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| Abstract | Groin pain is a common condition in athletes and accounts for up to 6 % of all athletes’ injuries. It affects athletes involved in running, jumping and kicking, and it is particularly common in professional soccer players. Groin pain is a serious condition because it can impair athletic performance and cause young athletes to change the level of sport and retire early from sport activity. The diagnosis of groin pain is difficult because of the anatomical complexity of the groin area, the large number of potential sources of groin pain and the coexisting pathologies which can affect the patient. Management is a challenge for physicians because treatment strategies are still debated, because of the little availability of evidence-based protocols and because many therapies are based on poor evidence clinical studies (level IV studies). In this chapter, the most common causes of groin pain that affect athletes and their management are discussed. |



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| Keywords (separated by “ - ”) | Adductor tendinopathy - Femoroacetabular impingement - Groin pain - Groin pain disruption - Hip arthroscopy - Osteitis pubis |

# Groin Pain

29

Nicola Maffulli, Alessio Giai Via, and Francesco Oliva

## 29.1 Introduction

Groin pain is well known among both athletes and physicians. Groin injuries account for about 6 % of all athletes' injuries, and the incidence increases up to 13 % in specific sports such as soccer [13]. The incidence ranges from 12 % to 16 % of all injuries per season in a recent prospective study of hip and groin injuries in professional soccer players, with a mean absence from competitions of 15 days [61]. This is probably due to typical soccer movements like jumps, dribbling and rapid twisting which cause high stress to the pubic symphysis and muscular imbalance. Kicking and running on uneven surfaces, male gender and preseasonal training are considered risk factors for developing groin pain [26].

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Diagnosis and management are major challenges for physicians because the aetiopathogenesis is not clear yet. Diagnosis is difficult because of the anatomical complexity of the groin area, the biomechanics of the pubic symphysis region and the large number of potential sources of groin pain (Table 29.1). A recent review reported that 30–90 % of patients are affected by different coexisting groin pathologies [56]. This condition justifies the term 'groin pain syndrome' (GPS). The nomenclature is also confusing. Many athletes with a diagnosis of 'sports hernia' or 'athletic pubalgia' have a spectrum of related pathologic conditions resulting from musculotendinous injuries and subsequent instability of the pubic symphysis without any finding of inguinal hernia at physical examination. For this reason, the term 'groin pain disruption' introduced by Gilmore is becoming more popular [19].

Management of groin pain is difficult, and patients usually undergo prolonged rest and many different treatments. The management of groin pain is multidisciplinary and consists of rehabilitation, physical therapies or surgery for patients who do not respond to conservative treatments [55].

## 29.2 Groin Anatomy

Knowledge of groin anatomy is of great importance in understanding the causes of groin pain. The groin region consists of ligaments, tendons, muscles and fascia which all insert to the pubic




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**Table 29.1** Differential diagnosis of groin pain

| Intra-articular pathologies | Extra-articular pathologies | Non-musculoskeletal disorders |
|---|---|---|
| Femoroacetabular impingement (FAI) syndrome | Insertional adductor and rectus abdominis tendinopathy | ***Intra-abdominal pathologies*** |
| Acetabular labral tears | Groin pain disruption | Appendicitis |
| Chondral lesions | Osteitis pubis | Diverticulitis/diverticulosis |
| Femoral neck stress fractures | Greater trochanter pain syndrome | Lymphadenitis |
| Osteoarthrosis | Lumbar radiculopathy | Inflammatory bowel disease |
| Transitory synovitis | Pubic ramus stress fracture | Inguinal hernia |
| Osteonecrosis of the femoral head | Apophyseal avulsion fractures | |
| Osteochondritis dissecans | Sacroiliac joint disorders | ***Genitourinary*** |
| Legg-Calvè-Perthes disease | Nerve entrapment | Adnexal torsion |
| Epiphysiolysis of the femoral head | Snapping hip syndrome | Nephrolithiasis |
| Septic arthritis | | Orchitis |
| Oncologic process | | Ovarian cysts |
| | | Pelvic inflammatory disease |
| | | Urinary tract infections |
| | | Endometriosis |
| | | Prostatitis |
| | | Testicular cancer |

bone and symphysis. The inguinal region consists of the inferior part of large flat muscular sheets (obliquus externus, internus and transversus abdominis), the rectus abdominis, the pyramidalis, the inguinal canal, the symphysis pubis and the femoral triangle. Central to the groin area is the inguinal ligament. The inguinal ligament is an important connective tissue structure which supports soft tissues in the groin as well as the external abdominal oblique muscle. It arises from the inferior aponeurosis of the external abdominal oblique and runs obliquely across the pelvis. On its superior and lateral end, it connects to the anterior iliac spine of the ilium and extends to the pubic tubercle of the pubis bone on its inferior and medial end. The inguinal ligament supports the muscles that run inferior to its fibres, including the iliopsoas and pectineus muscles of the hip. It also supports the nerves and blood vessels of the leg as they pass through the groin, including the femoral artery, femoral vein and femoral nerve. The support provided by the inguinal ligament is important to maintain the flexibility of the hip region while allowing vital blood and nerve supply to the leg. A small opening in the muscles and connective tissues of the abdomen, the superficial inguinal ring, is located just superior to the inguinal ligament. This opening is part of the inguinal canal and permits the spermatic cord in males and the round ligament of the uterus in females to exit the abdominopelvic cavity and pass through the external tissues of the pelvis. The pubic symphysis is an amphiarthrodial joint with limited mobility (it can be moved roughly 2 mm with 3° of rotation) but with good capacity of load absorption, thanks to the presence of hyaline and fibrous cartilage and connective tissue on its surface. The abdominal and paravertebral muscles act synergistically to stabilize the symphysis pubis during movements, particularly during static or dynamic single-leg stance [4]. The adductor muscles act as antagonists and exert opposing traction and rotation on the pubic symphysis. The femoral triangle is located in the upper inner thigh, and several structures pass through it: the femoral nerve, the femoral vessels and the sartorius, the iliopsoas, the pectineus and the adductor longus muscles. The adductor muscles also comprise the adductor brevis, the adductor magnus and the gracilis. Many peripheral nerves cross or innervate the anatomic structures of the inguinal region. These include the ilioinguinal nerve (T8–L1); the obturator nerve (L2–L4); the medial and intermediate cutaneous nerve of the thigh (L2–L3), with sensory function; and the femoral nerve (L2–L4) [4].

## 29.3 Insertional Adductors and Rectus Abdominis Tendinopathy

Insertional tendinopathy of the adductors and rectus abdominis is a frequent cause of groin pain in athletes. It involves the adductor muscles and/or the rectoabdominal muscles [57]. The incidence of insertional adductors tendinopathy is about 2.5–3 % in athletes and is more frequent in soccer, basketball, hockey and rugby players and long-distance runners (Paajanen 2011). More than 70 % of patients are males. Even if insertional adductor tendinopathy can develop independently, in most of the cases, it occurs in association with osteitis pubis. Hiti et al. suggested that groin pain and pubic osteitis are the most common causes of chronic groin pain in athletes [21].

The aetiopathogenesis is multifactorial. It is related to functional overuse and repeated microtraumas caused by torsion and traction of abdominal and adductor tendon insertions. The overloading of the pubic symphysis and insertional tendons could be induced by the strength imbalance between the hypertonic adductor muscle and hypotonic large flat muscular sheets of the abdomen [42]. Other authors suggest that this condition could also be induced by the hypertonia of the quadriceps femoris muscle [57]. Some intrinsic and extrinsic factors may predispose athletes to develop insertional adductor tendinopathy. The muscular imbalance is the main intrinsic factor, while reduced flexibility of the posterior chain muscles and/or iliopsoas-lumbar hyperlordosis; sacroiliac, sacrolumbar and hip arthropathy; and marked asymmetry and/or dissymmetry of lower limbs are other risk factors. Incorrect athletic training, unsuitable footwear and unfavourable conditions of the playground are considered as extrinsic factors [57].

### 29.3.1 Clinical Examination and Diagnosis

The main symptom is groin or lower abdominal pain, with radiation to the medial aspect of the thigh, abdomen and, in some cases, perianal area. The symptoms are unilateral at the beginning and occur after sport; but this condition is progressive in nature, limiting or stopping the sporting activities. In advanced stages, the pathology could progress bilaterally and could affect social life and everyday activities such as climbing stairs and getting up from a bed or a chair. Sometimes sneezing, coughing, defecating and sexual activity can reproduce the symptoms [48].

Diagnosis is based on clinical examination and supported by imaging. Painful points such as tendon insertions of adductor, rectoabdominal and iliopsoas muscles, the pubic symphysis and iliac spines are evaluated. Pain can also be reproduced with adduction or contraction of the abdominal, the iliopsoas, the rectus femoris and the adductor muscles against resistance and with passive stretching of the adductors and iliopsoas muscle. The mobility of the hips on all planes should be assessed. Specific tests show the shortening of the anterior chain (test of Thomas), the posterior chain (hamstring muscles) and sacroiliac joint (test of Patrick and test of Gaenslen). Finally, a peripheral neurological examination should be conducted.

Plain radiographs, ultrasound scan and MRI are useful to confirm the diagnosis. Plain radiographs are useful to exclude different causes of groin pain, including femoroacetabular impingement (FAI), hip osteoarthritis or fractures. Flamingo stress views are used to assess pelvic stability, which is measured as the amount of vertical displacement observed at the symphysis [18]. Flamingo stress views are obtained with the patient bearing weight alternately on each leg. If a displacement greater than 2 mm at the symphysis pubis is observed, a macro-instability of the symphysis pubis can be diagnosed. Other indirect signs of pelvic instability can be observed at plain radiography, such as spurs of the cortical bone, subchondral cysts and associated widening of the sacroiliac joint (Fig. 29.1). Ultrasound evaluation allows to assess musculotendinous structures, soft tissues and insertional area of tendons and ligaments. MRI usually shows bone marrow oedema, insertional tendinopathy of the adductors and rectus abdominis [45] and

**Fig. 29.1** Flamingo stress views show pelvic instability with displacement at the symphysis pubis greater than 2 mm. Note the subchondral cyst (*black arrow*) which is an indirect sign of degenerative changes

symphysis capsular disruption; central disc protrusion may also be present, in particular in soccer players [7].

### 29.3.2 Treatment

The management is multidisciplinary. Treatment includes rest and focused rehabilitation. Rehabilitation phases can be divided in acute, subacute and return to sport [57]. The first goal during acute phase is pain reduction. For this purpose, pharmacological, instrumental, physical and manual therapies are recommended. Laser therapy and extracorporeal shock wave therapy are useful to relieve pain. Rehabilitation measures consist of postural balance techniques through global and site-specific stretching, the use of mechanical and proprioceptive orthotic insoles and global postural re-education [60]. In the early stages, physical therapy involves isometric strengthening of the abdominal muscles and adductor muscles in the gym or in a therapeutic swimming pool. In the subacute phase, muscle strengthening is increased by the introduction of concentric and eccentric exercises and by cardiovascular reconditioning. Core stability exercises are useful in this phase [39]. Finally, running is gradually introduced, at first on a treadmill. The return-to-sport phase of rehabilitation consists of aerobic running with increasing speed.

If conservative measures have failed for at least 3 months, surgical intervention may be necessary [57]. Adductor longus tenotomy is commonly performed in order to reduce the stress of the hypertonic adductor muscle on the pubic symphysis and to reduce the muscular imbalance of the adductor-abdomino. Many authors reported good results and high rate of return to sport after adductor longus tenotomy. In a large series of professional soccer players, Mei-Dan et al. reported good or excellent results in 80 % of patients with a mean return to sport in 11 weeks (range, 4–36 weeks) [37]. Robertson et al. reported improvements in 91 % of patients (99/109) in particular in patients with the worst preoperative symptoms [49]. More recently good results have been reported with bilateral mini-invasive adductor tenotomy for athletes suffering from unilateral adductor longus tendinopathy refractory to nonoperative management [35]. At the time of the latest follow-up, 76 % of patients returned to their pre-injury level of sport or higher levels, with a median time to return to sport of 18 weeks. However, 3 of 29 patients ceased to participate in sport. Concern following adductor tenotomy is the potential for loss of hip adductor strength, although this does not seem to influence participation in high-level sports (Akermark et al. 1992; [37]).

## 29.4 Femoroacetabular Impingement Syndrome

Femoroacetabular impingement (FAI) syndrome is a common cause of pain and discomfort in young active non-dysplastic patients [16].

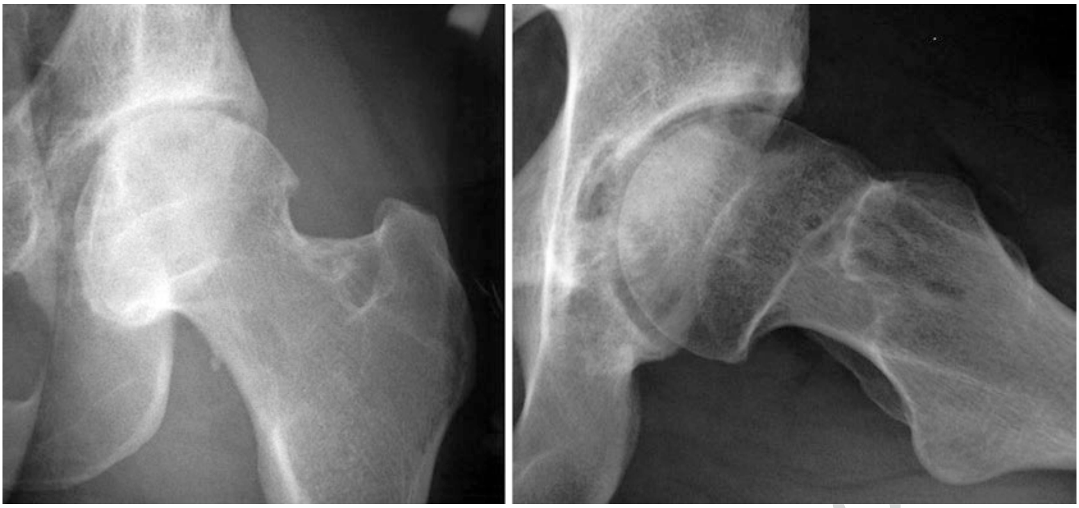

**Fig. 29.2** FAI of a 31-year-old soccer player. Large chondral lesions are evident at plain radiographs

Two types of impingement have been described, namely, cam impingement and pincer impingement. Cam impingement is caused by an abnormal morphology of the femoral head with increasing radius into the acetabulum during forceful motion, especially flexion. Pincer impingement is the result of an altered anatomy of the acetabulum, as coxa profunda or abnormal retroversion or anteversion of the acetabular rim, which cause pathological contact between the acetabular rim and the femoral head-neck junction [16]. Dynamic pincer impingement can occur in normal hips if the required range of movement is large or translated, as in dancers, gymnasts and hockey players [5]. Cam-type impingement is more common in young and athletic males, while the pincer-type impingement is more common in middle-aged females [16]. However, a minority of patients present pure FAI (14 %): most patients have a combination of both forms (86 %), the so-called mixed pincer and cam impingement.

FAI alters the biomechanics of the hip resulting in painful and limited range of motion, mostly in flexion and internal rotation. In cam impingement, the nonspherical portion of the femoral head adducting against the acetabular rim leads to deep chondral lesions and extensive labral tears. In pincer-type impingement, the first structure to fail is the acetabular labrum, leading to ossification of the rim and additional deepening of the acetabulum and worsening of the coverage. In pincer impingement, chondral lesions are smaller than in cam type and often limited to a small rim area [16]. However, FAI is not symptomatic in all cases. FAI in healthy young adults may be asymptomatic up to 35 % of cases [30].

### 29.4.1 Diagnosis

Groin pain and limited hip motion are the clinical key symptoms and signs of FAI. A decreased ROM, in particular of internal rotation, is the most common sign in case of FAI. People with asymptomatic FAI also demonstrate reduced ROM compared with people with no evidence of FAI [11]. Many specific clinical tests have been developed to support clinical diagnosis of FAI. A recent systematic review showed that hip-specific tests have high sensitivity but poor specificity and that only the FADIR test (flexion, adduction and internal rotation test) and the flexion-internal rotation test are valuable screening tests for FAI and acetabular labral tears [47].

Standard anteroposterior pelvic and lateral cross-table radiographs supported the first clinical suspicion of FAI disease (Fig. 29.2). MRI arthrography with gadolinium is important for assessing the status and extent of labral and cartilage lesions (Fig. 29.3) [22].

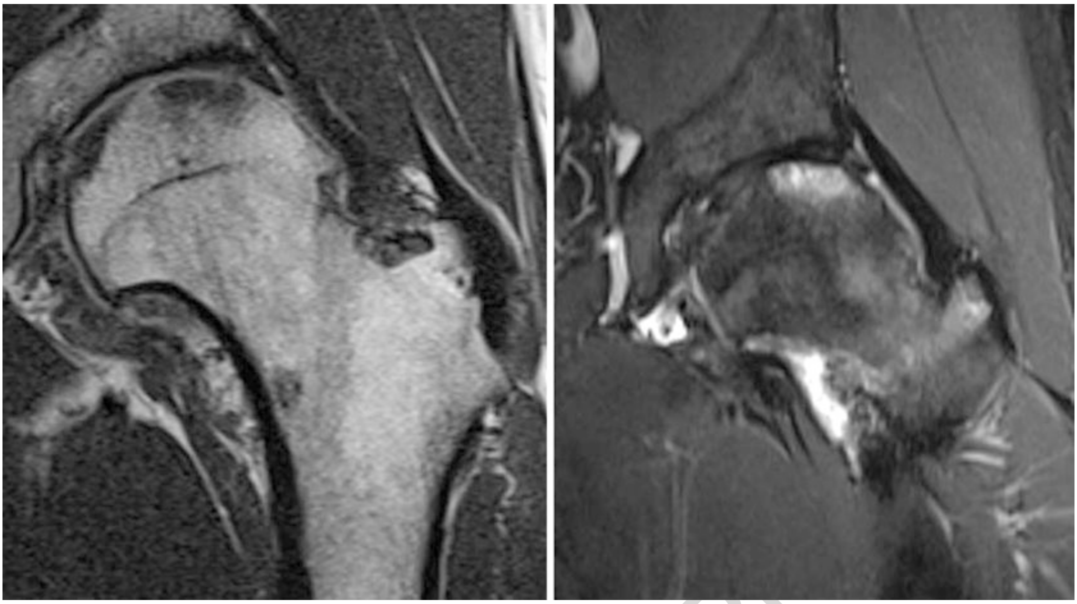

**Fig. 29.3** T1- and T2-weighted MRI with gadolinium of the same patient showing big osteochondral lesions and labral tear



## 29.4.2 Treatment

The management of FAI is still controversial. The appropriate timing for surgery is also debated, even though recent studies showed that delayed surgery may lead to progression of the disease to the point where joint preservation is no longer indicated [34]. Some authors suggest that patients should undergo surgery within 6 months of symptom onset [3].

Surgery is indicted to relieve symptoms, to treat concomitant degenerative joint disease and to encourage return to sport. According to present data, arthroscopy, open surgery and arthroscopic followed by mini-open surgery are comparable for functional results, biomechanics and return to sport [46]. Hip dislocation and open osteochondroplasty were considered the gold standard treatment, with good to excellent results in 70–80 % of patents [16, 34, 41]. These authors suggest that complex bony abnormalities including extra-articular impingement, major deformities and global pincer FAI are better treated by open techniques, which also allow femoral osteotomies or acetabular reorientations when they seem appropriate. Heterotopic ossification is the most frequent complication after open surgery [46].

Recent studies reported good results after less invasive arthroscopic treatment in terms of time to recovery and return-to-sport activity, allowing 93 % of patients to return to their pre-injury sport [46]. In a study on more than 600 patients, the quality of life scores improved in 76.6 % of cases after hip arthroscopy at 3 years follow-up [36]. However, arthroscopy is more technically demanding. A need for a revision hip arthroscopy has been reported for persistent symptoms, further debridement, lysis of adhesions and advanced osteoarthritis. A recent study showed that, in patients who undergo revision hip arthroscopy for persistence of groin pain, findings of FAI are still evident at imaging and revision surgery [20].

Finally, it is difficult to state whether surgery modifies the evolution of osteoarthritis in young patients and contributes to prevent the development of osteoarthritis. Open dislocation and debridement show a higher rate of conversion to total hip arthroplasty, particularly in patients with pre-existing severe osteoarthritis and cartilage lesions [46]. Concomitant cartilage lesions and degenerative changes result in lower clinical and functional scores, short-term pain relief, no evidence of long-term satisfactory outcomes and higher rate of conversion to total hip arthroplasty [46].

**Table 29.2** Stages of osteitis pubis according to Rodriguez et al.

| | Side of pain | Side of pain | Characteristics of pain |
|---|---|---|---|
| Stage 1 | Unilateral symptoms | Inguinal, with radiation to adductors. Usually involve the dominant leg | Mechanical, settles after rest, returns after training |
| Stage 2 | Bilateral symptoms | Inguinal pain involving the adductor muscles | Increases after training |
| Stage 3 | Bilateral symptoms | Groin, adductor region, suprapubic, abdominal muscles | During training, kicking, sprinting, turning. Cannot achieve training goals, forced to withdraw |
| Stage 4 | Generalized symptoms | Generalized, pelvic girdle and radiation to lumbar region | Walking, getting up, straining at stool, simple activities of daily living. Pain with defecation and sneezing |

## 29.5 Osteitis Pubis

Osteitis pubis is a painful degenerative condition of the pubic symphysis, surrounding soft tissues and tendons. It was first described by Beer in 1924 [53], and it is currently considered as one of the most debilitating syndromes to affect athletes [50]. The incidence in the general athletic population has been reported as 0.5–7 %. It mostly affects basketball players, distance runners and athletes participating in kicking sports, such as soccer or football, where the incidence is up to 13 % in patients with groin pain [9]. It affects more often males, while it has been reported in females in about 5 % of cases [58].

Even though the pathogenesis is still debated, currently the new concepts of 'sports-related chronic groin injury' and 'groin disruption injury' describe a condition of chronic groin pain associated with pubic instability [58]. Muscle imbalance between the abdominal and hip adductor muscles is considered the most important pathogenetic factor in the development of this condition [14]. The abdominal muscles act synergistically with the posterior paravertebral muscles to stabilize the symphysis, allowing single-leg stance while maintaining balance and contributing to the power and precision of the kicking leg. The adductors are antagonists to the abdominal muscles. Imbalances between abdominal and adductor muscle groups disrupt the equilibrium of forces around the symphysis pubis, predisposing the athlete to a subacute periostitis caused by chronic microtrauma.

### 29.5.1 Clinical Presentation and Diagnosis

Athletes with osteitis pubis commonly present with anterior and medial groin pain and, in some cases, may have pain centred directly over the pubic symphysis. Pain may also be felt in the adductor region, lower abdominal muscles, perineal region, inguinal region or scrotum. The pain is usually aggravated with running, cutting, hip adduction and flexion against resistance and loading of the rectus abdominis [6].

The diagnosis is clinical, based on clinical history, physical examination and functional assessment. Physical examination findings include tenderness to palpation of the pubic symphysis and pain with resisted strength testing of the adductor and lower abdominal muscle groups.

Imaging studies include plain radiography, MRI and CT scan, and they are advocated to exclude concomitant pathologies. MRI can show bone marrow oedema, and MRI findings were graded according to subchondral bone oedema, fluid in the pubic symphysis and periarticular oedema [29]. Osteitis pubis has been classified according to the severity of symptoms by Rodriguez et al. (Table 29.2) [50].

### 29.5.2 Treatment

Management is conservative first, while surgery is indicated in unresponsive patients. Many studies proposed different treatment options depending on the severity of symptoms. However, a recent systematic review showed that no level 1 studies are reported in literature. Current treatment of osteitis pubis is based on level 4 evidence studies, making it difficult to compare the efficacy of different treatment protocols [9].

A progressive rehabilitation programme produces good results [24]. Patients are moved through the protocol stages after they are able to perform exercises without pain and have achieved adequate levels of movement and core stability grading. The first stage is to focus on pain control and improve lumbo-pelvic stability. Gentle prolonged stretching, except for the adductors and ischiopubic muscles, is started. Cycling on an exercise bike is introduced as cardiovascular training. In the second stage, Swiss balls and other aids are indicated to perform resistance and strength contraction exercises of the pelvic floor, transversus abdominis and multifidus muscles. Gluteal strengthening is started. In the third and final stage, eccentric work on the sliding board is started. Running time is gradually increased, and changes of pace and direction are introduced. To reproduce the sport requirements, athletes start training on the field performing exercises mimicking their sport. Kicking is allowed only at the end of this stage. Eccentric abdominal wall strengthening exercises are started. Good results have been reported with this progressive rehabilitation programme, and most of the athletes diagnosed with stages III and IV returned to sport within 3 months (10–13 weeks).

Surgery is indicated in 5–10 % of cases which do not respond to conservative treatment [62]. Different surgical techniques have been described, such as curettage of the pubic symphysis, polypropylene mesh placement into the preperitoneal retropubic space and pubic symphysis stabilization. Satisfying results have been reported in a systematic review with these techniques (72 % of return to sport for curettage of the pubic symphysis, 92 % for polypropylene mesh placement into the preperitoneal retropubic space and 100 % for pubic symphysis stabilization) [9]. However, it is difficult to state which is the best treatment strategy for osteitis pubis because of lack of level 1 randomized controlled trials. Osteitis pubis has a negative impact on the career of an athlete, who may be obliged to stop their sporting activities. Prevention programmes based on specific sports-related demands should be tailored to the needs of each individual athlete. A correct diagnosis and an early treatment are fundamental for the management because patients diagnosed earlier experience fewer symptoms and faster return to play [64].

## 29.6 Sportsman Hernia/Athletic Pubalgia

Sportsman hernia is a syndrome characterized by chronic groin pain in athletes that is associated with a small direct inguinal hernia [32]. The term athletic pubalgia is currently used to describe the disruption and/or separation of the more medial common aponeurosis from the pubis, usually with insertional tendinopathy of the adductors and rectus abdominis muscles. In advanced phases, it can be associated with osteitis pubis and FAI. Currently, there is little consensus concerning this condition about aetiopathogenesis and even the nomenclature. While many authors distinguish between the terms 'sports hernia' and 'athletic pubalgia', others consider them different aspects of the same pathology considering the close relationship between structures implicated in the development of this condition [12, 31]. Different terms have also been used to describe this condition, including sports hernia, athletic pubalgia, Gilmore's groin [19], footballers' groin injury complex, pubic inguinal pain syndrome (PIPS) and syndrome of muscle imbalance of the groin [40]. As recent studies showed that this pathology rarely arises as a single condition but multiple coexisting pathologies are often present, such as posterior inguinal canal wall deficiency and intra- and extra-articular pathologies, the term 'groin pain disruption' (GPD) has become more popular [17].

GPD is more frequent in males, but an increasing number of female patients are being diagnosed [38]. The aetiology is debatable. Currently, many authors believe that the underlying aetiology is muscular imbalance and pelvic instability [31, 40, 38], although isolated traumatic tears of the conjoint tendon are occasionally diagnosed.

### 29.6.1 Clinical Presentation and Diagnosis

Athletes typically complain of gradually increasing activity-related lower abdominal and proximal adductor-related pain. The pain is typically located over the lower lateral edge of the rectus abdominis muscle and may radiate towards the testis, suprapubic region or adductor longus origin. The onset is usually insidious, but in some cases it can involve an initial sudden 'tearing' sensation. GPD pain is often aggravated by sudden acceleration, twisting and turning, cutting and kicking, sit-ups, coughing or sneezing [2].

Diagnosis is dependent upon concordance between the patient history, physical examination and imaging investigation. Palpation for a positive inguinal cough impulse is usually either negative or equivocal. Valsalva manoeuvres such as coughing and sneezing can occasionally reproduce symptoms. Fifty percent of the hernias became more apparent with Valsalva manoeuvre, and imaging obtained during Valsalva manoeuvre aids in the detection and characterization of suspected abdominal wall hernias [23].

### 29.6.2 Management

The first approach to GPD is traditionally nonsurgical. However, there are issues unique to the athlete regarding timing, sports seasons and level of athlete. Physical therapy is focused on core stabilization, postural retraining and normalization of the dynamic relationship of the hip and pelvic muscles [31]. After a period of rest, a gradual pain-free progression to sports may be possible. However, there are very little data about the effectiveness of nonsurgical treatment. Physical therapy and laparoscopic surgical repair have been compared in a recent RCT (Paajanen et al. 2011). The authors found that only 50 % returned to sport in the nonsurgical group at 1-year follow-up. Surgery is indicated after 3–6 months of failed conservative treatments and when the athlete is limited in season and unable to participate. A number of different surgical techniques have been described, including repair of the external oblique, transversus abdominis and transversalis fascia, repairs with mesh reinforcement, laparoscopic repairs, mini-open repairs and broad pelvic floor repairs with or without adductor releases and neurectomies [31]. Surgical repair of the sportsman hernia is associated with good functional outcomes, and 80–100 % return-to-sport rates have been reported ([28]; Paajanen et al. 2011). After surgery, a 3-month programme of post-operative physiotherapy is indicated to maintain pelvic stability and restore function.

## 29.7 Greater Trochanter Pain Syndrome

Lateral hip pain is a debilitating condition characterized by pain located at or around the greater trochanter. This is the site of confluence of three bursae, the hip abductor-lateral thigh muscles and the iliotibial band (ITB). Described for years as trochanteric bursitis, advanced imaging and surgical findings evidenced disorders involving partial tear or avulsion of the anterior aspect of the gluteus medius and minimus tendons, external snapping hip and insertional tendinopathies with no real bursal involvement [10]. For these reasons, the term 'greater trochanteric pain syndrome' (GTPS) is now used to better define this clinical condition [54]. GTPS is more frequent in women (F-M = 4:1) aged 40–60 years and affects from 10 % to 25 % of the general population and up to 35 % in patients who have leg length discrepancies and low back pain [63]. Abnormal force vectors acting across the hip, leading to abnormal hip biomechanics, are predisposing factors and also age, gender, ipsilateral ITB pain, knee osteoarthritis, obesity, low back pain and specific sporting activities. The higher prevalence in women could be related to the configuration of their pelvis. Though common in sedentary patients, runners are also particularly predisposed [2].

### 29.7.1 Clinical Presentation and Diagnosis

Diagnosis of GTPS is clinical. Patients usually report pain anterior or posterior to the greater trochanter from several months. Local tenderness over the greater trochanteric area can be noted at palpation and positive single-leg stance and resisted external rotation tests [33]. Plain radiography excludes concomitant hip or knee joint disease and can detect insertional calcific deposits at the greater trochanter. Ultrasound scans can be indicated to assess abductor tendon thickening, tendinopathy and partial- or full-thickness tears [27]. When there is suspicion of involvement of the gluteus muscle tendons, MRI is effective to recognize partial- and full-thickness tears, tendon calcification and muscle fatty atrophy.

### 29.7.2 Management

Conservative measures including relative rest, anti-inflammatory medication, ice, stretching and strengthening, physical therapy, shock wave therapy, ultrasound and local corticosteroid injection are commonly used [10]. However, often symptoms linger and recurrence occurs, and symptomatic athletes need to modify training for prolonged periods. Corticosteroid injections have been used for many years, but recurrence of symptoms and incomplete relief have been commonly recorded [10]. An RCT evaluated three treatment procedures, home training, corticosteroid injection and shock wave therapy [51]. Corticosteroid injections were found to be effective in the short term, with declining effectiveness over a few months. Repetitive low-energy radial SWT without local anaesthesia did not result in early pain relief, but provides a beneficial effect over several months, with a success rate of 68 % at 4 months and 74 % at 15 months. Home training exercises included progressive exercise including piriformis stretch, iliotibial band stretch standing, straight leg raise, wall squat with ball and gluteal strengthening. Their effects were evident after 4 months, with a 41 % success rate, increasing to 80 % at 15 months. Home training exercises were more effective in the longer term. In a case control study, Furia et al. found that 76.5 % of patients who participated in regular sporting activities and were treated with SWT were able to return to sports at their pre-injury levels, compared to the 66.7 % in the control group [15]. At the final follow-up, the number of patients with excellent and good results was significantly higher after SWT.

Several surgical procedures have been described for patients' refractory to conservative treatments. Brooker reported on five patients treated with fenestration or T-shaped incision of the iliotibial band [8]. At 1 year, patients were satisfied and had near-normal function, with a Harris Hip Score of 88 compared with a baseline score of 46. Slawski and Howard performed a simple longitudinal incision of the iliotibial band (ITB) and bursectomy [52]. All the patients were satisfied. Kagan firstly described rotator cuff tears of the hip [25]. He reported good outcomes after open repair and suture reattachment of the gluteus medius at a median follow-up of 45 months. Recently, Voss et al. also reported successful short-term outcomes on 10 patients who underwent endoscopic repair of gluteus medius tears [59]. However, despite the good results reported after open and arthroscopic procedures, all the studies are small and retrospective case series reporting success rates difficult to compare.

## 29.8 Summary

Evaluation and treatment of groin pain in athletes is challenging. It is important to remember that 'groin pain' means 'pain in the groin area' and is not a diagnosis. The groin anatomy is complex, and pain is often caused by the association of different conditions. Frequently, groin pain is a component of a more extensive pattern of 'groin pain disruption' which involves several concurrent pathologies. These may include not only intra-articular and extra-articular pathologies around the hip but also lumbar spine diseases, nerve entrapments and intra-abdominal and genitourinary pathologies. Muscular imbalance and pelvic instability seem to be the common denominator for many conditions causing athlete's groin pain. Correct diagnosis is mandatory for appropriate management. As the differential diagnosis for chronic groin pain is wide, thorough clinical examination is paramount. Symptoms may overlap, and no high-specificity tests are available.

Many different treatment protocols and strategies have been proposed to manage groin pain. Conservative management is indicated to stabilize the pelvis and pubic symphysis. Core stability exercises and muscle stretching and strengthening exercises of the abdominal, adductor, flexor and extensor hip muscles are effective for this purpose. Better results have been reported after surgical treatment for FAI and sportsman hernia. Surgery is also indicted for patients who do not respond to conservative management. However, given the complexity of the pathology, proper treatment should be multidisciplinary.

## References


1. Akermark C, Johansson C (1992) Tenotomy of the adductor longus tendon in the treatment of chronic groin pain in athletes. Am J Sports Med 20:640–643
2. Anderson K, Strickland SM, Warren R (2001) Hip and groin injuries in athletes. Am J Sports Med 29: 521–533
3. Aprato A, Jayasekera N, Villar R (2012) Timing in hip arthroscopy: does surgical timing change clinical results? Int Orthop 36:2231–2234
4. Bhosale PR, Patnana M, Viswanathan C, Szklaruk J (2008) The inguinal canal: anatomy and imaging features of common and uncommon masses. Radiographics 28:819–835
5. Bizzini M, Notzli HP, Maffiuletti NA (2007) Femoroacetabular impingement in professional ice hockey players: a case series of 5 athletes after open surgical decompression of the hip. Am J Sports Med 35:1955–1959
6. Beatty T (2012) Osteitis pubis in athletes. Curr Sports Med Rep 11:96–98
7. Branci S, Thorborg K, Bech BH, Boesen M, Nielsen MB, Hölmich P (2014) MRI findings in soccer players with long-standing adductor-related groin pain and asymptomatic controls. Br J Sports Med
8. Brooker AF Jr (1979) The surgical approach to refractory trochanteric bursitis. Johns Hopkins Med J 145:98–100
9. Choi H, McCartney M, Best TM (2011) Treatment of osteitis pubis and osteomyelitis of the pubic symphysis in athletes: a systematic review. Br J Sports Med 45:57–64
10. Del Buono A, Papalia R, Khanduja V, Denaro V, Maffulli N (2012) Management of the greater trochanteric pain syndrome: a systematic review. Br Med Bull 102:115–131
11. Diamond LE, Dobson FL, Bennell KL, Wrigley TV, Hodges PW, Hinman RS (2015) Physical impairments and activity limitations in people with femoroacetabular impingement: a systematic review. Br J Sports Med 49:230–242
12. Economopoulos KJ, Milewski MD, Hanks JB, Hart JM, Diduch DR (2013) Sports hernia treatment: modified bassini versus minimal repair. Sports Health 5:463–469
13. Ekstrand J, Ringborg S (2001) Surgery versus conservative treatment in soccer players with chronic groin pain: a prospective randomised study in soccer players. Eur J Sports Traumatol 23:141–145
14. Fricker PA, Taunton JE, Ammann W (1991) Osteitis pubis in athletes. Infection, inflammation or injury? Sports Med 12:266–279
15. Furia JP, Rompe JD, Maffulli N (2009) Low-energy extracorporeal shock wave therapy as a treatment for greater trochanteric pain syndrome. Am J Sports Med 37:1806–1813
16. Ganz R, Parvizi J, Beck M, Leunig M, Notzli H, Siebenrock KA (2003) Femoroacetabular impingement: a cause for osteoarthritis of the hip. Clin Orthop Relat Res 417:112–120
17. Garvey JF, Hazard H (2014) Sports hernia or groin disruption injury? Chronic athletic groin pain: a retrospective study of 100 patients with long-term follow-up. Hernia 18:815–823
18. Garvey JF, Read JW, Turner A (2010) Sportsman hernia: what can we do? Hernia 14:17–25
19. Gilmore J (1998) Groin pain in the soccer athlete: fact, fiction, and treatment. Clin Sports 17:787–793
20. Haviv B, Singh PJ, Takla A, O'Donnell J (2010) Arthroscopic femoral osteochondroplasty for cam lesions with isolated acetabular chondral damage. J Bone Joint Surg Br 92:629–633
21. Hiti CJ, Stevens KJ, Jamati MK, Garza D, Matheson GO (2011) Athletic osteitis pubis. Sport Med 41:361–376
22. Ito K, Minka MA II, Leunig M, Werlen S, Ganz R (2001) Femoroacetabular impingement and the cam-effect. A MRI-based quantitative anatomical study of the femoral head-neck offset. J Bone Joint Surg Br 83:171–176
23. Jaffe TA, O'Connell MJ, Harris JP, Paulson EK, Delong DM (2005) MDCT of abdominal wall hernias: is there a role for valsalva's maneuver? AJR Am J Roentgenol 184:847–851
24. Jardí J, Rodas G, Pedret C et al (2014) Osteitis pubis: can early return to elite competition be contemplated? Transl Med UniSa 10:52–58, 8
25. Kagan A 2nd (1999) Rotator cuff tears of the hip. Clin Orthop Relat Res 368:135–140
26. Karlsson MK, Dahan R, Magnusson H, Nyquist F, Rosengren BE (2014) Groin pain and soccer players: male versus female occurrence. J Sports Med Phys Fitness 54:487–493
27. Kong A, Van der Vliet A, Zadow S (2007) MRI and US of gluteal tendinopathy in greater trochanteric pain syndrome. Eur Radiol 17:1772–1783
28. Kopelman D, Kaplan U, Hatoum OA et al (2014) The management of sportsman's groin hernia in professional and amateur soccer players: a revised concept. Hernia. [Epub ahead of print]
29. Kunduracioglu B, Yilmaz C, Yorubulut M, Kudas S (2007) Magnetic resonance findings of osteitis pubis. J Magn Reson Imaging 25:535–539

30. Laborie LB, Lehmann TG, Engesæter I et al (2011) Prevalence of radiographic findings thought to be associated with femoroacetabular impingement in a population-based cohort of 2081 healthy young adults. Radiology 260:494–502
31. Larson CM (2014) Sports hernia/athletic pubalgia: evaluation and management. Sports Health 6:139–144
32. LeBlanc KE, LeBlanc KA (2003) Groin pain in athletes. Hernia 7:68–71
33. Lequesne M, Djian P, Vuillemin V, Mathieu P (2008) Prospective study of refractory greater trochanter pain syndrome. MRI findings of gluteal tendon tears seen at surgery. Clinical and MRI results of tendon repair. Joint Bone Spine 75:458–464
34. Leunig M, Beaulé PE, Ganz R (2009) The concept of femoroacetabular impingement: current status and future perspectives. Clin Orthop Relat Res 467:616–622
35. Maffulli N, Loppini M, Longo UG, Denaro V (2012) Bilateral mini-invasive adductor tenotomy for the management of chronic unilateral adductor longus tendinopathy in athletes. Am J Sports Med 40:1880–1886
36. Malviya A, Stafford GH, Villar RN (2012) Impact of arthroscopy of the hip for femoroacetabular impingement on quality of life at a mean follow-up of 3.2 years. J Bone Joint Surg Br 94:466–470
37. Mei-Dan O, Lopez V, Carmont MR, McConkey MO, Steinbacher G, Alvarez PD, Cugat RB (2013) Adductor tenotomy as a treatment for groin pain in professional soccer players. Orthopedics 36:1189–1197
38. Meyers WC, McKechnie A, Philippon MJ, Horner MA, Zoga AC, Devon ON (2008) Experience with "sports hernia" spanning two decades. Ann Surg 248: 656–665
39. Marshall PW, Murphy BA (2005) Core stability exercises on and off a swiss ball. Arch Phys Rehabil 86: 242–249
40. Morales-Conde S, Socas M, Barranco A (2010) Sportsmen hernia: what do we know? Hernia 14: 5–15
41. Naal FD, Miozzari HH, Wyss TF, Notzli HP (2011) Surgical hip dislocation for the treatment of femoroacetabular impingement in high-level athletes. Am J Sports Med 39:544–550
[AU10] 42. Orchard J, Read JW, Verrall GM, Slavotinek JP (2000) Pathophysiology of chronic groin pain in the athlete. ISMJ 1(1)
43. Paajanen H, Brinck T, Hermunen H, Airo I (2011) Laparoscopic surgery for chronic groin pain in athletes is more effective than nonoperative treatment: a randomized clinical trial with magnetic resonance imaging of 60 patients with sportsman's hernia (athletic pubalgia). Surgery 150:99–107
44. Paajanen H, Ristolainen L, Turunen H, Kujala UM (2011) Prevalence and etiological factors of sport-related groin injuries in top-level soccer compared to non-contact sports. Arch Orthop Trauma Surg 131: 261–266
45. Palisch A, Zoga AC, Meyers WC (2013) Imaging of athletic pubalgia and core muscle injuries: clinical and therapeutic correlations. Clin Sports Med 32:427–447
46. Papalia R, Del Buono A, Franceschi F, Marinozzi A, Maffulli N, Denaro V (2012) Femoroacetabular impingement syndrome management: arthroscopy or open surgery? Int Orthop (SICOT) 36:903–914
47. Reiman MP, Goode AP, Cook CE, Hölmich P, Thorborg K (2014) Diagnostic accuracy of clinical tests for the diagnosis of hip femoroacetabular impingement/labral tear: a systematic review with meta-analysis. Br J Sports Med [Epub ahead of print]
48. Robertson BA, Barker PJ, Fahrer M, Schache AG (2009) The anatomy of the pubic region revisited: implications for the pathogenesis and clinical management of chronic groin pain in athletes. Sports Med 39:225–234
49. Robertson IJ, Curran C, McCaffrey N, Shields CJ, McEntee GP (2011) Adductor tenotomy in the management of groin pain in athletes. Int J Sports Med 32:45–48
50. Rodriguez C, Miguel A, Lima H, Heinrichs K (2001) [AU11] Osteitis pubis syndrome in the professional soccer athlete: a case report. J Athl Train 36:437–440
51. Rompe JD, Segal NA, Cacchio A, Furia JP, Morral A, Maffulli N (2009) Home training, local corticosteroid injection, or radial shock wave therapy for greater trochanter pain syndrome. Am J Sports Med 37: 1981–1990
52. Slawski DP, Howard RF (1997) Surgical management of refractory trochanteric bursitis. Am J Sports Med 25:86–89
53. Schnute WJ (1961) Osteitis pubis. Clin Orthop 20:187–192
54. Segal NA, Felson DT, Torner JC et al (2007) Greater trochanteric pain syndrome: epidemiology and associated factors. Arch Phys Med Rehabil 88: 988–992
55. Serner A, van Eijck CH, Beumer BR, Hölmich P, Weir A, de Vos RJ (2015) Study quality on groin injury management remains low: a systematic review on treatment of groin pain in athletes. Br J Sports Med
56. Suarez JC, Ely EE, Mutnal AB et al (2013) Comprehensive approach to the evaluation of groin pain. J Am Acad Orthop Surg 21:558–570
57. Valent A, Frizziero A, Bressan S, Zanella E, Giannotti E, Masiero S (2012) Insertional tendinopathy of the adductors and rectus abdominis in athletes: a review. Muscles Ligaments Tendons J 10(2):142–148
58. Verrall GM, Slavotinek JP, Fon GT, Barnes PG (2007) Outcome of conservative management of athletic chronic groin injury diagnosed as pubic bone stress injury. Am J Sports Med 35:467–474
59. Voos JE, Shindle MK, Pruett A, Asnis PD, Kelly BT (2009) Endoscopic repair of gluteus medius tendon tears of the hip. Am J Sports Med 37:743–747
60. Weir A, Jansen J, van Keulen J, Mens J, Backx F, Stam H (2010) Short and mid-term results of a comprehensive treatment program for longstanding adductor-related groin pain in athletes: a case series. Phys Ther Sport 11:99–103
61. Werner J, Hägglund M, Waldén M, Ekstrand J (2009) UEFA injury study: a prospective study of hip and

groin injuries in professional football over seven consecutive seasons. Br J Sports Med 43:1036–1040

62. Williams PR, Thomas DP, Downes EM (2000) Osteitis pubis and instability of the pubic symphysis. When nonoperative measures fail. Am J Sports Med 28:350–355

63. Williams BS, Cohen SP (2009) Greater trochanteric pain syndrome: a review of anatomy, diagnosis and treatment. Anesth Analg 108:1662–1670

64. Wollin M, Lovell G (2006) Osteitis pubis in four young football players: a case series demonstrating successful rehabilitation. Phys Ther Sport 7:153–160

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