MIASNIKIEWICZ, Jakub, GOLENIEWSKA, Klaudia, KAMIL CIECHOMSKI, WIKTORIA CECUŁA, RYPEL-BOŚKA, Joanna, NATALIA SIUTA, ALEKSANDRA STUPECKA, MARCIN MIGIEL and IZABELA BRYNCZKA. Groin Pain: One Complaint, Numerous Potential Origins - Review of Literature. Quality in Sport. 2025;48:66910. eISSN 2450-3118.
https://doi.org/10.12775/QS.2025.48.66910
https://apcz.umk.pl/QS/article/view/66910

The journal has been awarded 20 points in the parametric evaluation by the Ministry of Higher Education and Science of Poland. This is according to the Annex to the announcement of the Minister of Higher Education and Science dated 05.01.2024, No. 32553. The journal has a Unique Identifier: 201398. Scientific disciplines assigned: Economics and Finance (Field of Social Sciences); Management and Quality Sciences (Field of Social Sciences).
Punkty Ministerialne z 2019 - aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398. Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych).
The authors declare that there is no conflict of interest regarding the publication of this paper.
Received: 27.11.2025. Revised: 03.12.2025. Accepted: 11.12.2025. Published: 15.12.2025.

Groin Pain: One Complaint, Numerous Potential Origins- Review of Literature

Jakub Miaśnikiewicz
Central Teaching Hospital of the Medical University of Lodz,
251 Pomorska Street, 92-213 Łódź, Poland
j.miasnikiewicz@gmail.com
ORCID: 0009-0003-3186-010X

Klaudia Goleniewska
University Clinical Hospital No. 2 of Medical University of Łódź,
113 Żeromskiego Street, 90-549 Łódź; Poland
kla.goleniewska@gmail.com
ORCID: 0009-0002-1597-9699

Kamil Ciechomski
Healthcare Service Center in Łowicz
28 Ułańska Street,
99-400 Łowicz, Poland
kamil.ciechomski@stud.umed.lodz.pl
ORCID 0009-0002-0049-2714

Wiktoria Cecuła
Central Clinical Hospital
of the Medical University of Łódź,
251 Pomorska Street,
92-213 Łódź, Poland
wiktoria.cecula@stud.umed.lodz.pl
ORCID: 0009-0005-8749-2312

Joanna Rypel-Bośka
Szpital Specjalistyczny Chorób Płuc
„Odrodzenie" im. Klary Jelskiej
ul. Gładkie 1, 34-500 Zakopane
joanna.rypel1999@gmail.com
ORCID: 0009-0002-2380-571X

Natalia Siuta
Niepubliczny Zakład Opieki Zdrowotnej w Gminie Nowy Targ
Ul. Podhalańska 2
34-471 Ludźmierz
natalia.siuta.99@gmail.com
ORCID: 0000-0001-8441-5382

Aleksandra Stupecka
University Clinical Hospital No. 1 named after Norbert Barlicki
22 Dr. Stefana Kopcińskiego Street, 90-153 Łódź, Poland
aleksandragieras@gmail.com
ORCID: 0009-0004-3585-9664

Marcin Migiel
Private Health Care Facility in the Commune of Nowy Targ
2 Podhalańska Street,
34-471 Ludźmierz, Poland
migielmarcin@gmail.com
ORCID: 0009-0003-3562-5051

Izabela Brynczka
Ludwik Rydygier Specialist Hospital, 1 Złota Jesień Street,
31-826 Kraków, Poland
iza.brynczka@gmail.com
ORCID: 0009-0002-1527-5659

Corresponding author:
Jakub Miaśnikiewicz
Email: j.miasnikiewicz@gmail.com

Abstract

Introduction

Groin pain is a prevalent and often persistent musculoskeletal issue among athletes, particularly in disciplines requiring rapid changes of direction, kicking, and high-intensity movements. Its multifactorial origin and overlapping symptomatology pose a diagnostic and therapeutic challenge for clinicians and therapists. Proper classification, accurate assessment, and individualized management are crucial for the best outcomes and minimizing time away from sport.

Aim of the Study

This literature review aims to synthesize current knowledge on the diagnosis, treatment, and prevention of groin pain in athletes, based on the latest evidence and clinical guidelines. The study also highlights the role of functional assessment and neuromuscular control in both rehabilitation and injury prevention.

Materials and Methods

A comprehensive literature search was conducted using electronic databases (PubMed, Scopus, Web of Science) to identify relevant studies, clinical guidelines, and systematic reviews published in recent years. This paper focuses on articles addressing the Doha agreement classification system, diagnostic modalities, rehabilitation strategies, and preventive programs targeting modifiable risk factors in athletic populations.

Conclusion

Groin pain management requires a multidisciplinary and individualized approach. The implementation of evidence-based classification systems and preventive strategies such as adductor strengthening, core stabilization, and proper load management can significantly reduce the incidence and recurrence of groin injuries. Future research should validate functional tests and refine preventive protocols to ensure greater efficacy and applicability in sport-specific contexts.

Keywords:groin pain, athletic pubalgia, sports hernia, Musculoskeletal injury, Injury prevention, Adductor strengthening, Doha classification, Functional assessment

1. Introduction

Groin pain represents a significant clinical and practical challenge, especially in athletes participating in sports that involve high-intensity movements [1–5]. While awareness of groin pain as a serious athletic injury dates back to at least 1980, as highlighted by Renström and Peterson [6], it continues to present a significant challenge for today’s sports medicine professionals. Groin pain may present as either acute or chronic, with a multifactorial etiology that frequently complicates both diagnosis and management. Anatomically, the groin region comprises a complex network of musculoskeletal, neural, and visceral structures, resulting in a high potential for overlapping pathologies [7]. Consequently, athletes often exhibit a wide range of symptoms that do not consistently correspond to a single tissue or structure, increasing the risk of misdiagnosis and prolonged recovery.

In recognition of ongoing challenges in terminology standardization and diagnostic approaches, the Doha Agreement Meeting in 2015 introduced a clinically relevant classification system. This framework distinguishes between adductor-related, iliopsoas-related, inguinal-related, pubic-related, hip-related groin pain and other causes of groin pain [8]. The classification aims to assist clinicians in making accurate diagnoses based on symptom location and provocative clinical tests, while also highlighting the possibility of multiple concurrent pathologies. Early and precise identification of the underlying cause(s) of groin pain is essential for developing targeted rehabilitation strategies and minimizing time lost from training and competition.

In addition to diagnostic complexity, groin pain is associated with a considerable risk of recurrence and long-term functional impairment, underscoring the importance of robust injury prevention strategies. Contemporary, evidence-based prevention programs increasingly focus on modifiable risk factors. These programs typically incorporate sport-specific strengthening exercises, dynamic warm-ups, flexibility training, and load management protocols. Tailored, sport-specific preventive strategies appear promising as a way to lower the risk of groin injuries.

This review aims to provide a comprehensive and integrated perspective on groin pain, encompassing both its clinical classification and diagnostic methodology, as well as current best practices in injury prevention. By synthesizing these two key aspects, the paper aims to assist clinicians, therapists, and sports professionals in optimizing the management of athletes affected by groin pain, thereby enhancing both short-term recovery and long-term athletic performance.

2. Epidemiology and Clinical Significance

2.1 Prevalence and Incidence

Groin pain is a common issue among athletes participating in sports that involve frequent changes of direction, sprinting, kicking, and physical contact, such as football, ice hockey, and bandy [1–5]. Among professional football players, groin injuries account for 5% to 18% of all injuries, with an annual incidence of up to 18 cases per 100 players [9,10]. In a study involving 17 professional football clubs, 68% of all groin-related injuries were attributed to the adductor muscles [9], which is consistent with data from collegiate athletes in the United States, where adductor or groin tears represented 24.5% of all hip and groin injuries [1]. In ice hockey, groin injuries make up approximately 10% of all injuries, and 45% of elite Swedish hockey players reported groin pain during a single season, with nearly 19% experiencing severe symptoms [11]. Most groin injuries are non-contact or result from overuse [1].

2.2 Risk Factors

According to level 1 and 2 evidence, the most consistently identified predictors of groin injury include previous groin injuries, higher levels of sports participation, decreased hip adductor strength, both in absolute values and relative to abductors, as well as a low level of sport-specific conditioning prior to the competitive season [8,12]. A prospective analysis involving 245 football players demonstrated that athletes with a history of groin pain in the previous season were 2.4 times more likely to experience similar complaints in the following season. Notably, each unit increase in hip adductor strength measured by the long-lever adductor squeeze test reduced injury risk by 35% [13]. Another study shows that previous lower limb injuries and a history of multiple groin injuries significantly increased the likelihood of developing severe groin-related symptoms [14]. Farrell et al., in their systematic review, identified previous acute groin injury, adductor muscle weakness, any injury sustained during the last season, and reduced rotational hip range of motion as significant risk factors for acute adductor muscle injury [15]. Moreover, a total hip joint rotation below 85° identified in preseason screening has been recognized as a factor strongly associated with the development of groin pain, although its clinical screening value remains limited [16]. Another important aspect is the influence of biological maturation. During periods of growth, forces acting on the adductor musculotendinous complex and the pubic bone significantly increase, potentially leading to overload injuries of the apophyses and tendon insertions. Therefore, young athletes should be closely monitored for signs of overuse, particularly during phases of intensified training [17]. From a demographic perspective, male sex, higher body mass index (BMI), and the preseason phase of the competitive season have been shown to increase the risk of groin pain [18,19]. A prospective analysis conducted among elite young soccer players demonstrated that higher BMI (OR = 1.32) and male sex (OR = 5.71) were significantly associated with an increased risk of developing groin pain during the season [20]. These findings are consistent with those of Tyler et al., who highlighted that groin injuries are particularly prevalent in football and ice hockey, and that their incidence may be reduced through pre-season risk factor screening [19].

Taken together, the current body of evidence supports the routine evaluation of individual risk profiles, especially history of groin or lower limb injuries, reduced adductor strength, and limited hip range of motion, before each season. While some demographic factors, such as sex or BMI, are non-modifiable, modifiable exposures like strength deficits and inadequate preseason conditioning represent key targets for early intervention strategies aimed at mitigating future groin injury risk.

2.3 Impact on Performance and Career

Groin pain is a prevalent and debilitating condition among athletes, particularly in sports involving rapid directional changes, kicking, and acceleration [1–5]. It not only affects immediate physical capacity but also poses a significant threat to long-term athletic participation and career sustainability. As highlighted by Whittaker et al., athletes with a history of groin injury have a 2.4 times greater risk of sustaining subsequent groin injuries (hazard ratio 2.4; 95% CI 1.2–4.6) compared to those without prior injury [12]. This cyclical pattern of reinjury may culminate not only in impaired performance and recurrent absences from training and competition but also in chronic pain, premature retirement, and even long-term functional disability [12]. Similarly, McSweeney et al. (2012) emphasize that both acute and chronic forms of hip and groin pain can lead to considerable morbidity, with some injuries severe enough to end athletic careers and impose financial burdens on professional organizations [21]. Functional deficits associated with groin pathology are also quantifiable. In a prospective case-control study, Chaari et al. (2022) demonstrated that athletes with groin pain exhibited significantly higher side-to-side asymmetries in the Y-Balance Test and reduced composite scores on the injured limb, which were associated with a markedly increased risk (OR = 7.48; 95% CI 2.15–26.00; $p < 0.01$) of subsequent lower-limb injuries [22]. These deficits may compromise neuromuscular control and stability, increasing vulnerability to further injury. As Elattar et al. (2016) succinctly noted, groin pain can lead to substantial disability and time lost from sports, underlining its potentially career-defining impact [23]. Collectively, these findings highlight the urgent need for early recognition, targeted rehabilitation, and injury prevention strategies to preserve athletic performance and career longevity.

3. Anatomical Structures Involved in Groin Pain

The groin and pelvic region is a complex anatomical area where diverse musculoskeletal and visceral disorders can cause nonspecific pain, making clinical diagnosis challenging [7]. Structurally, it encompasses the pubic symphysis, hip joint, inguinal canal, abdominal wall, and adductor musculature, all of which are functionally interrelated and may contribute to groin pain. The abdominal wall is layered from superficial to deep as follows: skin, superficial fascia, external oblique muscle and its aponeurosis, internal oblique, transversus abdominis, and finally the transversalis fascia and peritoneum [23]. The conjoint tendon, also known as the inguinal aponeurotic falx, is formed by the fused aponeuroses of the internal oblique and transversus abdominis muscles and joins the sheath of the rectus abdominis at a variable point near the pubic symphysis [7]. This anatomical configuration creates a structurally vulnerable region in the lower abdominal wall [23]. The inguinal canal, which transmits the spermatic cord in men and the round ligament in women, runs obliquely through this wall and is bordered by the inguinal ligament inferiorly (formed by the external oblique), the conjoint tendon superiorly, and the transversalis fascia posteriorly [24]. The inguinal canal itself has a floor (inguinal ligament), anterior wall (external oblique aponeurosis), posterior wall (transversalis fascia), and a roof formed by internal oblique and transversus abdominis fibers [25]. Notably, the pubic aponeurosis is a central structure in this region, formed by fibers from the rectus abdominis, external oblique, and conjoint tendon, and is continuous with the origins of the adductor longus and gracilis muscles. This aponeurotic connection—often referred to as the rectus abdominis/adductor aponeurosis—serves as a biomechanical fulcrum for force transmission across the anterior pelvis and is implicated in many cases of athletic pubalgia [23]. Additionally, the region is innervated by branches of the lumbar plexus (L1–L5), situated posterior to the psoas major, and neural variability in this region can contribute to divergent patterns of pain presentation and diagnostic complexity [26].

4. Classification and Etiology of Groin Pain

The Doha Agreement Meeting held in 2015 [8] marked a significant step toward unifying the clinical approach to athletic groin pain by introducing a standardized and anatomically-based classification system. Aimed at improving diagnostic clarity and consistency, this framework delineates five major categories of groin pain: adductor-related, iliopsoas-related, inguinal-related, pubic-related, and hip-related, while also allowing for the identification of other less common causes. The system emphasizes clinical assessment through symptom localization and specific provocative tests, acknowledging the frequent presence of overlapping or multiple pain sources in affected athletes.

4.1 Adductor-related groin pain

Adductor-related groin pain is a common clinical issue among athletes participating in sports involving cutting, pivoting, and kicking, such as soccer [27]. This condition is frequently associated with injury to the adductor longus tendon or its insertion on the pubic bone, as well as damage to the common aponeurosis connecting the rectus abdominis and adductor longus [28]. The primary injury mechanism involves forced abduction and external rotation of the hip, leading to acute trauma or repetitive microtrauma, which may result in chronic adductor enthesopathy [29].

Clinical diagnosis is primarily based on provocation tests, including palpation of the adductor longus insertion and resisted hip adduction, which demonstrate high diagnostic accuracy (80–95%) when compared to magnetic resonance imaging (MRI) [17]. Accurate palpation of the adductor longus tendon—from its insertion at the pubic bone down to the myotendinous junction approximately 10 cm distally within the muscle belly—is essential [17]. Diagnosis is established by reproduction by the isometric adductor squeeze test performed by using straight limbs, in association with tenderness on palpation over the adductor longus [17]. The most frequently positive clinical findings include tenderness at the adductor longus origin (94%) and pain during resisted hip adduction in maximal hip abduction (72%) [30]. However, the inter-examiner reliability of these tests varies from slight to substantial, and caution is advised, especially when palpating other adductor muscles not specifically involving the adductor longus [30].

Imaging plays an important complementary role in diagnosis. MRI, using appropriate sequences (e.g., T1-weighted and fat-suppressed T2-weighted), enables the evaluation of both acute and chronic pathologies in the adductor region, including enthesis edema and pubic bone stress changes, while also ruling out alternative causes of groin pain [29,31–33]. Specifically, MR imaging abnormalities in the anterior pubic bone and adductor longus enthesis have been demonstrated to correlate strongly and reliably with the clinically painful side in chronic adductor-related groin pain [34]. Ultrasound can also visualize muscle and tendon attachments, particularly noting that the adductor longus is the only adductor muscle with a distinct tendon, measuring approximately 1 cm, whereas the other adductors attach primarily via muscle fibers [35].

Crow et al. (2010) highlighted the utility of squeeze tests not only as diagnostic tools but also as effective methods for monitoring and identifying athletes at risk of developing groin pain [36]. Among the different test variations, the long-lever adductor squeeze test was found to offer the highest test–retest reliability and to generate the greatest torque in the adductor muscles, making it particularly useful for detecting early signs of muscular weakness. Their findings also demonstrated that reduced hip adductor strength is often present both prior to and at the onset of groin-related symptoms, reinforcing the role of strength testing in early risk identification and injury prevention. Furthermore, a history of previous groin injury and weak adductor muscles are considered significant intrinsic risk factors, with previously injured players exhibiting more than twice the risk of recurrence and those with weak adductors showing a fourfold increased risk of injury [37].

4.2 Iliopsoas-related groin pain

The iliopsoas muscle is a complex musculotendinous unit formed by the convergence of the iliacus and psoas major muscles [38]. The psoas major originates from the lateral surfaces of the vertebral bodies from T12 to L5, while the iliacus arises from the inner surface of the iliac fossa [26]. These two muscles unite at the level of the inguinal canal, crossing anterior to the hip joint to form a common tendon that inserts onto the lesser trochanter of the femur [26,38]. The iliopsoas muscle is involved in posture, walking, and running, and is the strongest hip flexor. Moreover, through its contribution towards the external rotation of the lower limb as well as the stability of the lumbar spine and pelvis, it is an integral part of movement biomechanics [38]. The iliopsoas bursa is the largest synovial bursa in the human body that resides under the musculotendinous part of the iliopsoas below the hip joint capsule and lateral to the femoral vessels [26]. It is around 5–7 cm in length and 2–4 cm in breadth, and is seen bilaterally in 98% of adults [39]. In around 15% of people, the iliopsoas bursa communicates directly with the hip joint [26,39]. This anatomical configuration is of importance in the lubrication as well as the movement of the tendon of the muscle and is a cause of pain in the conditions of iliopsoas bursitis, tendonitis, impingement, and snapping hip syndrome [38].

In athletes, the cause of iliopsoas pathology is usually due to two primary factors: acute injury and repetitive overuse. Acute injury most commonly is the result of eccentric contraction or direct trauma, with overuse injury being common in activities that entail repetitive hip flexion or lateral rotation of the thigh in running, football, and gymnastics [26]. The presentation of iliopsoas-associated groin pain is usually tenderness over the affected area [40]. According to

Weir et al. (2015) [8], this type of groin pain is more likely when pain is elicited during resisted hip flexion and/or stretching of the hip flexors. Iliopsoas-related groin pain typically encompasses two frequently observed clinical entities: iliopsoas bursitis and iliopsoas tendinitis.

4.2.1 Iliopsoas bursitis

Diagnosis of iliopsoas bursitis is not straightforward, as its clinical presentation is similar to other groin-pain-causing conditions like hernias, lymphadenopathy, and tumors. Thus, imaging is usually necessary in distinguishing the bursitis from other possible pathologic masses [41]. Precise diagnosis of iliopsoas bursitis requires the proper imaging methods for the evaluation of the structural and vascular features of the bursa. Ultrasound (US) examination facilitates the identification of the classic features of bursitis, like the existence of an anechoic or hypoechoic fluid between the iliopsoas tendon and the capsule of the hip joint [41]. The bursa, originating at the level of the femoral head, typically extends medially and may also extend deep to the psoas major tendon and iliopsoas tendon [42,43]. Alterations in the structure of the bursa, such as the existence of the septa, synovial thickening, and increased vascularization, might arouse the suspicion of malignancy [41].

Another method of assessing iliopsoas bursitis is with the use of Magnetic Resonance Imaging (MRI) that yields helpful information on the spatial and dimensional relationships of the involved structures [41]. For bursitis, a thin-walled, homogeneously hypointense nodule is typically observed in images obtained using the T1 sequence, and it appears hyperintense in images acquired using the T2 sequence. But with chronic conditions, the wall of the bursa is thicker, and the bursa contents become more complex [26]. MRI provides a comprehensive view of the iliopsoas tendon, bursa, and surrounding soft tissues. These imaging techniques are essential for accurate diagnosis and differentiating bursitis from other pathologies around the hip joint.

4.2.2 Tendinitis

Thickening of the iliopsoas tendon, hypoechoic changes, and an increased Doppler signal on imaging characterize iliopsoas tendinitis or tendinopathy [43]. These findings suggest inflammation or degeneration of the tendon, which is crucial for guiding treatment, particularly rehabilitation strategies focused on eccentric strengthening and load management [43]. The identification of tendinopathy is vital in rehabilitation because it enables clinicians to individualize treatment that facilitates tendon repair and prevents the condition from worsening. However, it should be noted that physical examination, ultrasound (US), and magnetic resonance imaging (MRI), although widely used in the diagnostic evaluation of iliopsoas tendinopathy, may not consistently correlate with outcomes. A recent study by Haskel et al. (2021) found that physical examination findings, as well as both US and MRI findings, were not predictive of a positive response to peritendinous iliopsoas corticosteroid injections in patients with presumed iliopsoas tendinopathy (IPT) [44]. This puts emphasis on a more integrated approach in the process of diagnosis, with clinical evaluation playing a specific role in distinguishing intra-articular hip pathologies from tendinopathy, and imaging not being an adequate tool in determining treatment.

4.3 Inguinal-related (sports hernia) groin pain

Inguinal-related groin pain, often referred to as "sports hernia" or "athletic pubalgia", is characterized by chronic, activity-related discomfort in the groin region without an actual herniation of soft tissue [45,46]. This condition is associated with a weakened posterior wall of the inguinal canal, particularly involving the transversalis fascia, leading to pain during physical exertion and to the protrusion of preperitoneal fat through areas such as the Hesselbach triangle or deep inguinal ring, without the presence of a true hernia [24,46]. The term "hernia" is considered a misnomer in this context, as there is no actual protrusion of abdominal contents, and the exact pathoanatomy remains a subject of debate [45]. In the context of athletic activities, repetitive stress and increased intra-abdominal pressure can weaken the posterior wall of the inguinal canal, particularly the transversalis fascia. This weakening may result in nerve irritation and localized pain, contributing to the clinical presentation of inguinal-related groin pain [45].

Ultrasound imaging serves as a primary diagnostic tool, enabling dynamic assessment of the inguinal canal during Valsalva maneuvers to detect fat protrusion medial to the inferior epigastric vessels [24]. Additionally, MRI can provide confirmation by revealing bulging of the anterior and posterior walls or the presence of fat within the spermatic cord, and may also visualize the conjoint tendon [24]. Despite its utility, the interpretation of ultrasonography findings requires caution. While posterior abdominal wall weakness and bulging can be visualized through dynamic ultrasonography, these findings are also prevalent in asymptomatic athletes, leading to a high risk of false-positive results [47]. Clinical examination remains a vital component in the diagnostic process [48]. A study involving 44 athletes demonstrated that the most prevalent positive palpation test was recognisable injury pain during scrotal invagination combined with a Valsalva maneuver, observed in 79% of cases [49]. However, the interexaminer reliability for various clinical tests ranged from slight to substantial, highlighting the need for a comprehensive assessment approach.

MRI plays a supplementary role, primarily to exclude alternative diagnoses such as inguinal canal masses [50]. Occasionally, it can identify injuries to aponeurotic structures as areas of hyperintensity. Nonetheless, similar to ultrasonography, MRI findings should be interpreted within the broader clinical context due to the potential for non-specific results [50]. The variability in terminology and the lack of consensus on the precise anatomical structures involved underscore the complexity of diagnosing and managing this condition [46].

4.4 Pubic-related groin pain

Pubic-related groin pain has been declared to be a specific clinical entity among the groin pain syndromes of athletes, with characteristics including localized pain over the pubic symphysis and surrounding bone structures [8,51]. The pubic symphysis is a fibrocartilaginous joint made up of a central disc between hyaline cartilage-covered articular surfaces of the pubic bones, capable of withstanding tensile, compressive, and shearing forces [51,52]. Under normal circumstances, it allows for little movement—up to 2 mm of translation and approximately 1° of rotation [52]. This joint is subjected to high levels of mechanical forces during sporting endeavors, especially those involving high-speed changes of direction, and is believed to be extremely provocative [51,53]. Clinically, patients typically present with midline pubic pain, which may radiate to the proximal adductor or lower abdominal regions [54]. Localized tenderness on direct palpation of the pubic symphysis is a typical physical finding [23].

Imaging studies, including MRI and radiographs, frequently reveal pubic-related changes such as bone marrow oedema (BMO), sclerosis, and joint surface irregularities [55–57]. However, their clinical significance is limited. Branci et al. [53] observed that although athletes with adductor-related groin pain (ARGP) demonstrated more severe BMO grades than asymptomatic players, many degenerative features (e.g., sclerosis and subchondral irregularities) were equally present in asymptomatic individuals. Similarly, Nielsen et al. (2025) [58] reported high prevalence of typical radiographic findings—bone lucency (87% vs. 83%), proliferation (67% vs. 61%), and sclerosis (64% vs. 50%)—in both symptomatic and asymptomatic football players. These findings did not correlate with groin pain severity or functional impairment as measured by the Five-Second Squeeze Test (5SST) or Hip and Groin Outcome Score (HAGOS). Despite the good reliability of the Aspetar Pubic Symphysis Radiographic Severity Score (PSRS), its use in clinical decision-making is limited, as it does not provide meaningful diagnostic differentiation [58]. Furthermore, in adolescent and young adult athletes, clinicians should consider pubic apophysitis as a differential diagnosis, particularly in cases of adductor-related groin pain [59]. Since the maturation of the apophyseal plate typically continues until approximately 21 years of age, MRI, rather than CT due to radiation concerns, may be a more appropriate modality to detect apophyseal stress-related changes [59]. Taken together, these findings highlight the importance of a thorough clinical examination over imaging, with direct palpation of the pubic symphysis remaining a cornerstone in diagnosing pubic-related groin pain.

4.5 Hip-related groin pain

The International Hip-related Pain Research Network (IHiPRN) consensus statement recommends that hip-related pain be organized into three main diagnostic categories: femoroacetabular impingement (FAI) syndrome, acetabular dysplasia and/or hip instability, and other intra-articular conditions not directly linked to specific bone morphology, such as isolated labral, chondral, or ligamentum teres pathologies [60]. This framework provides a clinically meaningful approach for organizing the differential diagnosis of hip-related groin pain, facilitating more targeted assessment and management strategies. Each of these conditions is characterized by unique biomechanical, structural, and clinical features that warrant further elaboration.

4.5.1 Femoroacetabular impingement (FAI)

Femoroacetabular impingement (FAI) syndrome is a motion-related clinical condition of the hip, defined by the presence of symptoms, clinical signs, and characteristic imaging findings, all of which are required for diagnosis [61,62]. The most common symptom is pain in the groin area that occurs during movement or while maintaining certain positions. This pain may also radiate to the lower back, buttocks, or thigh [61]. In addition to pain, patients often report catching, locking, clicking, stiffness, reduced range of motion, or a feeling of instability in the hip joint [61]. FAI is frequently associated with long-standing hip pain and may coexist with other intra-articular pathologies[63]. This clinical relevance is reflected in the population of elite athletes, where symptomatic FAI represents a considerable proportion of hip injuries. For instance, in a large, multisport NCAA Division I cohort, 3.0% of athletes were diagnosed with symptomatic FAI, accounting for 13.9% of all hip injuries; notably, hip injuries comprised 9.2% of all musculoskeletal injuries in this group [64].

The most frequently used clinical test is the flexion-adduction-internal rotation (FADIR) test, which, according to some studies, shows high sensitivity (0.94–0.99) but low specificity, making it more useful for ruling out than confirming FAI [65]. Initial imaging should comprise an anteroposterior radiograph of the pelvis and a lateral film of the femoral neck to determine joint morphology, diagnose cam or pincer deformity, and eliminate other sources of hip pain[62]. When a more detailed evaluation of cartilage or the labrum is necessary, cross-sectional imaging is recommended [61].

4.5.2 Acetabular dysplasia

Acetabular dysplasia is characterized by improper alignment of the femoral head and the acetabulum caused by differences in their orientation, size, and contour, which, in turn, may cause hip instability and an augmented load on the rim of the acetabulum during everyday activities.[60,66–68]. Traditionally, diagnosis has relied on the evaluation of acetabular anatomy using anteroposterior (AP) pelvic radiographs, with the lateral center-edge angle (LCEA) being the most commonly used parameter. However, acetabular dysplasia is a three-dimensional deformity that is not optimally assessed by standard two-dimensional imaging, which can lead to underdiagnosis or misclassification, especially in cases of borderline dysplasia [68,69]. Radiographic criteria indicative of dysplasia include an LCEA of less than 20 degrees and an acetabular index greater than 10 degrees, reflecting deficient lateral coverage and excessive acetabular inclination, respectively [69]. Additionally, the false-profile view is used to assess anterior coverage, with an anterior center-edge angle (ACEA) below 18 degrees suggesting anterior undercoverage [69]. Advanced imaging modalities such as 3D computed tomography and magnetic resonance arthrography are often employed in surgical candidates to better characterize complex bony anatomy and associated labral pathology [69].

Physical examination of patients with acetabular dysplasia typically reveals a positive Trendelenburg sign, an antalgic or Trendelenburg gait, and in some cases a positive impingement maneuver, which replicates the typical pain in the groin [69]. The Trendelenburg test is a measure of hip abductor function by observing pelvic droop when standing on a single leg, whereas passive hip flexion with a combination of adduction and internal rotation, which is the impingement test, is a highly sensitive test routinely employed in the clinic for the identification of both labral damage and bony impingement [61,69].

4.5.3 Hip instability

Hip instability, frequently associated with dysplasia, refers to non-physiological movement within the hip joint that results in pain, which may or may not be accompanied by a sense of joint instability [70]. Despite the inherently stable structure of the hip, due to the articulation between the femoral head and acetabulum, instability can arise from both traumatic and non-traumatic disruptions to bony and soft tissue integrity [70]. According to Reiman et al. [71], among available clinical assessments, the prone instability test has shown the greatest diagnostic promise, evidenced by a notably high positive likelihood ratio; however, the overall strength of this finding is constrained by the limited methodological quality of the supporting studies. Additional assessments, such as the abduction–hyperextension–external rotation (AB-HEER) test and the foot progression angle walking test, have demonstrated moderate utility; however, further validation is warranted. It is also worth noting that patient-reported symptoms alone remain insufficient for reliably diagnosing acetabular dysplasia or hip instability, given the current limitations in the evidence base [60]**.**

4.6 Other causes of groin pain

4.6.1 Inguinal hernia

An inguinal hernia typically presents as a swelling in the groin that becomes apparent during activities such as straining, lifting, coughing, or standing. This swelling is often associated with pain or discomfort, although these symptoms may be subtle. In some cases, complications such as obstruction or strangulation may occur [72]. Patients frequently report a progressively enlarging bulge in the groin; however, up to one-third of individuals may be asymptomatic. Symptoms tend to worsen with physical exertion or during the Valsalva maneuver [73].

On physical examination, the groin should be inspected for a visible bulge, and the examiner should observe for an expansile mass during straining [73]. In men, diagnosis is usually based on clinical assessment and rarely requires imaging. In contrast, imaging is more commonly indicated in women, as well as in cases of recurrent hernias, suspected postoperative complications, or when other causes of groin pain, such as groin masses or hydroceles, are considered [73]. Ultrasonography is the first-line imaging modality, with a reported sensitivity of 33% to 86% and specificity of 77% to 90% for detecting occult hernias [73]. It is beneficial when the hernia is not evident on clinical examination [73]. If groin pain is present without an associated swelling, alternative diagnoses such as groin strain, sports-related injury, or pathology of the hip or lower back should be considered [72].

4.6.2 Femoral hernia

Femoral hernias classically present as mildly painful, non-reducible lumps in the groin, typically located inferolateral to the pubic tubercle. However, not all cases present with a palpable mass; some patients may experience only vague abdominal or groin pain without any visible or palpable swelling [74]. This can make clinical diagnosis challenging, especially in the early stages or in patients with a higher body mass index. Ultrasonography serves as a valuable diagnostic tool in such cases, as it is non-invasive, widely accessible, and highly accurate in distinguishing femoral from inguinal hernias [74]. It offers both high sensitivity and specificity, making it the imaging modality of choice when clinical findings are inconclusive [74].

4.6.3 Nerve entrapment syndromes

Nerve entrapment syndromes, although rare, can be a clinically significant cause of groin pain and should be considered in the differential diagnosis, especially in athletes. Recognition of these syndromes is essential, as they offer potential for targeted treatment while avoiding unnecessary and invasive diagnostic procedures [75]. Groin pain of neural origin can result from previous pelvic surgeries, direct trauma, sports-related injuries, abdominal muscle hypertrophy due to overtraining, or idiopathic mechanisms [75]. Pain associated with nerve entrapment is often neuropathic, described as sharp, lancinating, or stabbing, and may radiate beyond the groin to include the pubic area, pelvic viscera, buttocks, thigh, or even knee [75,76]. Clinical features frequently include neurophysiological abnormalities such as hypoesthesia, hyperesthesia, or allodynia [76].

Specific nerve involvements present distinct patterns. Obturator nerve entrapment typically begins as a deep, poorly localized ache near the adductor origin at the pubic bone, with possible radiation to the ipsilateral anterosuperior iliac spine and medial thigh, particularly during activity [77]. Pain mimics intermittent claudication, subsiding with rest and recurring with exertion [77]. Diagnosis can be supported by needle electromyography (EMG) showing selective denervation of the hip adductors [77].

Ilioinguinal neuralgia is characterized by chronic, often continuous groin paresthesias and pain extending from the medial thigh to the genital region, scrotum or testicle in men and labia majora in women [78]. Pain is exacerbated by movements such as coughing or hip extension and alleviated by hip flexion. EMG, particularly with evaluation of the pyramidalis muscle, may aid diagnosis [78].

Genitofemoral neuralgia manifests as burning or intermittent pain and paresthesias in the inguinal area, extending to the genital region and upper medial thigh. Symptoms are aggravated by hip hyperextension and relieved by lying down with the hip flexed [78].

Given the overlap in symptomatology, careful clinical evaluation supported by electrophysiological studies is critical for accurate diagnosis and appropriate management.

4.6.4 Referred pain: lumbar spine, sacroiliac joint

In cases of groin pain without identifiable pathology on hip imaging, alternative sources such as sacroiliac joint (SIJ) dysfunction or lumbar spine disorders should be considered. Kurosawa et al. [79] reported that approximately 50% of patients with SIJ dysfunction experience groin pain, in contrast to fewer than 10% of patients with lumbar spinal stenosis (LSS) or lumbar disc herniation (LDH) [79]. Clinical signs useful in distinguishing SIJ dysfunction include pain in the posterior superior iliac spine (PSIS) area, pain aggravated by sitting, a positive SIJ shear test, and tenderness of the PSIS and long posterior sacroiliac ligament (LPSL) [79]. These findings help differentiate SIJ dysfunction not only from LSS but also from LDH [79].

4.6.5 Stress and avulsion fractures

Stress fractures are an important differential diagnosis in athletes presenting with groin pain, particularly following a sudden change in training intensity. These injuries result from repetitive mechanical overload and commonly present with gradually worsening pain during weight-bearing activities, such as running. The pain typically intensifies after activity and improves with rest [80]. Common sites of stress fractures that lead to groin pain include the pubic ramus, most frequently the inferior branch, and the femoral neck [80].

In contrast, avulsion fractures are more prevalent in adolescents and typically result from an unexpected, forceful muscular contraction. Palpation and stretching of the affected site reproduce the pain [80]. Diagnostic imaging, particularly plain radiographs, can reveal the avulsed bone fragment. These injuries most commonly involve muscle attachment sites of the sartorius, rectus femoris, gluteus minimus, iliopsoas, adductors, and transversus abdominis [80].

5. Prevention and Screening

In recent years, many studies have assessed the effectiveness of various prevention programs aimed at reducing the incidence of groin pain among athletes, particularly soccer players [81–83]. As previously discussed in this article, groin pain presents a significant challenge for both athletes and sports rehabilitation professionals, being one of the leading causes of time loss in sports, particularly those involving dynamic, multidirectional movements, such as football. Therefore, the development of effective preventive strategies is crucial in mitigating such injuries.

One of the most commonly adopted preventive approaches involves programming exercises that strengthen the adductor muscles and stabilize the pelvis, thereby reducing the risk of groin injuries. In a 16-week cluster randomized trial conducted by Fujisaki et al. (2022) [84], the effectiveness of a groin pain prevention program in male high school soccer players was evaluated, and risk factors associated with such injuries were identified. The study included 202 players from seven Japanese high schools, divided into three groups: Group A performed only the Copenhagen Adduction Exercise (CAE), Group B completed both the CAE and the Nordic Hamstring Exercise (NHE). At the same time, Group C continued standard training without additional interventions. The results showed that Group B experienced the lowest number of groin injuries (4 cases), compared to Group A (6 cases) and Group C (18 cases). Analysis revealed that the risk of groin injury was significantly lower in Group B (RR=0.19; 95% CI: 0.07–0.54) and Group A (RR=0.42; 95% CI: 0.19–0.90) compared to the control group. The group that performed both exercises reported the fewest injuries compared to the control group, and the risk of groin pain was nearly three times lower (RR=0.19; 95% CI: 0.07–0.54). These findings suggest that the combination of both exercises is more effective than performing either in isolation. Additionally, increased hip abduction range of motion and reduced eccentric adductor strength in the dominant leg were identified as risk factors for the development of groin pain.

Similar conclusions were drawn from a study by Cotellessa et al. (2023) [85], who conducted a 24-week prevention program that included exercises targeting adductor and core muscle strengthening. In the intervention group, the incidence of groin pain syndrome (GPS) was 14.3%, compared to 28.6% in the control group. Although these differences were not statistically significant, the study emphasized the importance of increasing hip adduction strength as a potential means of reducing injury risk. It is also noteworthy that the number of severe GPS cases was substantially lower in the intervention group, suggesting that strengthening programs may play a particularly important role in reducing the severity of injuries. However, further research involving larger sample sizes and diverse athletic populations is necessary to confirm these findings and optimize preventive strategies.

Additionally, analysis conducted by Short et al. (2021) [86] and studies published in Physical Therapy in Sport suggest that the key element in preventing groin injuries is an individualized approach for each athlete. Prevention programs that account for the specific needs of athletes, such as their previous injury history, muscle imbalances, or positioning requirements, demonstrate higher effectiveness in reducing injury risk. Such an approach enables better adjustment of the interventions, which in turn increases their effectiveness.

All these studies unequivocally indicate the importance of an integral approach towards the prevention of groin pain. The application of exercises that improve strength, range of movement, and control of movements is apparently crucial in preventing groin injuries, particularly in sports that require dynamic and multi-plane movements. Although not all studies revealed statistically significant differences, the results suggest that an effective preventive program should be individualized and incorporate both physical conditioning and the prevention of recurring injury. Such an approach might significantly contribute to the improvement of athletes' health and performance.

6. Conclusion

Groin pain constitutes a significant clinical and functional challenge in the athletic population. The area’s complex anatomy, combined with the fact that symptoms often stem from multiple overlapping causes, makes it tricky to pinpoint a single source and provide straightforward treatment. Despite the progress made in recent years, including the development and growing use of the Doha agreement classification system, there remains a need for more precise diagnostic strategies, particularly those integrating clinical examination with imaging and functional assessment.

A deeper understanding of pathophysiological mechanisms, including the roles of hip adductor weakness, reduced core stability, and altered biomechanics, has contributed to the development of more tailored rehabilitation protocols. At the same time, the consistently high incidence and recurrence rates of groin pain emphasize the critical importance of preventive measures. Evidence supports the use of multifaceted prevention programs that incorporate strengthening of the adductor and core musculature, neuromuscular control, dynamic flexibility, and load management, especially in high-risk sports and during periods such as the pre-season.

This review highlights the need for an integrative approach to both diagnosis and prevention of groin pain. Future research should focus on enhancing the objectivity and specificity of diagnostic tools, validating functional assessment batteries, and identifying reliable markers for risk stratification. Additionally, large-scale, sport-specific studies are necessary to evaluate the long-term effectiveness of injury prevention protocols across different athletic populations, sexes, and age groups.

Ultimately, the effective management of groin pain requires collaboration among sports medicine physicians, physiotherapists, strength and conditioning coaches, and the athletes themselves. By combining precise diagnosis with individualized rehabilitation and evidence-based prevention, we can not only reduce injury burden but also promote optimal athletic performance and long-term musculoskeletal health.

Disclosure

Authors do not report any disclosures.

Author's Contribution

Conceptualization: Jakub Miaśnikiewicz, Klaudia Goleniewska
Methodology: Klaudia Goleniewska, Aleksandra Stupecka
Software: not applicable.
Check: Natalia Siuta, Joanna Rypel-Bośka
Formal analysis: Joanna Rypel-Bośka, Kamil Ciechomski
Investigation: Natalia Siuta, Izabela Brynczka
Resources: Kamil Ciechomski, Wiktoria Cecuła
Data curation: Marcin Migiel, Aleksandra Stupecka
Writing-rough preparation: Jakub Miaśnikiewicz, Izabela Brynczka
Writing-review and editing: Klaudia Goleniewska, Klaudia Goleniewska
Visualization: Wiktoria Cecuła, Marcin Migiel
Supervision: Jakub Miaśnikiewicz, Klaudia Goleniewska
Project administration: Jakub Miaśnikiewicz
Receiving funding: not applicable.
All authors have read and agreed with the published version of the manuscript.

Funding Statement:

Not applicable.

Institutional Review Board Statement:

Not applicable.

Informed Consent Statement:

Not applicable.

Data Availability Statement:

The authors confirm that the data supporting this study are available in the article's references.

Conflict of Interest:

Authors declare no conflict of interest.
In preparing this work, the author(s) used Perplexity AI for the purpose of improving language and readability, text formatting, and verification of bibliographic styles. After using this tool/service, the author(s) have reviewed and edited the content as needed and accept full responsibility for the substantive content of the publication.

References

1. Kerbel YE, Smith CM, Prodromo JP, Nzeogu MI, Mulcahey MK. Epidemiology of Hip and Groin Injuries in Collegiate Athletes in the United States. *Orthop J Sports Med*. 2018;6(5). doi:10.1177/2325967118771676

2. Paajanen H, Hermunen H, Ristolainen L, Branci S. Long-standing groin pain in contact sports: a prospective case–control and MRI study. *BMJ Open Sport Exerc Med*. 2019;5(1):e000507. doi:10.1136/bmjsem-2018-000507

3. Quinn A. Hip and Groin Pain: Physiotherapy and Rehabilitation Issues. *Open Sports Med J*. 2010;4(1):93-107. doi:10.2174/1874387001004010093

4. Ryan J, DeBurca N, Mc Creesh K. Risk factors for groin/hip injuries in field-based sports: a systematic review. *Br J Sports Med*. 2014;48(14):1089-1096. doi:10.1136/bjsports-2013-092263

5. Serner A, Tol JL, Jomaah N, et al. Diagnosis of Acute Groin Injuries: A Prospective Study of 110 Athletes. *Am J Sports Med*. 2015;43(8):1857-1864. doi:10.1177/0363546515585123

6. Renström P, Peterson L. Groin injuries in athletes. *Br J Sports Med*. 1980;14(1):30-36. doi:10.1136/bjsm.14.1.30

7. Boutin RD, Robinson P. Pelvis and Groin: Practical Anatomy, Injury Patterns, and Imaging Findings. In: Hodler J, Kubik-Huch RA, von Schulthess GK, eds. *Musculoskeletal Diseases 2021-2024: Diagnostic Imaging*. IDKD Springer Series. Springer; 2021. Accessed June 6, 2025. http://www.ncbi.nlm.nih.gov/books/NBK570153/

8. Weir A, Brukner P, Delahunt E, et al. Doha agreement meeting on terminology and definitions in groin pain in athletes. *Br J Sports Med*. 2015;49(12):768-774. doi:10.1136/bjsports-2015-094869

9. Mosler AB, Weir A, Eirale C, et al. Epidemiology of time loss groin injuries in a men's professional football league: a 2-year prospective study of 17 clubs and 606 players. *Br J Sports Med*. 2018;52(5):292-297. doi:10.1136/bjsports-2016-097277

10. Weber MA, Rehnitz C, Ott H, Streich N. Groin Pain in Athletes. *RöFo - Fortschritte Auf Dem Geb Röntgenstrahlen Bildgeb Verfahr*. 2013;185(12):1139-1148. doi:10.1055/s-0033-1335304

11. Wörner T, Thorborg K, Clarsen B, Eek F. Incidence, Prevalence, and Severity of and Risk Factors for Hip and Groin Problems in Swedish Male Ice Hockey Players: A 1-Season Prospective Cohort Study. *J Athl Train*. 2022;57(1):72-78. doi:10.4085/1062-6050-0522.20

12. Whittaker JL, Small C, Maffey L, Emery CA. Risk factors for groin injury in sport: an updated systematic review. *Br J Sports Med*. 2015;49(12):803-809. doi:10.1136/bjsports-2014-094287

13. Esteve E, Casals M, Saez M, et al. Past-season, pre-season and in-season risk assessment of groin problems in male football players: a prospective full-season study. *Br J Sports Med*. 2022;56(9):484-489. doi:10.1136/bjsports-2020-102606

14. Langhout R, Tak I, Van Beijsterveldt AM, et al. Risk Factors for Groin Injury and Groin Symptoms in Elite-Level Soccer Players: A Cohort Study in the Dutch Professional Leagues. *J Orthop Sports Phys Ther*. 2021;48(9):704-712. doi:10.2519/jospt.2018.7990

15. Farrell SG, Hatem M, Bharam S. Acute Adductor Muscle Injury: A Systematic Review on Diagnostic Imaging, Treatment, and Prevention. *Am J Sports Med*. 2023;51(13):3591-3603. doi:10.1177/03635465221140923

16. Tak I, Engelaar L, Gouttebarge V, et al. Is lower hip range of motion a risk factor for groin pain in athletes? A systematic review with clinical applications. *Br J Sports Med*. 2017;51(22):1611-1621. doi:10.1136/bjsports-2016-096619

17. Thorborg K. Current Clinical Concepts: Exercise and Load Management of Adductor Strains, Adductor Ruptures, and Long-Standing Adductor-Related Groin Pain. *J Athl Train*. 2023;58(7-8):589-601. doi:10.4085/1062-6050-0496.21

18. Groin pain and soccer players: male versus female occurrence - The Journal of Sports Medicine and Physical Fitness 2014 August;54(4):487-93. Accessed May 20, 2025. https://www.minervamedica.it/en/journals/sports-med-physical-fitness/article.php?cod=R40Y2014N04A0487

19. Tyler TF, Silvers HJ, Gerhardt MB, Nicholas SJ. Groin Injuries in Sports Medicine. *Sports Health Multidiscip Approach*. 2010;2(3):231-236. doi:10.1177/1941738110366820

20. Schoffl J, Dooley K, Miller P, Miller J, Snodgrass SJ. Factors Associated with Hip and Groin Pain in Elite Youth Football Players: A Cohort Study. *Sports Med - Open*. 2021;7(1):97. doi:10.1186/s40798-021-00392-w

21. McSweeney SE, Naraghi A, Salonen D, Theodoropoulos J, White LM. Hip and Groin Pain in the Professional Athlete. *Can Assoc Radiol J*. 2012;63(2):87-99. doi:10.1016/j.carj.2010.11.001

22. Chaari F, Boyas S, Sahli S, et al. Postural balance asymmetry and subsequent noncontact lower extremity musculoskeletal injuries among Tunisian soccer players with groin pain: A prospective case control study. *Gait Posture*. 2022;98:134-140.

doi:10.1016/j.gaitpost.2022.09.004

23. Elattar O, Choi HR, Dills VD, Busconi B. Groin Injuries (Athletic Pubalgia) and Return to Play. *Sports Health Multidiscip Approach*. 2016;8(4):313-323. doi:10.1177/1941738116653711

24. Bou Antoun M, Reboul G, Ronot M, Crombe A, Poussange N, Pesquer L. Imaging of inguinal-related groin pain in athletes. *Br J Radiol*. 2018;91(1092):20170856. doi:10.1259/bjr.20170856

25. Tuma F, Lopez RA, Varacallo MA. Anatomy, Abdomen and Pelvis: Inguinal Region (Inguinal Canal). In: *StatPearls*. StatPearls Publishing; 2025. Accessed May 2, 2025. http://www.ncbi.nlm.nih.gov/books/NBK470204/

26. Chopra A, Robinson P. Imaging Athletic Groin Pain. *Radiol Clin North Am*. 2016;54(5):865-873. doi:10.1016/j.rcl.2016.04.007

27. McHugh MP, Nicholas SJ, Tyler TF. Adductor Strains in Athletes. *Int J Sports Phys Ther*. 2023;18(2). doi:10.26603/001c.72626

28. Zeppieri G, Smith MS, Roach RP. Nonsurgical Management of Adductor-related groin pain with Ultrasound-Guided Platelet-Rich Plasma Injection and Physical Therapy in a Competitive Soccer Player: A Case Report. *Int J Sports Phys Ther*. 2024;19(7). doi:10.26603/001c.120209

29. Dimitrakopoulou A, Schilders E. Sportsman’s hernia? An ambiguous term. *J Hip Preserv Surg*. 2016;3(1):16-22. doi:10.1093/jhps/hnv083

30. Heijboer WMP, Weir A, Vuckovic Z, Tol JL, Hölmich P, Serner A. Clinical examination tests for adductor- and pubic-related groin pain in athletes with longstanding groin pain: Inter-examiner reliability and prevalence of positive tests. *Phys Ther Sport*. 2024;66:9-16. doi:10.1016/j.ptsp.2023.12.008

31. Khan W, Zoga AC, Meyers WC. Magnetic Resonance Imaging of Athletic Pubalgia and the Sports Hernia. *Magn Reson Imaging Clin N Am*. 2013;21(1):97-110. doi:10.1016/j.mric.2012.09.008

32. Paajanen H, Hermunen H, Karonen J. Pubic Magnetic Resonance Imaging Findings in Surgically and Conservatively Treated Athletes with Osteitis Pubis Compared to Asymptomatic Athletes during Heavy Training. *Am J Sports Med*. 2008;36(1):117-121. doi:10.1177/0363546507305454

33. Zoga AC, Kavanagh EC, Omar IM, et al. Athletic Pubalgia and the “Sports Hernia”: MR Imaging Findings. *Radiology*. 2008;247(3):797-807. doi:10.1148/radiol.2473070049

34. Robinson P, Barron DA, Parsons W, Grainger AJ, Schilders EMG, O’Connor PJ. Adductor-related groin pain in athletes: correlation of MR imaging with clinical findings. *Skeletal Radiol*. 2004;33(8):451-457. doi:10.1007/s00256-004-0753-2

35. Pesquer L, Reboul G, Silvestre A, Poussange N, Meyer P, Dallaudière B. Imaging of adductor-related groin pain. *Diagn Interv Imaging*. 2015;96(9):861-869. doi:10.1016/j.diii.2014.12.008

36. Crow JF, Pearce AJ, Veale JP, VanderWesthuizen D, Coburn PT, Pizzari T. Hip adductor muscle strength is reduced preceding and during the onset of groin pain in elite junior Australian football players. *J Sci Med Sport*. 2010;13(2):202-204. doi:10.1016/j.jsams.2009.03.007

37. Engebretsen AH, Myklebust G, Holme I, Engebretsen L, Bahr R. Intrinsic Risk Factors for Groin Injuries among Male Soccer Players: A Prospective Cohort Study. *Am J Sports Med*. 2010;38(10):2051-2057. doi:10.1177/0363546510375544

38. Anderson CN. Iliopsoas. *Clin Sports Med*. 2016;35(3):419-433. doi:10.1016/j.csm.2016.02.009

39. Johnston CAM, Wiley JP, Lindsay DM, Wiseman DA. Iliopsoas Bursitis and Tendinitis: A Review. *Sports Med*. 1998;25(4):271-283. doi:10.2165/00007256-199825040-00005

40. Tramer JS, Holmich P, Safran MR. The Iliopsoas: Anatomy, Clinical Evaluation, and Its Role in Hip Pain in the Athlete: A Scoping Review. *JAAOS - J Am Acad Orthop Surg*. 2024;32(13):e620. doi:10.5435/JAAOS-D-23-01166

41. Corvino A, Venetucci P, Caruso M, et al. Iliopsoas bursitis: The role of diagnostic imaging in detection, differential diagnosis and treatment. *Radiol Case Rep*. 2020;15(11):2149-2152. doi:10.1016/j.radcr.2020.08.036

42. Jacobson JA. *Fundamentals of Musculoskeletal Ultrasound E-Book: Fundamentals of Musculoskeletal Ultrasound E-Book*. Elsevier Health Sciences; 2017.

43. Manske RC, Voight M, Wolfe C, Page P, Bardowski B. The Use of Diagnostic Musculoskeletal Ultrasound for the Evaluation of the Iliopsoas in the Anterior Hip: A Guide for Rehabilitation Providers. *Int J Sports Phys Ther*. 2024;19(12):1642-1646. doi:10.26603/001c.126334

44. Haskel JD, Kaplan DJ, Fried JW, Youm T, Samim M, Burke C. The Limited Reliability of Physical Examination and Imaging for Diagnosis of Iliopsoas Tendinitis. *Arthrosc J Arthrosc Relat Surg*. 2021;37(4):1170-1178. doi:10.1016/j.arthro.2020.12.184

45. Minnich JM, Hanks JB, Muschaweck U, Brunt LM, Diduch DR. Sports Hernia: Diagnosis and Treatment Highlighting a Minimal Repair Surgical Technique. *Am J Sports Med*. 2011;39(6):1341-1349. doi:10.1177/0363546511402807

46. Swan KG, Wolcott M. The Athletic Hernia: A Systematic Review. *Clin Orthop*. 2007;455:78-87. doi:10.1097/BLO.0b013e31802eb3ea

47. Thorborg K, Reiman MP, Weir A, et al. Clinical Examination, Diagnostic Imaging, and Testing of Athletes With Groin Pain: An Evidence-Based Approach to Effective Management. *J Orthop Sports Phys Ther*. 2018;48(4):239-249. doi:10.2519/jospt.2018.7850

48. Brunt LM. Hernia Management in the Athlete. *Adv Surg*. 2016;50(1):187-202. doi:10.1016/j.yasu.2016.03.014

49. Heijboer WMP, Vuckovic Z, Weir A, Tol JL, Hölmich P, Serner A. Clinical examination for athletes with inguinal-related groin pain: interexaminer reliability and prevalence of

positive tests. *BMJ Open Sport Exerc Med*. 2023;9(1):e001498. doi:10.1136/bmjsem-2022-001498

50. Zoga AC, Roedl JB. *Imaging of the Athlete, An Issue of Radiologic Clinics of North America*. Elsevier Health Sciences; 2016.

51. Serner A, Arnaiz J, Mosler A, et al. Classifying radiographic changes of the pubic symphysis in male athletes: Development and reproducibility of a new scoring protocol. *Eur J Radiol*. 2021;134:109452. doi:10.1016/j.ejrad.2020.109452

52. Becker I, Woodley SJ, Stringer MD. The adult human pubic symphysis: a systematic review. *J Anat*. 2010;217(5):475-487. doi:10.1111/j.1469-7580.2010.01300.x

53. Branci S, Thorborg K, Bech BH, Boesen M, Nielsen MB, Hölmich P. MRI findings in soccer players with long-standing adductor-related groin pain and asymptomatic controls. *Br J Sports Med*. 2015;49(10):681-691. doi:10.1136/bjsports-2014-093710

54. Mandelbaum B, Mora SA. Osteitis pubis. *Oper Tech Sports Med*. 2005;13(1):62-67. doi:10.1053/j.otsm.2004.09.011

55. Branci S, Thorborg K, Nielsen MB, Hölmich P. Radiological findings in symphyseal and adductor-related groin pain in athletes: a critical review of the literature. *Br J Sports Med*. 2013;47(10):611-619. doi:10.1136/bjsports-2012-091905

56. Coker DJ, Zoga AC. The Role of Magnetic Resonance Imaging in Athletic Pubalgia and Core Muscle Injury. *Top Magn Reson Imaging*. 2015;24(4):183. doi:10.1097/RMR.0000000000000056

57. Kunduracioglu B, Yilmaz C, Yorubulut M, Kudas S. Magnetic resonance findings of osteitis pubis. *J Magn Reson Imaging*. 2007;25(3):535-539. doi:10.1002/jmri.20818

58. Nielsen MF, Hölmich P, Branci S, et al. Pubic-Related Radiographic Findings in Male Football Players With Long-Standing Groin Pain, and Asymptomatic Controls — Are They Clinically Relevant? *Scand J Med Sci Sports*. 2025;35(5):e70068. doi:10.1111/sms.70068

59. Sailly M, Whiteley R, Read JW, Giuffre B, Johnson A, Hölmich P. Pubic apophysitis: a previously undescribed clinical entity of groin pain in athletes. *Br J Sports Med*. 2015;49(12):828-834. doi:10.1136/bjsports-2014-094436

60. Reiman MP, Agricola R, Kemp JL, et al. Consensus recommendations on the classification, definition and diagnostic criteria of hip-related pain in young and middle-aged active adults from the International Hip-related Pain Research Network, Zurich 2018. *Br J Sports Med*. 2020;54(11):631. doi:10.1136/bjsports-2019-101453

61. Clohisy JC, Knaus ER, Hunt DM, Lesher JM, Harris-Hayes M, Prather H. Clinical Presentation of Patients with Symptomatic Anterior Hip Impingement. *Clin Orthop*. 2009;467(3):638-644. doi:10.1007/s11999-008-0680-y

62. Griffin DR, Dickenson EJ, O’Donnell J, et al. The Warwick Agreement on femoroacetabular impingement syndrome (FAI syndrome): an international consensus statement. *Br J Sports Med*. 2016;50(19):1169-1176. doi:10.1136/bjsports-2016-096743

63. Reiman MP, Peters S, Sylvain J, Hagymasi S, Ayeni OR. Prevalence and Consistency in Surgical Outcome Reporting for Femoroacetabular Impingement Syndrome: A Scoping Review. *Arthroscopy*. 2018;34(4):1319-1328.e9. doi:10.1016/j.arthro.2017.11.037

64. Safran MR, Foard SJ, Robell K, Pullen WM. Incidence of Symptomatic Femoroacetabular Impingement: A 4-Year Study at a National Collegiate Athletic Association Division I Institution. *Orthop J Sports Med*. 2022;10(4):23259671221084979. doi:10.1177/23259671221084979

65. Reiman MP, Goode AP, Cook CE, Hölmich P, Thorborg K. Diagnostic accuracy of clinical tests for the diagnosis of hip femoroacetabular impingement/labral tear: a systematic review with meta-analysis. *Br J Sports Med*. 2015;49(12):811-811. doi:10.1136/bjsports-2014-094302

66. Genda E, Iwasaki N, Li G, MacWilliams BA, Barrance PJ, Chao EYS. Normal hip joint contact pressure distribution in single-leg standing—effect of gender and anatomic parameters. *J Biomech*. 2001;34(7):895-905. doi:10.1016/S0021-9290(01)00041-0

67. Henak CR, Abraham CL, Anderson AE, et al. Patient-specific analysis of cartilage and labrum mechanics in human hips with acetabular dysplasia. *Osteoarthritis Cartilage*. 2014;22(2):210-217. doi:10.1016/j.joca.2013.11.003

68. Wilkin GP, Ibrahim MM, Smit KM, Beaulé PE. A Contemporary Definition of Hip Dysplasia and Structural Instability: Toward a Comprehensive Classification for Acetabular Dysplasia. *J Arthroplasty*. 2017;32(9):S20-S27. doi:10.1016/j.arth.2017.02.067

69. Breidel KE, Coobs BR. Evaluating and managing acetabular dysplasia in adolescents and young adults. *JAAPA*. 2019;32(8):32-37. doi:10.1097/01.jaa.0000574520.01551.65

70. Shu B, Safran MR. Hip Instability: Anatomic and Clinical Considerations of Traumatic and Atraumatic Instability. *Clin Sports Med*. 2011;30(2):349-367. doi:10.1016/j.csm.2010.12.008

71. Reiman MP, Décary S, Mathew B, Reiman CK. Accuracy of Clinical and Imaging Tests for the Diagnosis of Hip Dysplasia and Instability: A Systematic Review. *J Orthop Sports Phys Ther*. 2019;49(2):87-97. doi:10.2519/jospt.2019.8476

72. Kurzer M, Kark A, Hussain T. Inguinal Hernia Repair. *J Perioper Pract*. 2007;17(7):318-330. doi:10.1177/175045890701700704

73. Shakil A, Aparicio K, Barta E, Munez K. Inguinal Hernias: Diagnosis and Management. *Am Fam Physician*. 2020;102(8):487-492.

74. Whalen HR, Kidd GA, O'Dwyer PJ. Femoral hernias. *BMJ*. 2011;343(dec08 1):d7668-d7668. doi:10.1136/bmj.d7668

75. Rassner L. Lumbar Plexus Nerve Entrapment Syndromes as a Cause of Groin Pain in Athletes: *Curr Sports Med Rep*. 2011;10(2):115-120. doi:10.1249/JSR.0b013e318214a045

76. Loos MJA, Scheltinga MRM, Roumen RMH. Surgical Management of Inguinal Neuralgia

After a Low Transverse Pfannenstiel Incision. *Ann Surg*. 2008;248(5):880-885. doi:10.1097/SLA.0b013e318185da2e

77. Bradshaw C, McCrory P, Bell S, Brukner P. Obturator Nerve Entrapment: A Cause of Groin Pain in Athletes. *Am J Sports Med*. 1997;25(3):402-408. doi:10.1177/036354659702500322

78. Viswanathan A, Kim DH, Reid N, Kline DG. SURGICAL MANAGEMENT OF THE PELVIC PLEXUS AND LOWER ABDOMINAL NERVES. *Neurosurgery*. 2009;65(4):A44-A51. doi:10.1227/01.NEU.0000339124.49566.F2

79. Kurosawa D, Murakami E, Aizawa T. Groin pain associated with sacroiliac joint dysfunction and lumbar disorders. *Clin Neurol Neurosurg*. 2017;161:104-109. doi:10.1016/j.clineuro.2017.08.018

80. LeBlanc KE, LeBlanc KA. Groin pain in athletes. *Hernia*. 2003;7(2):68-71. doi:10.1007/s10029-002-0105-x

81. Cotellessa F, Puce L, Formica M, et al. Effectiveness of a Preventative Program for Groin Pain Syndrome in Elite Youth Soccer Players: A Prospective, Randomized, Controlled, Single-Blind Study. *Healthc Basel Switz*. 2023;11(17):2367. doi:10.3390/healthcare11172367

82. Esteve E, Rathleff MS, Bagur-Calafat C, Urrútia G, Thorborg K. Prevention of groin injuries in sports: a systematic review with meta-analysis of randomised controlled trials. *Br J Sports Med*. 2015;49(12):785-791. doi:10.1136/bjsports-2014-094162

83. Hölmich P, Larsen K, Krogsgaard K, Gluud C. Exercise program for prevention of groin pain in football players: a cluster-randomized trial: Exercise program for prevention of groin pain in football players. *Scand J Med Sci Sports*. 2010;20(6):814-821. doi:10.1111/j.1600-0838.2009.00998.x

84. Fujisaki K, Akasaka K, Otsudo T, Hattori H, Hasebe Y, Hall T. Effects of a Groin Pain Prevention Program in Male High School Soccer Players: A Cluster-Randomized Controlled Trial. *Int J Sports Phys Ther*. 2022;17(5). doi:10.26603/001c.36631

85. Cotellessa F, Puce L, Formica M, et al. Effectiveness of a Preventative Program for Groin Pain Syndrome in Elite Youth Soccer Players: A Prospective, Randomized, Controlled, Single-Blind Study. *Healthcare*. 2023;11(17):2367. doi:10.3390/healthcare11172367

86. Short SM, MacDonald CW, Strack D. Hip and Groin Injury Prevention in Elite Athletes and Team Sport - Current Challenges and Opportunities. *Int J Sports Phys Ther*. 2021;16(1):270-281. doi:10.26603/001c.18705