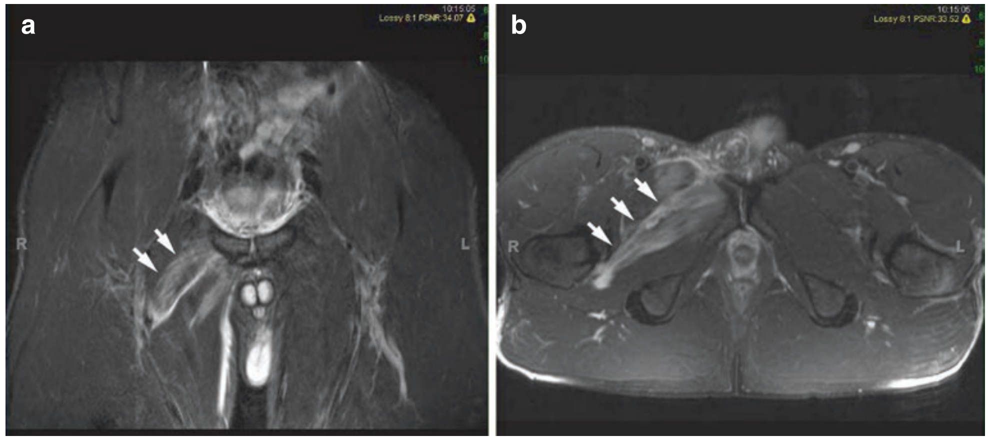

Fig. 19.2 MRI that shows extensive contusion that involves right adductor muscle group. Note the edema (bright appearance) throughout the muscle belly and feathery appearance indicating hemorrhage into the muscle planes. (**a**) STIR (short T1 inversion recovery) coronal sequences and (**b**) T2 fat-suppressed sequence

Iliopsoas Strain: Muscular strains of the iliopsoas present with deep groin or hip pain that is aggravated by hip flexion. The mechanism of injury is often from a hit the player sustains when the leg is extended, a common occurrence in soccer players. Symptoms consist of pain with resisted hip flexion [15], pain with passive hip extension, and a snapping sensation in the hip. Treatment consists of nonsteroidal anti-inflammatories, rest, stretching, and strengthening exercises. A corticosteroid injection may be considered for recalcitrant cases.

Hip Injuries: Hip injuries may also be a source of groin pain in athletes. These may include labral tears, femoral acetabular impingement, and femoral neck fractures. Symptoms may overlap or coexist with sports hernia-type pubalgia injuries. Labral tears present with pain in the hip or groin and mechanical symptoms such as a locking or catching sensation. Treatment is often arthroscopic debridement. Femoral acetabular impingement is a condition in which the femoral head and acetabulum rub abnormally and the resultant excessive friction may lead to cartilage damage, labral tears, and early hip arthritis. Stress fractures of the femoral neck should also be considered in the differential diagnosis and may lead to avascular necrosis if unrecognized. Exclusion of hip pathology first requires examination by an experienced orthopedist. Plain hip X-rays are useful, but hip MRI is necessary to identify labral tears.

Athletic groin injuries should be managed initially with standard conservative management techniques. The vast majority of these injuries resolve and do not evolve into a sports hernia or chronic pubalgia. However, injuries that persist more than 3 months without significant improvement are associated with an increased likelihood of requiring surgical intervention. Ekstrand [22] carried out a prospective, randomized trial in soccer players with chronic groin pain of more than 3 months duration. Players were randomized into four groups—controls with no treatment, two different physical therapy groups, and a surgically treated group who underwent inguinal floor repair ± inguinal and iliohypogastric neurectomy. Only the surgically treated group showed substantial and statistically significant improvement over the 6 months of the study. In another prospective trial, Paajanen and colleagues randomized 60 athletes with 3–6 months of chronic exertional groin pain to either continued physical therapy or surgical treatment using a laparoscopic mesh repair [23]. After 3 months, 90% of the surgically treated athletes had returned to sport compared to only 27% in the conservatively treated group, and by 12 months, the return to sport rate was 97% vs 50%. Moreover, seven patients in the physical therapy group crossed over to surgery after 6 months. These studies provide strong support for the rationale for surgical management in appropriately selected athletes.

Diagnostic Evaluation

Terminology

Various terms have been used to refer to athletic injuries to the lower abdominal/inguinal region that result in a syndrome of chronic exertional pain. These include "sports hernia," athletic pubalgia [24], abdominal core injury, posterior abdominal wall deficiency [25, 26], Gilmore's groin [27, 28], and hockey groin syndrome [29]. The term sports hernia is potentially misleading because it implies the presence of a conventional hernia which is not the case. More recently, a consensus conference meeting held by the British Hernia Society advocated the term "inguinal disruption" [30], and a second Delphi process expert consensus meeting in Doha, Qatar, recommended the following terminology, inguinal-related groin pain, adductor-related groin pain, iliopsoas-related groin pain, hip-related groin pain, and other anatomic causes of groin pain (neurologic, gynecologic, urologic, etc.,), to better describe the anatomic origins of the pain [31]. To date, these terms have not yet become ingrained in clinical usage, and, therefore, the broader term athletic pubalgia is more commonly used to describe this group of clinical entities. As will be discussed below, the pathophysiology is more complex than a simple hernia, and therefore, the term sports hernia is not a precisely accurate description of this condition. Nonetheless, "sports hernia" is firmly ingrained in the athletic community and sports media and will likely continue to be used in everyday practice.

Clinical Presentation

The classic symptoms in athletes with athletic pubalgia-type injury are pain that is localized to the lower abdominal and inguinal region that occurs during the extremes of exertion, such as with the initial propulsive movements of running, skating, and sudden stops, starts, or cutting movements. Ice hockey players may have pain when shooting the puck and soccer athletes with kicking the soccer ball. Other sports commonly associated with sports pubalgia include middle-distance running, lacrosse, football, rugby, cricket, and Australian rules football; swimming, cycling, and boxing have also associated with this condition but less commonly so [32]. The onset is often insidious without a specific precipitating event, and there may be associated adductor symptoms. One or both sides of the groin may be involved.

A challenge in evaluating and managing groin pain in athletes is that the clinical presentation may vary substantially and may not be limited to distal rectus and inguinal floor pathology. Meyers [33] has described 17 different clinical syndromes that involve non-hip soft tissue structures that can be primary causes of athletic groin pain. These most commonly include variations of injuries to the rectus abdominis, adductor muscle groups, or a combination thereof. Less common variants include severe osteitis variant, baseball pitcher/hockey goalie syndrome in which there is a tear of the adductor and adductor muscle belly, iliopsoas variant, and rectus femoris variant. Because of the potential coexistence of more than one site of injury and overlap of symptoms with hip and other pathology, it is important that such athletes undergo careful examination by a sports orthopedist prior to referral to a hernia surgeon to exclude a source of pain from the hip and other sources. In addition, an appropriate trial of conservative management and physical therapy should first be undertaken with rare exception.

Evaluation of the athlete with a chronic groin injury should include a detailed history regarding the injury. Questions that should be asked include precise location of pain, duration, onset, involvement of thigh or hip, activities that worsen the pain, presence with sneezing or coughing, and whether pain occurs only with activity or also with rest. The level of sport activity and intensity of participation should also be determined, as many groin injuries, especially in noncollegiate or professional athletes, are related to overuse. Patients should also be queried regarding what conservative management steps such as icing, anti-inflammatory medications, and physical therapy that have been undertaken before evaluation.

Physical exam findings are a critical component of the assessment and must include evaluation of the inguinal floor, pubis, rectus abdominis, adductors and hip flexors, and hip and should include muscle-specific resistance maneuvers to identify areas of pain and tenderness. In the classic sports hernia pubalgia syndrome, the most consistent findings are tenderness in the medial portion of the inguinal canal or along the distal rectus abdominis muscle. Other findings that may be present include a dilated external inguinal ring, a palpable gap or defect over the external oblique aponeurosis and inguinal floor, and pain with a resisted sit-up or resisted trunk rotation (Fig. 19.3). Pain with resisted adduction and adductor tightness may be present, especially if there is an adductor component to the injury which is frequently the case. A true inguinal hernia is rarely present, and there is typically no clinically evident hernia bulge. In our series of athletes in whom this diagnosis was made, the most common exam findings preoperatively were a weak inguinal floor (90.7%), tenderness over the medial inguinal floor/lower lateral rectus (80.2%), pain with a resisted sit-up (63.8%) or trunk rotation (73.3%), and pain with resisted adduction (56.7%) [34].

Imaging

Imaging tests are important to exclude other pathology and to help substantiate the diagnosis. Plain X-rays are usually normal but should be done if hip pathology or stress fracture is suspected. A bone scan may be ordered to rule out

Fig. 19.3 Exam for athletic pubalgia with palpation of both inguinal floors during a sit-up

osteitis pubis but is less commonly utilized than other imaging modalities. Pelvic MRI has been the most useful modality in our experience because of the details of the bony pelvis and associated muscular tears and strains it provides. Pelvic MRI was also the preferred method of imaging in patients with suspected athletic pubalgia in the British Hernia Society consensus statement released in 2014 [30]. In the athletes with a sports pubalgia seen at our center, the most common MRI findings have been edema or stress reaction and secondary cleft sign in the adjacent pubis (Fig. 19.4). Tears of the distal rectus or rectus/adductor complex may also be seen in some cases (Fig. 19.5). Adductor pathology may include tears and/or edema indicating underlying chronic tendinopathy (Fig. 19.6). Zoga and colleagues [35] recently reported results of MR imaging in 141 patients in whom athletic pubalgia was diagnosed clinically. The most common findings were rectus abdominis tendon injury, combined rectus and adductor

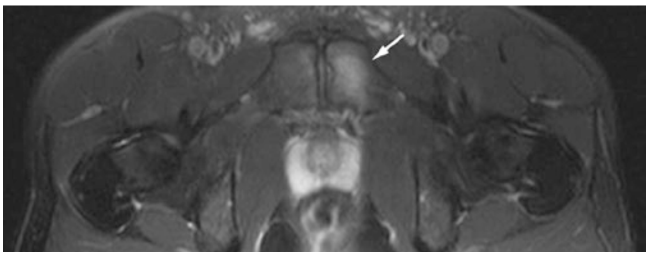

Fig. 19.4 T2 fat-suppressed MRI sequence that shows marrow edema (*arrows*) in the pubis in an athlete with sports pubalgia

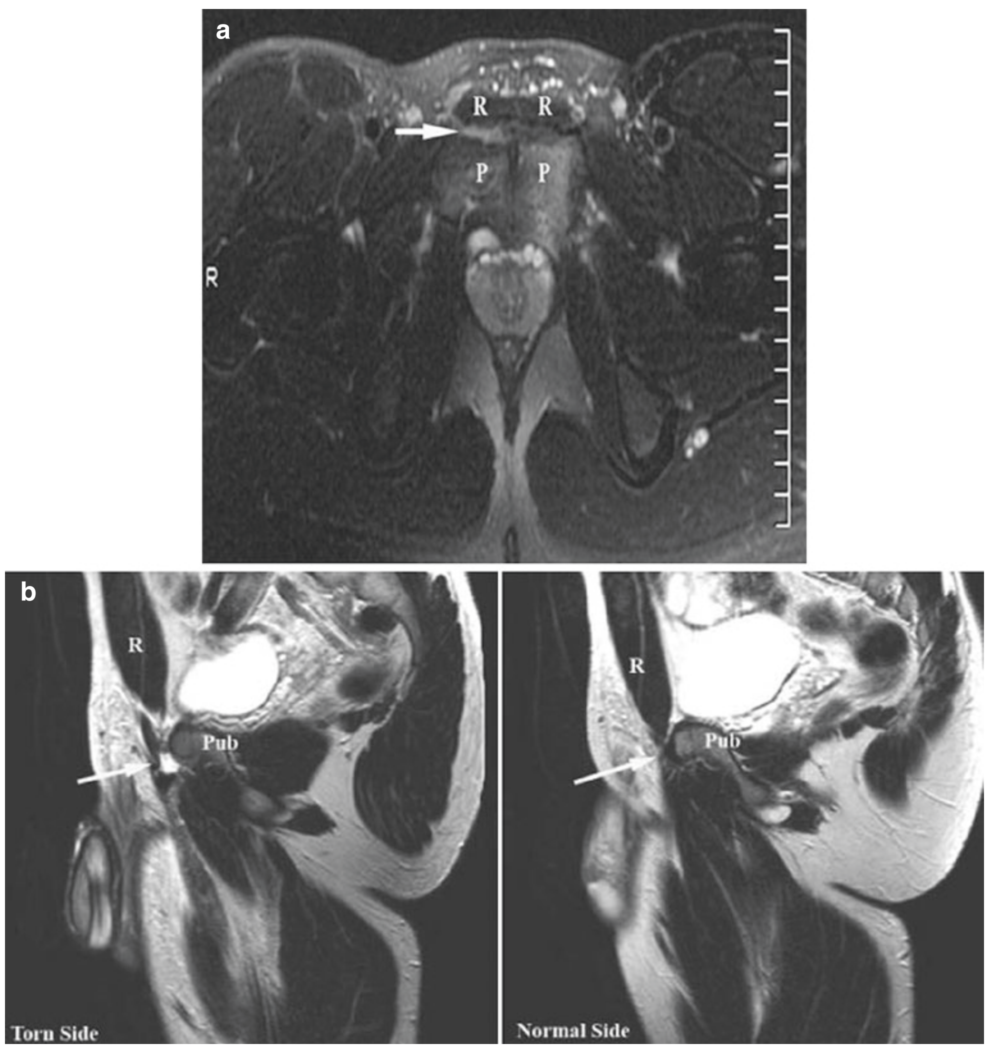

Fig. 19.5 (**a**) T2 fat-suppressed MRI of right distal rectus tear (*arrow* pointing to bright fluid in cleft where rectus is torn); *R* = rectus, *P* = pubis. (**b**) Sagittal fat-suppressed sequence that shows distal rectus tear with discontinuity (*left hand panel*) and normal contralateral side (*right hand panel*). The arrow on the left panel points to the tear (appears bright on this sequence) and to the normal rectus insertion on the right panel. *R* = rectus, *Pub* = pubis

Fig. 19.6 MRI of high-grade left adductor tendon avulsion (*arrows*)

injury, symphysis marrow edema, and a secondary cleft. The secondary cleft sign refers to an abnormal extension of the central symphyseal cleft at the anterior-inferior margin of the body of the pubis. It is thought to result from a microtear at the origin of the adductor longus and gracilis tendons [36].

Improved MRI imaging techniques have resulted in positive findings in a higher percentage of patients in recent years. Zoga [35] reported that MRI had a sensitive of 68% and specificity of 100% for rectus abdominis tendon injury and 86% and 89% sensitivity and specificity, respectively, for adductor tendon injury. MRI techniques for sports pubalgia should center the imaging volume on the pelvis which is facilitated by use of a phase array pelvic surface coil [36]. Both fat-suppressed T1-weighted and fat-suppressed fluid-sensitive imaging sequences should be included. Imaging should be carried out in three orthogonal planes (coronal, axial, and sagittal); additionally, axial/oblique sequences may be useful for better delineating adductor tendon origins [36].

Although not as commonly employed in North America, some groups have utilized ultrasound in the evaluation of athletic groin pain [37, 38]. Ultrasound has the advantage of real-time dynamic assessment of the inguinal floor and abdominal wall and can be used in conjunction with patient Valsalva maneuvers. The disadvantages are that it is operator-dependent and, therefore, requires an experienced examiner and does not readily visualize the other bony and muscular structures around the pubis and pelvis. Muschawek and Berger [38] preferentially utilize ultrasound as the primary imaging modality in athletes with groin pain. A high-frequency transducer (5–13 MHz) is used, and the motion of the inguinal canal and floor is observed with the patient supine during a stress maneuver (Valsalva). Positive findings consist of a convex anterior bulge of the posterior inguinal floor during Valsalva.

Pathophysiology

Several mechanisms have been proposed to account for the pain symptoms in athletic pubalgia syndromes. As discussed above, Meyers has proposed the concept of the “pubic joint” in which the pubis acts as the central fulcrum for the powerful abdominal and thigh muscles [39, 40]. Normally these muscles are symmetrically distributed. In athletes, especially those performing at high levels, tremendous torque is generated across the pelvis. If an imbalance in these forces is present, for example, from relative weakness of one or more muscle groups, then further weakening may develop leading to increased stress across the pubis and chronic pubalgia pain. The pain may result due to weakening of the rectus muscle at the pubic insertion site, which in turn results in unopposed action of the adductor longus [39] and increased pressure within the adductor compartment. Cadaver dissections have also shown that the anterior edge of the inferior pubis has fine, teeth-like projections that contact the adductor muscles and tendons, which may contribute to adductor compartment pain. The approach to repair as described below, therefore, is tailored to address these biomechanical considerations.

A second potential mechanism for athletic pubalgia involves weakening in the posterior floor of the inguinal canal. The weak posterior floor can result from an imbalance in forces between the relatively stronger hip musculature and the weaker lower abdominals [41, 42]. The weak posterior inguinal floor can lead to widening of the groin canal which in turn allows the rectus muscle to retract medially and superiorly [43]. The increased tension at the pubic bone that results causes pain at the symphysis or one or both sides of the pubis. Muschawek has theorized that compression or entrapment of the genital branch of the genitofemoral nerve by a discrete, localized bulge in the posterior wall of the inguinal canal during Valsalva maneuver is involved in the pain pathway in some athletes (Fig. 19.7). This concept has led to selective resection of the genital nerve in some athletes in her series.

Finally, the Montreal group [29, 44] has postulated that tears in the aponeurosis of the external oblique coupled with entrapment of branches of the ilioinguinal or iliohypogastric nerves are the central pathophysiologic mecha-

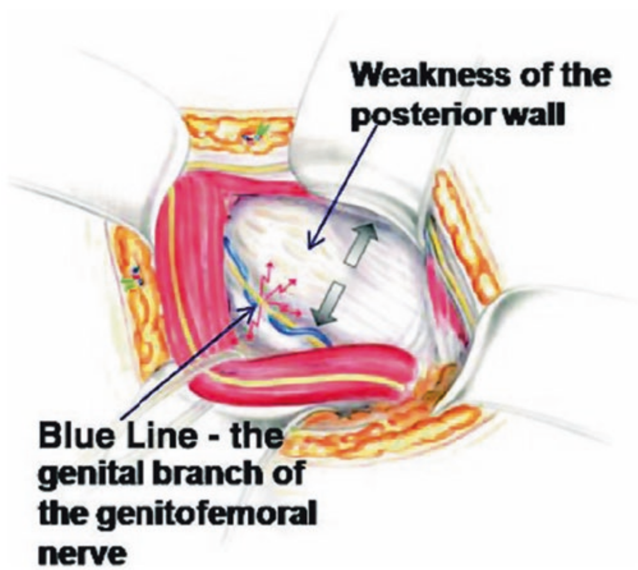

Fig. 19.7 Schematic illustration of localized bulge in posterior inguinal floor with compression of the genital branch of the genitofemoral nerve. From Muschawek U, Berger L. Sports Health (2010); 2; p. 217 (with permission)

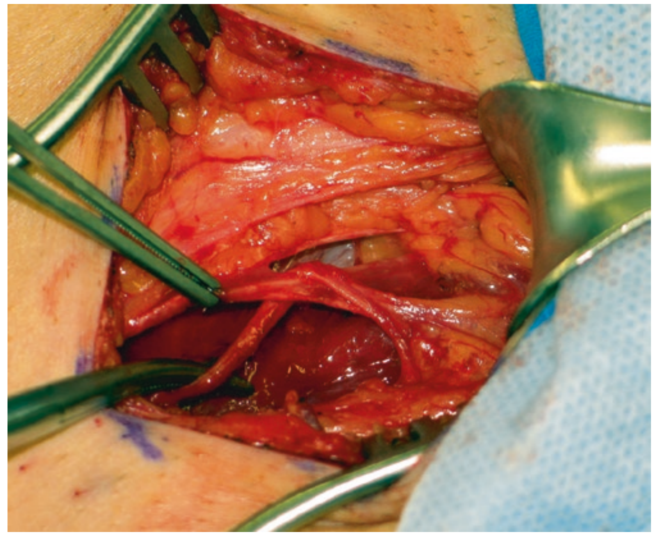

Fig. 19.8 Ilioinguinal nerve exiting through a tear in the external oblique aponeurosis medial to the external ring. Note the acute angle the nerve takes as it exits the aponeurosis, which may be a source of tension on the nerve and resultant pain

nism for athletic pubalgia pain. The external oblique tears may be central, medial, or lateral and single or multiple and may arise from increased intra-abdominal pressure during Valsalva that occur during sudden changes in movement or intense abdominal contraction such as what occurs in pushing against an opponent. A bulky internal oblique has also been a common operative finding and may limit space in the inguinal canal, thereby applying outward pressure on the external oblique that may ultimately lead to a tear. Tension on one or more of nerves as they exit the external oblique may sometimes be observed at operation (Fig. 19.8).

A number of findings have been described at operation that reflect the above mechanisms. These include an attenuated external oblique aponeurosis, disruption or weakness of the posterior inguinal floor, a thin or torn rectus insertion, and, importantly, absence of an inguinal hernia [7]. Other findings that have been reported include a torn or hypertrophied internal oblique [29], entrapment of the ilioinguinal or iliohypogastric nerves within a torn external oblique aponeurosis with a normal posterior inguinal floor [13, 29], and compression of the genital nerve by localized bulging of the posterior inguinal floor. The most common operative findings in our athletes have been an attenuated external oblique aponeurosis (96.7%) (Fig. 19.9), weakened or disrupted inguinal floor (100%) (Fig. 19.10), and lower rectus abnormality in 80.3% (lax insertion, muscular tears) [34]. There was only one indirect hernia identified (1.6%). Clinically insignificant cord lipomas were removed in 18%.

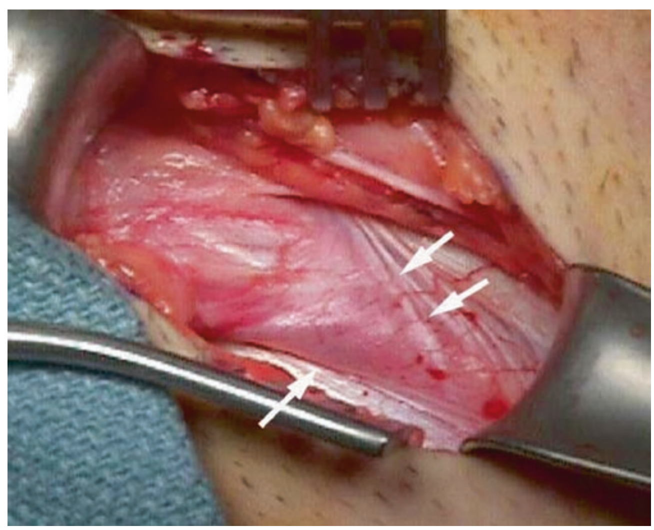

Fig. 19.9 Operative photograph showing marked attenuation in the external oblique aponeurosis

Regardless of the precise pathophysiologic mechanism of groin pain, it would appear that the central variable common to these injuries is stress across the lower abdominal wall that leads to weakening in the posterior inguinal floor or distal rectus tears or both. Whether nerve entrapment is a significant component or not is an unresolved issue, as many groups have reported successful outcomes of surgical repair without nerve resection. Factors that may contribute to the increasing incidence of these injuries include increased weight and strength training, year-round training without

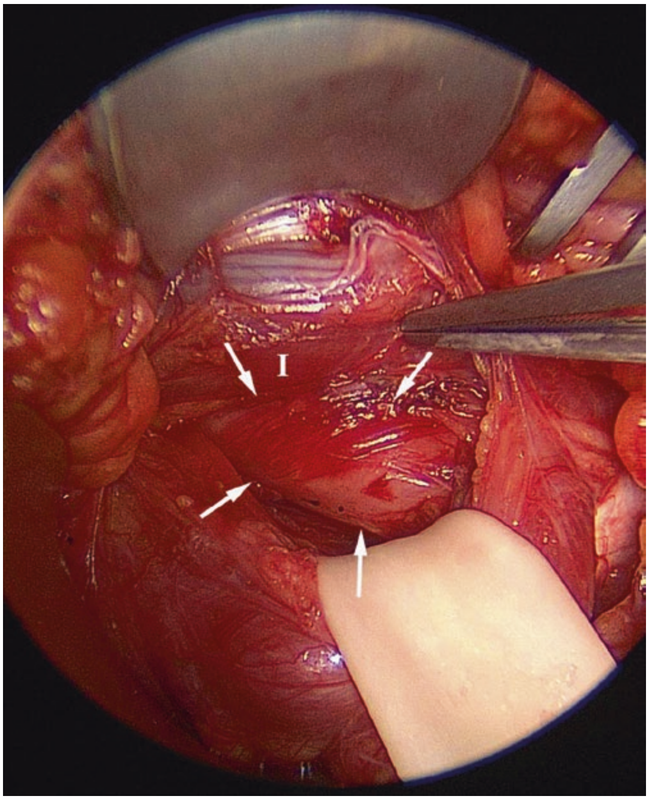

Fig. 19.10 Operative photograph showing a deficient posterior inguinal floor indicated by the *arrows*. The instrument is pointing to the internal oblique labeled I. A Penrose drain encircles the cord structures which are retracted laterally

significant time off, single-sport focus at a young age, and lack of balance in strength and flexibility between the abdomen/core and lower body.

Surgical Treatment

Surgical treatment for sports pubalgia should be reserved for patients and athletes who have the appropriate history and physical exam findings, have confirmatory evidence and/or exclusion of other significant confounding pathology with imaging (MRI or ultrasound), and have failed a trial of conservative management. In general, surgery should be considered only after 8 weeks or more of rest, physical therapy, and other local treatment measures. For recreational athletes, the period of rest and therapy is especially important since they do not often have access to experienced athletic trainers and other resources that are available in the collegiate and professional athletic setting. In our series, the average time from onset of symptoms and injury to surgical treatment has averaged over 10 months.

Consensus is lacking regarding the preferred surgical technique for repairing sports pubalgia injuries, which in part reflects disagreement about the pathomechanics of the injury. To date, in published series, no operation has generated consistently superior outcomes when compared to another operation, but no direct comparisons have been carried out in any controlled trials. In general, three broad categories of repair have been employed: open primary tissue repairs, open tension-free mesh repairs, and laparoscopic mesh repair as described in detail below. Despite differences in approaches, the common goal of each of these operations is to provide support and stability of the inguinal floor and distal rectus across the pubis.

Surgical Approaches

1. Primary pelvic floor repair: Two principal primary repair techniques have been described—primary pelvic floor repair by Meyers [24] and a minimal repair technique [38] by Muschawek. Neither of these techniques employs mesh.

Meyers Technique: The precise technical details of the Meyers approach have not been shown but broadly consist of suture plication or reattachment of the inferolateral border of the rectus abdominis fascia to the pubis and inguinal ligament [24]. This repair is somewhat analogous to a Bassini hernia repair but with differences in the way the sutures are oriented. The goal of the operation is instead to reattach or reinforce the anterior abdominal attachments to the pubis and adjacent ligaments. In order to accomplish this, the distal rectus abdominis muscle fascia is attached directly to the pubis and the inguinal ligament, using a near vertical line of sutures and by staying as close to the pubis and as anterior possible, maximizing anterior pelvic support. A second row of sutures is placed posteriorly onto the rectus fascia to add stability to the anterior row of sutures which is the primary line of support (W Meyers, personal communication).

The pelvic floor repair operation has been coupled with an adductor release in selected athletes. In the adductor component of the procedure, the anterior epimysial fibers of the adductor longus are incised 2–3 cm from their insertion into the pubis while leaving the adductor muscle intact. Conceptually, he describes a relative compartment syndrome that may exist on one or more of the adductor muscles and that the “release” allows escape of edema due to the entrapment. It is important to recognize that this is not a complete release of the adductor tendon attachment to the pubis but rather a relative loosening of the adductor compartment. It should also be noted that release of one or more adductor muscles is sometimes carried out as an isolated procedure without accompanying pelvic floor repair.

In 2003, Muschawek developed a “minimal repair” technique for athletes with chronic sports groin injuries [38]. The goal of this operation is to stabilize the posterior inguinal floor using a nearly tension-free suture method. The operation is performed under local anesthesia with sedation, and the technique is somewhat analogous to the Shouldice hernia repair but differs in that only the localized area of defect is opened and repaired and not the entire inguinal floor. In selected cases, the genital nerve is sometimes resected because of resultant pressure on the nerve from the posterior floor bulging and resultant nerve fibrosis that can result. A continuous suture is placed using a lip of iliopubic tract sutured first to itself and then over to inguinal ligament. A second row of suture is then placed to lateralize the rectus abdominis fascia which she postulates has been retracted medially and cranially by the posterior floor weakness (Fig. 19.11). These lines of suture serve to counteract the tension at the pubic bone by displacement of the rectus. Lastly, a muscular collar is placed at the deep internal ring using the lateral internal oblique in order to protect the cord structures. Conceptually, mesh is avoided in order to preserve the slide bearing function and elasticity in the inguinal floor.

2. Open tension-free mesh repair: Since primary tissue repairs of true inguinal hernia have been replaced by tension-free mesh approaches because of fewer recurrences and earlier return to activity associated with the latter, it is logical that a tension-free mesh approach could accomplish the goals described above of providing stability and support of the posterior inguinal floor and pubic joint. As a result, several groups including ours have preferentially used mesh to repair sports pubalgia injuries. The techniques used have employed lightweight polypropylene mesh or polytetrafluoroethylene (PTFE) meshes and have either been placed posteriorly and sutured to transversalis aponeurosis/rectus sheath and inguinal ligament similar to the Lichtenstein repair or more anteriorly to support the external oblique aponeurosis.

The approach used by this author is typically carried out under local anesthesia with sedation. The external oblique aponeurosis, which is often thin and attenuated, is opened along the plane of its fibers just as for standard inguinal hernia repair. A careful search is made for the ilioinguinal nerve, which is resected if it is entrapped by a slit in the external oblique or if its course is such that it is vulnerable to adhesion to the mesh or would otherwise interfere with the repair. A search is made for an indirect sac, and any cord lipoma is resected. Damaged or attenuated internal oblique fibers are debrided, and the floor is then reconstructed suturing the mesh medially to the transversus aponeurosis and medially to the inguinal ligament (Fig. 19.12). Although the internal ring is intact in these cases, the mesh is split as it is for a Lichtenstein repair, and the two limbs are sutured together to the inguinal ligament so that a flat conformity of mesh to the posterior floor is maintained. Additionally, one or two interrupted sutures are placed to anchor the mesh and distal rectus in order to further stabilize the rectus and pubis anteriorly. The intact fibers of the external oblique are then sutured together with a heavy absorbable suture (2-0 polyglactic acid) to eliminate the area of attenuation.

The Montreal group utilizes PTFE mesh in their repair and prefers to place the mesh more anteriorly to support the external oblique layer [29, 44]. The repair is carried out under general anesthesia, and the slit in the external oblique is opened generously. The patch is sutured in place to the

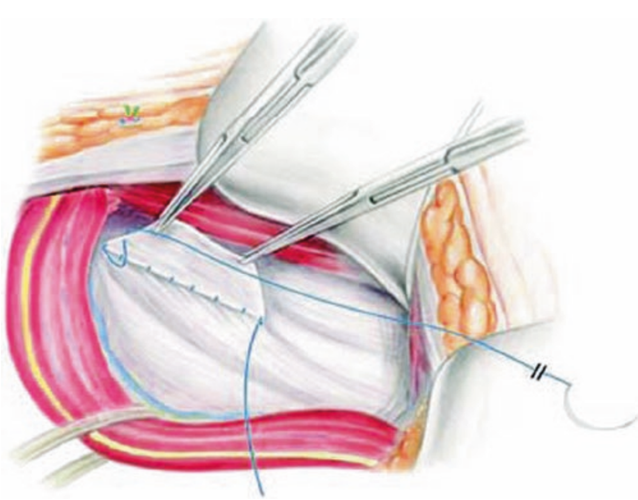

Fig. 19.11 Schematic illustration of the Muschawek minimal repair technique. Two double rows of continuous suture are placed to repair the defect. From Muschawek U, Berger L. Sports Health (2010); 2; p. 218 (with permission)

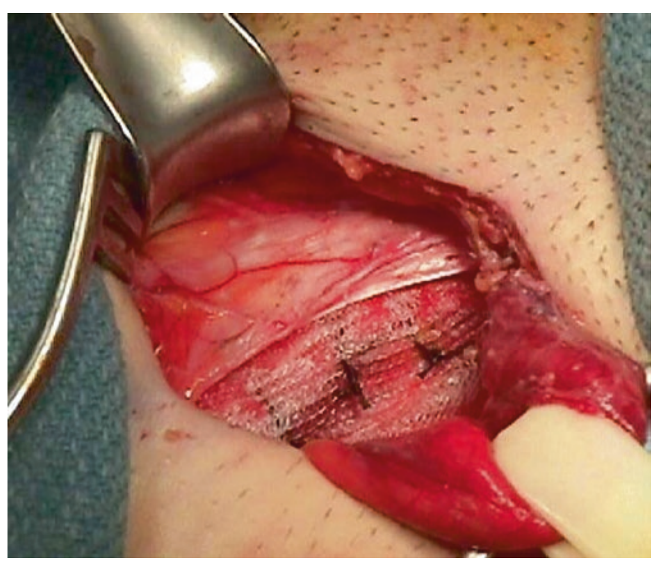

Fig. 19.12 Open tension-free mesh repair of sports pubalgia that shows mesh reinforcement of the posterior inguinal floor and distal rectus

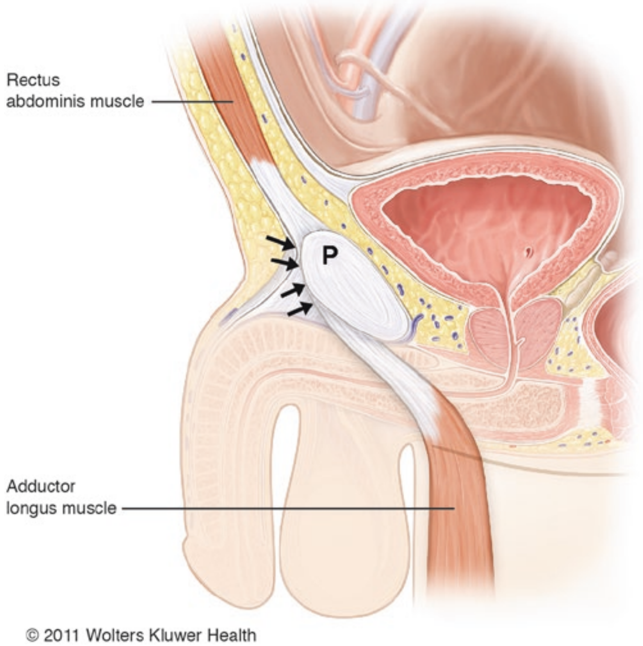

Fig. 19.13 Schematic anatomy of the rectus-pubis-adductor complex attachments from the sagittal view. *Arrows* indicate the area of potential aponeurosis tear. Modified from Brunt LM. Sports Hernia: In: Masters Techniques in Hernia Surgery. Jones DB (ed). Lippincott, Wilkins, Williams. (2013); Fig. 20.2A

external oblique beyond the margins of the tears using interrupted 2-0 polypropylene sutures (Fig. 19.13). The ilioinguinal and/or iliohypogastric nerves are also routinely resected.

Adductor release: In patients who have athletic pubalgia with demonstrated adductor tendinopathy with symptoms refractory to conservative management (such as physical therapy or corticosteroid injections), a partial adductor release (with or without an accompanying inguinal floor repair) may improve outcomes. The patient's hip should be flexed and externally rotated in a "frog-leg" position. The adductor longus tendon is easily palpable as a thick, strong band on the medial inner thigh. A 2-centimeter incision is made overlying the tendon, 2 centimeters distal to the inguinal crease. A #11 blade can be used to create multiple, staggered incisions in the epimysial fibers of the tendon sheath over a distance of 2–3 cm. This releases tension on the tendon and underlying muscle compartment without performing a complete release [45, 46]. It should be noted that percutaneous adductor tenotomy has also been reported for this condition [47].

3. Laparoscopic (posterior) mesh repair: Laparoscopic repair is a third potential option in athletes with groin pain that is preferred by some groups. However, its role in the repair of athletic pubalgia injuries is unclear. The total extraperitoneal (TEP) approach is generally used in this setting although transabdominal preperitoneal (TAPP) repair and exploration may be indicated in some athletes to exclude intra-abdominal sources of pain (e.g., inflammatory bowel disease, etc.) or gynecologic pathology in women. The technique is similar to that for standard TEP inguinal hernia repair (Fig. 19.14). Lloyd has employed an inguinal ligament release laparoscopically based on the concept that tension in the inguinal ligament is the primary source of pain in this condition. The inguinal floor is then reinforced with a mesh placed laparoscopically similar to a standard TAPP repair [48].

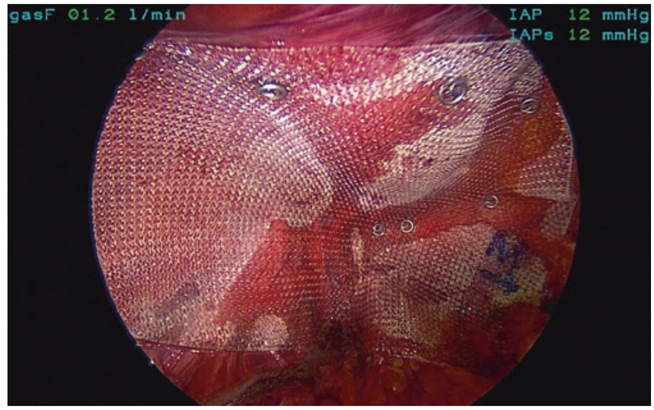

Fig. 19.14 Laparoscopic extraperitoneal mesh positioned to repair the posterior inguinal floor defect

Outcomes of Surgical Treatment: A summary of reported outcomes of surgical treatment depicted by category of repair is given in Table 19.1. Reported results have in the vast majority of cases indicated a return to sport in 90% or more of cases. However, follow-up has been variable or in many cases not reported. Additionally, many studies are small, retrospective, single-center case series [32]. The interval to return to sport has ranged from 2 weeks to 4 months. In our series of over 250 cases of repair, most athletes have returned to their sports within 8 weeks of injury, with returns as early as 5–6 weeks in some cases of in-season repair. Because many of these athletes are operated on at the conclusion of their season, the time pressures for return to play are lessened, and they often extend their rehab over a period of 8–12 weeks.

Primary Repair: Meyers has reported observations from operations in 5218 athletes out of 8490 individuals (61.4%) evaluated for possible sports hernia pubalgia [33]. In the operated individuals, there were 26 different procedures and 121 combinations of procedures performed. The precise details of the procedures performed were not provided but appeared to primarily involve either pelvic floor repair with various combinations of release procedures. The most common sports involved were football, soccer, and hockey, which accounted for 70% of cases. Complications were hematomas that required reoperation in 0.3%, wound infection in 0.4%, dysesthesia in 0.3%, and penile thrombosis in

Table 19.1 Reported results of surgical treatment of sports hernia

	Center	N	Length of follow-up	Interval to return to play	Return to sport
Open primary repairs					
Polglase [56]	Australia	64	8 mo	–	63%
Gilmore [27]	UK	300	–	–	97%
Steele [26]	Australia	47	–	4 months	77%
Meyers [33]	Philadelphia	5218	24 months	Up to 3 months	95.3%
Muschawek [38]	Munich	129	–	4 weeks	
Open primary repair with adductor tenotomy					
Harr [45]	Washington D.C.	22	8 weeks	6–8 weeks	100%
Messaoudi [57]	Deurne	71	4 years	4 months	68% to the same level; 27% to a lower level
Adductor tenotomy alone					
Schilders [54]	London	43	40 months	9.2 weeks	97.6%
Maffulli [55]	London and Rome	29	36 months	–	76%
Open mesh repairs					
Joesting [58]	Minnesota	45	12 months	–	90%
Brown [44]	Montreal	98	–	–	97%
Kopelman [59]	Haifa	51	36.1 months	4.3 weeks	96%
Laparoscopic repairs					
Paajanen [49]	Helsinki	41	50 months	1 month	95%
Van Veen [50][a]	Rotterdam	55	24 weeks	3 months	91%
Ziprin [51]	London	17	–	42 days	94%
Evans [60]	UK	287	3 mos–4 years	4 weeks	90%
Genitsaris [61]	Thessaloniki	127	5 years	2–3 weeks	100%
Mann [62]	Leicester	73	–	4 weeks	99%
Laparoscopic repair with adductor tenotomy					
Rossidis	Gainesville	54	18 months	24 days	100%

[a]Four patients underwent adductor tenotomy

0.1%. Recurrent problems occurred in 16 patients, and reoperation after prior standard inguinal hernia repair (open of laparoscopic) at outside institutions was done in 241 patients. Further details regarding the type of symptomatic failure in these outside procedures were not reported.

Muschawek reported outcomes of a prospective cohort study of 129 patients treated from 2008 to 2009 [38]. At 4 weeks post-repair, 96.1% of athletes had resumed training, and full return to pre-injury sports activity had occurred in 75.8%. No recurrences were reported over the course of follow-up.

Tension-Free Mesh Repairs: Brown and colleagues [44] reported outcomes in 98 elite hockey players using the PTFE mesh approach. Overall, 97 of 98 athletes were able to return to play. Three recurrences occurred between 4 and 6 years after the original repair. All had remedial re-repair and were able to return to play.

At the Washington University Medical Center, over 250 athletes have been operated on for athletic pubalgia over the last 15 years. The majority of these repairs were performed open (87.2%) and were performed laparoscopically in 12.8%. Repairs were unilateral in 82.2% cases and bilateral in 17.8%. Of these patients, 8.9% had had a previous sports hernia repair on either side. Symptomatic outcomes assessed at intermediate (1 year) follow-up showed a successful return to athletic competition in over 90% of cases.

4. Laparoscopic repair: In soccer players with sports hernias, successful outcomes of laparoscopic mesh repairs have been reported by some groups [49–51]. In one study of 55 athletes with chronic groin pain, incipient hernias were diagnosed in 36 cases (65%) including 9 that were bilateral, and true inguinal hernias were seen in 20 athletes (36%) [50]. Laparoscopic repair was carried out in all cases, and five athletes also had an adductor tenotomy performed. At 6–8 weeks, 48 of the patients (88%) had returned to normal sports activities without pain. Five patients had residual groin pain at 12 weeks that ultimately resolved with rest and physical therapy [50]. Of note is that the high incidence of true inguinal hernias in this series differs from that reported in multiple series of open repairs. Whether this observation is due to different

selection criteria for surgery or an artifice of the laparoscopic viewpoint is unclear.

One small prospective randomized trial has been carried out that compared laparoscopic to open repair, primarily in rugby players [52]. Open repair consisted of Bassini repair in 3 athletes and Lichtenstein-type repairs in 11. Training was resumed at 4 weeks in 9 of 14 patients repaired conventionally and 13 of 14 repaired laparoscopically. Recurrent pain developed after one laparoscopic and one open repair each. Despite the apparent earlier resumption of full physical activity after laparoscopic repair, it should be noted that the role of laparoscopic repair in this setting remains controversial. Indeed, a potentially higher failure rate and need for operative reintervention in some of these athletes have been observed anecdotally by some groups [40].

Some groups have reported outcomes in patients after adductor tenotomy alone or in tandem with open or laparoscopic floor repairs. These trials have given varying results, with return to sport rates ranging from 76 to 100% [53–55].

Rehabilitation

Postoperative rehabilitation plays an important role in return to athletics after repair regardless of the surgical approach. Our group has described a stepwise series of activities and exercises (Table 19.2) to assist athletes and athletic trainers

Table 19.2 Postoperative rehabilitation protocol

Phase	Time	Therapy	Sets	Reps	Resistance	Notes
1	0–1 Weeks	Walking	1	5–60 min	3–6 MPH	When patient is able to walk 20 min. continuous begin light hamstring, quad, gastroc low back, and groin stretching
2	2–4 Weeks	Active hip ROM (leg swings), treadmill incline walking, wall sits w/ Swiss ball, quad stabilization, hamstring/gastroc/low back strengthen, begin bike workouts at 2 weeks	1	8 reps per exercise	As tolerated	At start of 3–4 weeks begin scar mobilization of surgical site—ART of surrounding muscle groups—at 4 weeks ART of affected psoas muscle. Avoid excessive trunk extension
3	3–4 Weeks	Hip flexor stretching w/ progression to resistance, light jogging, initiate exercises for transversalis and obliques, controlled rotation exercises, bridging progression, core stabilization exercises	1	8 reps per exercise	As tolerated	Continue scar mobilization
4	4–5 Weeks	Increase to speed and interval training on bike or treadmill, lunges, light sports-specific activities, single leg slideboard/theraband, lower abdominal exercises, continue core stabilization exercises	1	8 reps per exercise	As tolerated	Continue scar mobilization
5	6–8 Weeks	Speed/function/volume and intensity to maximum, end-stage quadruped/stabilization exercises, muscle length restored/adductor strength bilateral, drills and scrimmage w/ team, MD approval and discharge				Confidence is established with timed drills/bilateral muscle strength, positive finding presurgery now negative, continues emphasis placed on maintaining muscle lengthening and symmetrical abdominal strength through adherence to stabilization program

in guiding return to elite-level athletic competition with applicability to a variety of sports [34]. A focus on both core abdominal strengthening and stabilization as well as lower body strength, flexibility, and balance with special attention to any associated adductor conditions is, we believe, essential to a successful outcome.

Other groups [29, 50] have outlined a schedule for return to sport following surgical repair but with fewer details than provided in our protocol. Muschawek [43] has utilized an accelerated path for return to sport in athletes undergoing the minimal repair technique. Patients are allowed to lift up to 20 kg for the first 14 days after surgery. Biking and running may be resumed as soon as the athlete is pain-free, and activity can be increased after the first 8 days as tolerated. This approach resulted in return to sport activity in 83% of athletes. These findings make the case for a more rapid and flexible timeline for increased activity in this population of patients that is based on symptoms and comfort level rather than a rigid time-based sequence, especially for athletes who have surgery in season, in order to minimize the number of training sessions and games missed.

Summary

In summary, groin injuries are a significant problem in athletes. A multidisciplinary team approach to evaluation and management involving the athletic trainer, orthopedist, physical therapist, and hernia surgeon is key to accurate diagnosis, treatment, and selection of patients for surgical intervention. Surgeons who evaluate athletes for "sports hernia and athletic pubalgia must develop an understanding of the clinical presentation and diagnostic evaluation of related groin injuries. Surgical repair, coupled with a structured rehabilitation program that focuses on balancing strength and flexibility in the lower abdominal and thigh muscles, should allow return to competitive play within several weeks in appropriately selected athletes.

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