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GROIN PAIN SYNDROME IN ATHLETES: A STRUCTURED NARRATIVE REVIEW

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ABSTRACT – Groin pain syndrome (GPS) is a common clinical situation in sports that involves rapid accelerations, decelerations, changes of direction, and kicking. Despite this, there remains confusion about the taxonomic classification of GPS, impacting correct diagnosis. This review starts with the first descriptive studies on GPS and progresses to provide a comprehensive overview of all the relevant publications currently available in the literature. This structured narrative review was conducted according to the Arksey and O'Malley methodological framework. After screening 1,032 articles, 89 have been and summarized in this study. Based on the studies included, the review was subdivided into four sections: initial descriptive studies of GPS, GPS taxonomic classification, GPS conservative treatment, and GPS surgical treatment.

Current literature highlights that GPS often represents a genuine diagnostic challenge for clinicians and requires a complex and multi-specialist diagnostic approach capable of evaluating the entirety of the clinical conditions that can cause GPS. Therefore, it is inexact to talk about conservative and surgical treatment of GPS in general terms.

KEYWORDS: Groin disruption, Athletic pubalgia, Inguinal pathologies, Sport hernia, Gilmore's groin.

INTRODUCTION

Groin pain syndrome (GPS) is an important current clinical topic in sports medicine and is an increasing problem in many sports involving cutting maneuvers, changes in direction, and kicking, such as soccer, football, ice hockey, handball, and rugby[1,2]. Indeed, due to numerous risk factors such as high activity loads and short recovery periods between matches, GPS is on the increase in several sports, such as soccer, where it already represents 10-18% of all-time loss injuries[1]. Recent studies[3], based on time loss, report a GPS incidence in soccer of up to 2.1/1,000 hours of total exposure. In such studies[3-7], injuries are recorded only if a player is unable to participate in soccer training and/or in a competition. There is evidence that this "time loss" definition detects only one-third of all GPS injuries in male soccer players[8]. Therefore, the "time loss injury" approach may be inappropriate for assessing GPS epidemiology as the recorded data could merely reflect the surface of a more extensive underlying issue[8]. Indeed, it is not

uncommon for soccer players to continue training despite pain due to GPS, and thus, the definition of "overuse injury" may be more appropriate for the description of certain types of GPS injuries[9,10]. GPS covers a range of symptoms localized in the inguinal-pubic-adductor area and shows a multifactorial etiopathogenesis. Consequently, its diagnosis, conservative and surgical treatment, requires a multidisciplinary approach. The anatomical and biomechanical complexity of the groin area often makes GPS a challenge to diagnose. Moreover, the sheer number of different clinical conditions that can give rise to this syndrome is probably why GPS is still not fully understood and remains a subject of scientific debate. This structured narrative review (SNR) traces how knowledge of the clinical, diagnostic, and therapeutic concepts concerning GPS has evolved toward the current findings published in present-day literature.

MATERIALS AND METHODS

This SNR is based on the Arksey and O'Malley methodological framework[11]. The purpose of an NR is to summarize, in a state-of-the-art publication, a particular topic within a specific area of research available in the literature. The purpose of this NR is to consult and discuss current literature and to document how our understanding of the clinical, diagnostic, and therapeutic concepts concerning GPS has evolved. This SNR unfolds in a five-step process typical of structured narrative studies[11,12], i.e.:

Step 1: Identification of the Research Question

This SNR aimed to answer the question: "How has knowledge of the clinical, radiological, diagnostic and therapeutic aspects of GPS evolved?"

Step 2: Identification and Studies Selection

Research started on 10 December 2023 and finished on 30 December 2023 and was conducted without publication data limitation or language restriction on the following databases: PubMed/MEDLINE, Scopus, ISI, EXCERPTA. The string of keywords used was: "groin pain syndrome," "pubalgia," "athletic pubalgia," "inguinal disruption," "inguinal hernia," "sport hernia," "osteitis pubis," "cam-Fai" and "adductor tendinopathy," suitably connected to each other through Boolean operators.

Step 3: Studies Selection for Detailed Analysis

The inclusion criteria adopted for this SNR were based on the following studies 1) GPS in populations of athletes, 2) GPS etiopathogenesis, 3) GPS taxonomic classification, 4) GPS clinical assessment, 5) GPS radiological assessment, 6) GPS conservative and surgical treatment. All articles complying with these inclusion criteria were evaluated for their relevance by four reviewers (BGN, BAN, BAL, AA). Cross-references from the selected articles were screened to verify their possible relevance. All double citations were removed. For each article, the relevant information was extracted and recorded on an *ad hoc* Excel spreadsheet. For every discussion concerning the inclusion or exclusion of some articles, the opinion of the senior author (BGN) was decisive.

Step 4: Data Extraction

In agreement with the recommendations formulated by Arskey and O'Malley[11], a "descriptive-analytical" data extraction tool was developed by the first author (BGN). The purpose of this extraction tool was to contextualize and rationally classify the studies' content.

Step 5: Summary of the Selected Study Results

Qualitative content analysis[13] was used to summarize the data from the selected studies. No attempt was made to represent the data obtained from the selected studies in other terms (e.g., statistical

analysis, meta-analysis). This SNR is restricted to a synthetic narrative description of the main data obtained from the different studies considered.

RESULTS

This SNR included 89 articles; the process of article selection is presented in Figure 1.
The studies were grouped into five main categories, i.e.:

1. Initial descriptive studies of GPS.
2. GPS taxonomic classification.
3. GPS radiological assessment.
4. GPS conservative treatment.
5. GPS surgical treatment.

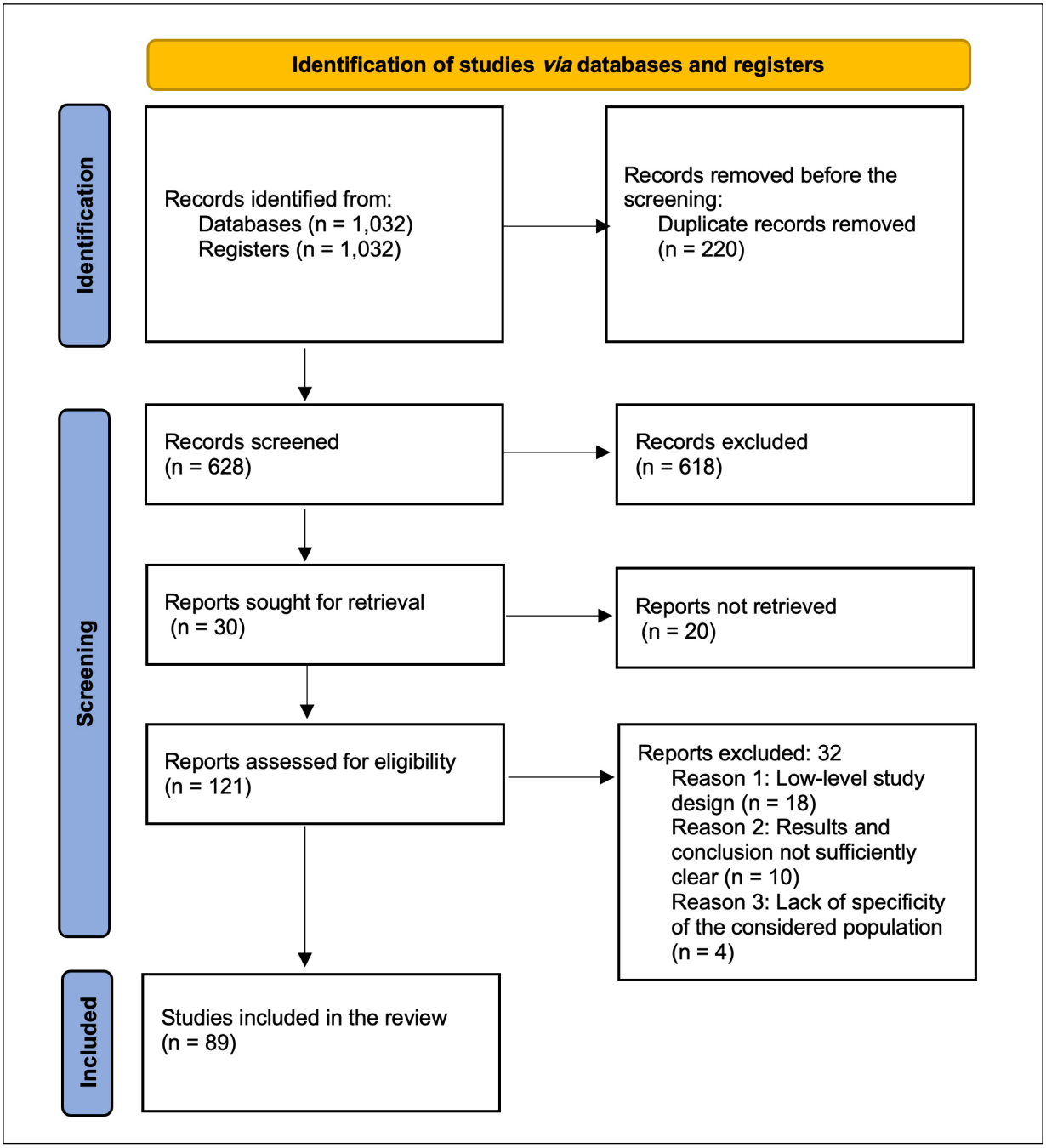

Figure 1. The process of articles' selection.

INITIAL DESCRIPTIVE STUDIES OF GPS

The first description of GPS (defined with the term "pubalgia") dates back over 90 years ago and is attributed to Spinelli[14], who observed and described this pathology in a group of young fencers. It was 1955 before a second author[15] addressed the topic of pain in the inguinal region. Ten years later, Knoch[16] published a study on pain in the symphysis-inguinal region and addressed the role of differential diagnosis. In 1968, Iles[17] published an article in Canadian Family Physician entitled "Adductor injury: a common cause of groin pain often misdiagnosed as hernia," which illustrates the limited understanding of GPS at the time. Indeed, the concepts disclosed by the author were confusing, especially from an epidemiological point of view. The pectineus was indicated as the major muscle involved in injury to the adductors muscle complex, with the adductor longus in second place. Furthermore, this article[17] contains the obsolete term "strain," the use of which is now discouraged[18]. In this paper[17], the author compares the clinical condition of adductor strain to that of supraspinatus strain and "tennis elbow," confusing the clinical condition of an adductor injury with that of an adductor tendinopathy. However, the conceptual errors in this study are not limited to the one mentioned above. The author also confuses the symptoms of an inguinal hernia with those of an adductor injury. In fact, he states that "a patient suffering from an adductor strain may complain of pain during sexual intercourse or when lifting a weight"[17]. However, these are typical symptoms of a hernia pathology. In addition to this, the relationship between GPS and the presence of an inguinal hernia is strongly questioned. As far as the medical treatment is concerned, the author states, "The most effective treatment seems to be the local injection of a corticosteroid preparation combined with procaine (or a similar agent such as xylocaine)"[17]. Therefore, if the term "adductor strain" refers to "adductor injury," this type of treatment is absolutely incompatible with the current guidelines[18,19] on the treatment of muscle injuries. Even when discussing differential diagnoses, conceptual confusion is always present. However, the paper deserves some acknowledgment. Specifically, in reference to small hernias, which are accurately described as "difficult to diagnose," the terms "incipient hernia," "weakness at the internal ring," and "wide ring" are mentioned. Although used in a debatable context, these terms are conceptually correct and remain in use today.

In 1974, Harris and Murray[20], in a paper focused on the radiological study of the pubic symphysis in 37 athletes, found radiological changes in 76% of the subjects similar to those of osteitis pubis. However, in the text, the authors[20] wrote, "Though the radiological appearance may resemble that of osteitis pubis, there was no evidence that infection caused the lesion in this series". This shows that, at the time, the concept of overuse pubic osteopathy had not yet been correlated with the radiological changes of the symphysis found in athletes affected by GPS. In 1980, Smodlaka[21] revised the theory based on outdated sources[22], suggesting that the primary cause of GPS was the opposing tension on the symphysis caused by the adductor longus and the rectus abdominis. This theory, unfortunately still used today, later became known as the "rectus-adductor syndrome". Over the years, the rectus adductor syndrome became the main cause of GPS in football players[22]. This hypothesis was based on the fact that football players were considered to be athletes with strong adductor muscles and weak abdominal muscles. For many years, the main etiopathogenesis of GPS has been attributed to this presumed imbalance in the symphysis. In the early 1980s, there were several speculative hypotheses on the etiopathogenesis of GPS, such as that of the "pseudo-visceral syndrome," "pseudo-hip pain", and "adductor pseudo-tendinitis"[23]. In this period, one of the few noteworthy attempts in dealing with the etiopathogenetic classification of GPS can be attributed to Brunet et al[24]. The authors, based on previous studies by Durey and Rodineau[25], classified GPS into three different anatomical-clinical conditions: abdominal wall pathology affecting the lower part of the external and internal obliquus and transversus abdominis muscles, the adductor muscles pathology, which mainly affects the adductors superficial lodge (i.e., adductor longus and pectineus) and the pubic symphysis pathology.

In 1998, Gilmore[26] introduced the concept of "Gilmore's groin". The author describes this clinical situation as a severe musculotendinous injury of the groin, which can be successfully treated by surgical restoration of normal anatomy. Gilmore refers to various pathologies found during surgical intervention, the most frequent of which were torn external oblique aponeurosis, torn conjoined tendon, conjoined tendon torn from the pubic tubercle, dehiscence between the conjoined tendon and inguinal ligament.

This initial period of descriptive studies of GPS ends with the studies of Bouvard et al[27] who, revisiting the classifications of Durey and Rondineau[25], Brunet et al[24] and Vidalin et al[28], classified GPS into four categories:

1. GPS due to pubic osteoarthropathy affecting the symphyseal joint and whose etiology is mainly caused by overuse. It is important to underline that this is the first time the concept of "osteitis" was replaced by "pubic osteoarthropathy" and clearly described.
2. GPS due to inguinal canal pathologies, including sports hernia, described for the first time by Fournier and Richon[29].

3. GPS due to rectus abdominis insertional tendinopathies.
4. GPS due to adductors insertional and pre-insertional tendinopathy. In this last category, the authors[29] describe the "obturator nerve canal syndrome" for the first time.

Although of little clinical interest, this paragraph dedicated to the initial descriptive studies on GPS will help to understand the evolution GPS has experienced in recent years in terms of taxonomic, clinical, and therapeutic approaches.

GPS TAXONOMIC CLASSIFICATION

The first organically structured taxonomic classification is credited to Omar et al[30]. The authors classified GPS, from an etiopathogenetic point of view, into eight nosological categories for a total of 39 clinical conditions. Although it is undoubtedly a significant classification, it is not free from criticism. For example, in the "Traumatic causes" category, "baseball pitcher-hockey goalie syndrome" is mentioned. The baseball pitcher-hockey goalie syndrome, according to several studies[26-28], is a clinical condition that tends to occur in these athletes and primarily involves scarring and fibrosis of the fascia or epimysium that covers the adductor muscles below their point of insertion to the pubic bone. This scarring constricts the muscle and causes pain. However, there is no evidence of this clinical condition in the current literature. In the category "Neurological causes," only ilioinguinal nerve entrapment is considered, omitting all other nerve entrapments that can cause GPS. In the "Referred pain" category, "piriformis syndrome" is considered. However, this is due to the fact that at the time the classification was drafted, the concept of "deep gluteal syndrome" did not yet exist. In addition to this, the classification suffers from numerous omissions, such as the weakness of the posterior wall of the inguinal canal, prepubic aponeurotic complex injuries, anterior cutaneous nerve entrapment syndrome, and many other clinical conditions that may cause GPS.

In 2012, the period of Consensus Conferences (CC) on GPS began, and four CCs on this topic have been held to date.

The first CC was the Manchester Consensus Conference[31]. The aim of this CC was to produce a multidisciplinary consensus to determine the current position on the nomenclature, definition, diagnosis, imaging modalities, and management of what the authors defined as a "Sportsman's groin". A group of experts in the diagnosis and management of GPS was invited to participate in a consensus conference held by the British Hernia Society in Manchester (UK) on 11-12 October 2012. One of the main outcomes of this CC was that the term "inguinal disruption" (ID) was replaced and preferred to that of "sportsman's hernia" because the latter was not considered anatomically correct due to the absence of a true inguinal hernia. The etiopathogenesis of ID was identified in an abnormal tension in the groin area, particularly around the inguinal ligament attachment. A second clinical condition identified by the CC in the etiopathogenesis of ID was an external oblique disruption leading to small tears through which nerves supplying the inguinal canal could become trapped (i.e., genital branch of the genito-femoral nerve, iliohypogastric nerve and ilioinguinal nerve). The CC experts recommended a multidisciplinary approach with tailored physiotherapy as the primary treatment. In the case of this conservative treatment failing, the CC suggested various techniques of surgery aimed at releasing the tension in the inguinal canal and reinforcing it with a mesh or suture repair. Although merit is due to the initiative behind the Manchester Consensus Conference, as it was the first CC of its kind on the topic, there are several areas where its conclusions could be reconsidered.

For example, in the etiopathogenesis of GPS, the CC took into consideration only the causes concerning the inguinal pathologies. Other important muscular, joint, visceral and neuropathic clinical conditions were completely ignored. Moreover, the CC experts reached the erroneous conclusion that the "ultrasound of the inguinal canal is usually normal in many athletes with chronic groin pain". They also added that "ultrasound is accurate for detecting true inguinal or femoral hernias, but these are rare in athletes". In fact, today, it is known that the majority of athletes suffering from chronic GPS present an inguinal pathology (i.e., weakness of the posterior wall of the inguinal canal, direct hernia, external oblique hernia, and femoral hernia in the female population)[32-36]. Furthermore, the statement "true inguinal or femoral hernias are rare in athletes" does not reflect epidemiological data[33,34].

In addition, the panelists placed too much emphasis on conservative treatment when it is known that it fails in the case of inguinal pathologies (e.g., hernia or weakness of the posterior wall of the inguinal canal)[35,37,38].

Apart from objective criticisms, the Manchester Consensus Conference[31] must be recognized for highlighting, for the first time, the importance of a multidisciplinary approach in the diagnosis and treatment of GPS.

The second CC that focused on GPS was the "Doha agreement meeting on terminology and definitions in groin pain in athletes"[39]. This meeting addressed the fact that the heterogeneous taxonomy of groin injuries in athletes added confusion to what was already an intrinsically complicated matter. Therefore, the Doha agreement was organized to reach a consensus on the standard terminology for GPS. To this end, a one-day agreement meeting was held on 4 November 2014. Twenty-four international experts from 14 different countries participated.

A consensus was reached on a classification system structured into three main categories:

1. Adductor-related, iliopsoas-related, inguinal-related and pubic-related groin pain.
2. Hip-related groin pain.
3. Other causes of groin pain in athletes.

The CC experts[39] agreed that the definitions and terminology adopted were to be based on medical history and physical examination, making them simple and suitable for both clinical practice and research. The main criticism of the Doha agreement meeting is that it oversimplified a topic that is one of the most complicated in the field of Sports Medicine, both from an anatomical and a diagnostic point of view. In fact, "simplifying" must not be confused with "trivializing". However, the Doha agreement[39] meeting must be given merit for having made a commendable attempt at defining the taxonomic classification of GPS.

It is also important to remember that Taylor et al[40] examined the prevalence of different causes of groin pain in athletes using the recent Doha consensus classification of terminology and definitions of groin pain in athletes. In a population of 100 athletes (98% of athletes were male, of which 60% were soccer players), they reported that multiple causes of groin pain were found in 44% of athletes; adductor-related groin pain was the most common clinical complaint (61% of athletes); and pubic-related groin pain was the least present (4% of athletes). Furthermore, the inter-examiner reliability of the Doha classification system was verified by Heijboer et al[41]. The authors found that examiners were in agreement when classifying athletes with a single clinical aspect of groin pain but less so when classifying those with multiple clinical aspects. This represents indirect proof of the poor validity of the Doha classification in complex clinical conditions.

"The Groin Pain Syndrome Italian Consensus Conference on terminology, clinical evaluation and imaging assessment in groin pain in athletes"[32] was the third CC that focused on GPS in athletes. The Groin Pain Italian Consensus Conference was organized by the Italian Society of Arthroscopy in Milan on 5 February 2016, with the participation of 41 experts from different medical backgrounds. The Consensus Conference experts reached a unanimous consensus concerning the three separate sections of the summary document: diagnostic classification document consensus, clinical presentation document consensus and imaging assessment document consensus.

The most important points of this CC can be summarized as follows. The following definition of GPS was proposed and approved: "Any clinical symptom reported by the patient, located at the inguinal-pubic-adductor area, affecting sports activities and/or interfering with Activities of Daily Living (ADL) and requiring medical attention". Furthermore, a further subdivision of the GPS into three main categories was proposed based on the pathogenesis and the onset of symptoms:

- GPS of traumatic origin, in which the onset of pain is due to any acute trauma, and this hypothesis is supported by medical history, clinical examination, and imaging.
- GPS due to functional overload, characterized by insidious and progressive onset, without an acute trauma or a situation to which the onset of pain symptoms can be attributed with certainty.
- Long-standing GPS (LSGPS) or chronic GPS, in which the cohort of symptoms reported by the patient continues for a long period (over 12 weeks) and is recalcitrant to any conservative therapy.

The etiology of GPS was subdivided into 11 nosological categories for a total of 63 different clinical conditions. Moreover, based on both the literature and current expert opinion, the CC panelists approved the second document concerning GPS clinical examination. The clinical examinations approved and recommended during the consensus were subdivided into four categories as follows:

- First category: specific test for adductor muscles (six clinical tests approved).
- Second category: specific test for abdominal muscles (four clinical tests approved).
- Third category: specific test for the hip joint (seven tests approved).
- Fourth category: clinical evaluation of inguinal diseases (seven tests approved).

Based on the literature review and the expert opinion of the specialists present, the CC panelists approved a third document concerning the GPS imaging assessment. This third document consisted of a specific imaging battery for GPS diagnosis consisting of X-ray, ultrasound, and MRI examinations.

Finally, a flow chart based on the results of the Consensus Conference was discussed and approved[32]. It is important to underline that this is the first flow chart about the diagnostic and therapeutic path of GPS present in literature.

The document outlining the taxonomic classification of GPS has been viewed by some as overly complex. However, we firmly believe that GPS and especially the forms of LSGPS represent a true diagnostic challenge for the clinician that necessitates a detailed and exhaustive set of guidelines and definitions without which the clinician would not be able to successfully approach and deal with the complexity of the diagnosis. The diagnostic approach proposed by the Italian Consensus Conference was verified both by a multidisciplinary assessment of 320 athletes[33] and in a population of 37 female athletic subjects[34] affected by LSGPS. Both these studies were conducted in accordance with the Italian Consensus Conference[32].

The first study[33] calculated the sensitivity, specificity, positive predictive value, negative predictive value, and likelihood ratio of the clinical tests approved by the Italian Consensus Conference[32]. Based on the recorded results, the authors hierarchized the tests based on their realistic clinical usefulness. Consequently, in order to optimize clinical evaluation and minimize patient discomfort, clinical evaluation should be based on tests with a greater likelihood ratio.

In the male population, LSGPS presents either a single cause or multiple causes in respectively 74% and 26% of cases on average. Furthermore, almost 58% of all cases linked to a single clinical cause can be attributed to inguinal pathologies alone[33]. LSGPS in the female population showed only one pathological cause, with inguinal pathologies and acetabular labrum tears representing the most frequent etiologies[34]. This difference is probably due to particular anatomical differences related to gender. For this reason, women affected by LSGPS represent an important subset of patients[34].

Adductor tendinopathy is probably overrated as an etiopathogenetic source of LSGPS in men and women[33,34]. Indeed, these studies[33,34] reported that adductor tendinopathy is responsible for only about 2% of cases of LSGPS. This data clearly highlights the imprudence of relying solely on a single diagnosis of this type without considering other potential pathological associations.

The latest CC on the GPS is the Groin Pain Syndrome Italian Consensus Conference update 2023[35]. This consensus was an update of the Groin Pain Syndrome Italian Consensus Conference 2016[32]. This second Italian Consensus Conference was organized by the Italian GPS Study Group (IGPSSG). The IGPSSG board members led this CC held in Cotignola, on 10 June 2023, with the participation of 55 experts from different scientific/specialist backgrounds. The scientific committee of IGPSSG identified six topics that represented an update on the recommendations and taxonomic classification formulated by the 2016 CC[32]. Specifically, the six documents proposed were:

- Document 1: clinical and radiological definition of sports hernia and clinical conditions pertaining to the inguinal pathologies that cause GPS.
- Document 2: pre-pubic aponeurotic complex (PPAC) injuries as possible causes of GPS.
- Document 3: ischio-femoral impingement syndrome (IFIS) as a possible cause of GPS.
- Document 4: anterior inferior iliac spine impingement (AIISI) as a possible cause of GPS.
- Document 5: anterior cutaneous nerve entrapment syndrome (ACNES) as a possible cause of GP.
- Document 6: pectineo foveal impingement (PFI) as a possible cause of GPS.

The Groin Pain Syndrome Italian Consensus Conference update 2023[35] reached a consensus on:

A correct clinical and imaging definition of sports hernia and of other clinical conditions, such as flattening and ballooning, which are part of the inguinal pathologies causing GPS.

- Considering PPAC injuries as a possible cause of GPS and part of the category “musculotendinous causes”.
- Including IFIS as a possible cause of GPS in a new category of “extra-articular causes”.
- Considering AIISI as a possible cause of GPS and including it in the new category of “extra-articular causes”.
- Considering ACNES as a possible cause of GPS and including it in the category of “neurological causes”.
- PFI is currently not recognized as a possible cause of GPS until a greater amount of evidence on the matter is published in peer-reviewed journals.

Finally, in an additional voting session, the hip anterosuperior labral tear with avulsion of rectus femoris (HALTAR) lesions, which were previously included in the “articular cause”[32], were included in the new category of “extra-articular causes”.

Therefore, the etiology of GPS was updated compared to the previous CC of 2016[32]. The new taxonomic classification includes 12 categories (*vs.* 11 in the previous CC) and 67 pathologies (*vs.* 63 in the previous CC). In summary, this CC provided clinicians with a broader and more in-depth vision of GPS to better clinical decision-making processes. The new taxonomic classification proposed by Groin Pain Syndrome Italian Consensus Conference update 2023[35] is shown in Table 1.

Table 1. The most common and probable diseases causing GPS, identified by the Groin Pain Italian CC in the 2023 update[35]. The classification is subdivided into 12 different categories including 67 possible different clinical presentations (table from Bisciotti et al[42]).

1) **Articular causes**
   - Acetabular labrum tear
   - Femoroacetabular impingement (FAI)
   - Hip osteoarthritis
   - Intra-articular loose bodies
   - Hip instability
   - Adhesive capsulitis
   - Legg-Calvé-Perthes disease and its outcomes
   - Dysplasia and its outcomes
   - Epiphysiolysis and its outcomes
   - Avascular necrosis of the femoral head
   - Sacroiliac joint disorders
   - Lumbar spine disorders
   - Synovitis

2) **Extra-articular causes**
   - Anterior inferior iliac spine impingement
   - Hip antero-superior labral tear with avulsion of rectus femoris
   - Ischiofemoral impingement syndrome

3) **Visceral causes**
   - Inguinal hernia
   - Other types of abdominal hernia
   - Intestinal diseases

4) **Bone causes**
   - Fractures and their outcomes
   - Stress fractures
   - Avulsion fractures
   - Iliac crest contusion (hip pointers)

5) **Musculotendinous causes**
   - Rectus abdominis injuries
   - Rectus abdominis tendinopathy
   - Adductors muscles injuries
   - Adductor tendinopathy
   - Rectus abdominis – adductor longus common aponeurosis injuries
   - Iliopsoas injuries
   - Iliopsoas tendinopathy
   - Prepubic aponeurotic complex (PPAC) injuries
   - Other indirect muscle injuries and their outcomes
   - Direct muscle injuries
   - Iliopsoas impingement (I)
   - Snapping internal hip
   - Snapping external hip
   - Bursitis
   - Weakness of the inguinal canal posterior wall

6) **Pubic symphysis related causes**
   - Osteitis pubis
   - Symphysis instability
   - Symphysis degenerative arthropathy

7) **Neurological causes**
   - Nerve entrapment syndrome
   - Anterior cutaneous nerve entrapment syndrome

8) **Developmental causes**
   - Apophysitis
   - Growth plate at pubic level

9) **Genitourinary disease-related causes (inflammatory and non-inflammatory)**
   - Prostatitis
   - Epididymitis
   - Corditis
   - Orchitis
   - Varicocele
   - Hydrocele
   - Urethritis
   - Other infections of the urinary tract
   - Cystitis
   - Ovarian cysts
   - Endometriosis
   - Ectopic pregnancy
   - Round ligament entrapment
   - Testicular/ovarian torsion
   - Ureteral lithiasis

10) **Neoplastic causes**
   - Testicular carcinoma
   - Osteoid osteoma
   - Other carcinomas

11) **Infectious causes**
   - Osteomyelitis
   - Septic arthritis

12) **Systemic causes**
   - Inguinal lymphadenopathy
   - Rheumatic diseases

GPS RADIOLOGICAL ASSESSMENT

Correct imaging documentation is extremely important to help the clinical process. For this reason, these two aspects must be strongly correlated in order to avoid misinterpretation of radiological signs that are only incidental and not related to the actual symptoms of the patient. A well-defined imaging protocol is strongly recommended for all patients with GPS[32]. During "The Groin Pain Syndrome Italian Consensus Conference on terminology, clinical evaluation and imaging assessment in groin pain in athletes"[32], a document concerning the imaging assessment based on the literature review[30,43-53] and on CC panelist opinions was approved. The document was based on a standard protocol for GPS imaging assessment composed of the following routine examinations:

X-Ray Examination

The radiography routinely included the following exams: anterior-posterior view in the upright position (AP1); anterior-posterior view in the upright position and alternately on one foot (Flamingo view) (AP2); Dunn view (45° hip flexion view) (D).

A radiographic assessment was recommended to gather specific information, including the presence of a cross sign (AP1) (overlap between the anterior and posterior wall of the acetabulum), the enlargement and/or erosion and/or sclerosis of the symphysis (AP1), a symphysis asymmetry >2 mm (AP2), and the calculation of the α angle (D).

Ultrasound (US) Examination

A US assessment was recommended to gather the following information: evaluation of the muscle-tendon unit of the abdominal and adductor muscles, dynamic assessment of the inguinal canal structures, examination of internal organs, and evaluation of the urinary tract and external genitalia.

MRI Evaluation

Regarding MRI evaluation, the use of a device of at least 1.5 T and a non-contrast protocol was recommended. The recommended planes were coronal, sagittal, axial, axial oblique planes, coronal oblique planes, and sagittal oblique planes.

The acquisition sequences recommended were T1, T2 and T2 fat-saturated (T2 FS), STIR, and proton density fat saturation (PD FS).

MRI assessment was recommended to obtain the information reported in Table 2.

Recently, the MRI imaging protocol shown in Table 2 was revisited and integrated, considering the inter-slices distance and the field of vision (FOV)[42]. A synthesis of the technical indication is shown in Table 3. Furthermore, the technical indications for the MRI assessment of the PPAC injuries have been specified (Table 4).

MRI Diagnostic Reliability

The diagnostic reliability in LSGPS is very high, making the magnetic resonance examination one of the main means of investigation in the field. Indeed, MRI examination shows 77.78% accuracy, 100.00% sensitivity, 69.23% specificity, 55.56% positive predictive value (PPV), and 100.00% negative predictive value (NPV) in evaluating LSGPS[46].

Concerning the hip chondral and labral damages assessment, MRI arthrogram is preferable to standard MRI[42], showing the following results[47]:

- Labral tears: sensitivity 83.52%, specificity 63.64%, PPV 90.48%, NPV 48.28%.
- Chondral damages: sensitivity 24.49%, specificity 82.81%, PPV 52.17%, NPV 58.89%.

GPS CONSERVATIVE TREATMENT

As a logical outcome of the information presented, it is evident that there is no single method for the conservative treatment of GPS. Indeed, conservative treatment depends on the specific clinical condition or the association of clinical conditions causing GPS[54]. Certain clinical situations are clearly more suited to conservative treatment, while others may be less appropriate or may not respond favorably.

Table 2. MRI findings of clinical relevance in GPS suggested by The Groin Pain Syndrome Italian Consensus Conference on terminology, clinical evaluation and imaging assessment in groin pain in athlete[32] (table from Bisciotti et al[42]).

Pathologies	MRI sequences	MRI findings
Adductor muscle injuries	Oblique axial PD FS and T2 FS Coronal STIR	Signal hyperintensity in fluid-sensitive sequences
Adductor tendinopathy	Oblique axial oblique T1; Oblique axial PD FS; T2 FS and T1; Coronal T1	Increased signal intensity at the tendon and/or at its enthesis level in the fluid-sensitive sequences. Tendon swelling and/or changes in enthesis morphology
Rectus abdominis injuries	Sagittal STIR and oblique axial PD FS	Signal hyperintensity in fluid-sensitive sequences
Rectus abdominis tendinopathy	Sagittal STIR and oblique axial PD FS	Increased signal intensity in the fluid-sensitive sequence at rectus abdominis muscle-tendon junction level and/or an increased rectus abdominis tendon volume
Obturator hernia	Coronal and axial T1 and PD weighted sequences	Protrusion of fat through the foramen between the pectineus and obturator externus muscles. Of great importance is the evaluation of the comparison for symmetry with the contra-lateral canal
Acetabular labrum lesion	MRI arthrography: coronal STIR (FOV 30-40 cm); coronal PD or intermediate FS (FOV 16 cm), sagittal or intermediate FS (FOV 16 cm); radiant T1 or T1 FS.	Spreading of the contrast medium into the labral defect
Stress fractures	T1, T2 and STIR in coronal, sagittal and axial view	Signal hyperintensity in the fluido-sensitive sequences and signal hypointensity in T1 sequences
Symphyseal apophysitis	Coronal T1; axial T1	Signal hypointensity corresponding to the anteromedial ossification nucleus
Bone marrow edema (BME)	Coronal T1; coronal T2 FS; oblique axial T2 FS; oblique axial PD FS	Signal hyperintensity in the fluido-sensitive sequences. Signal hypointensity in T1 sequences. Grade 1: BME ≤1 cm, Grade 2: BME >1 cm and ≤2 cm, Grade 3: BME >2 cm
Subcondral cyst	Coronal STIR; oblique axial oblique T2	Presence of subchondral cyst (hyperintense subchondral cystic element in fluid-sensitive sequences)
Central disc protrusion	Coronal T1; oblique axial oblique T1	Protrusion of the central symphyseal fibrous disc. In coronal images the central disc protrudes cranially with respect to the margins of the symphyseal joint. In oblique axial sequences it protrudes posteriorly
Secondary inferior cleft sign	Coronal STIR; oblique axial PD FS	High signal intensity line extending laterally and inferiorly to the lower part of the symphysis, and which appears to be in communication with the symphyseal joint space

Continued

Table 2 *(continued)*. MRI findings of clinical relevance in GPS suggested by The Groin Pain Syndrome Italian Consensus Conference on terminology, clinical evaluation and imaging assessment in groin pain in athlete[32] (table from Bisciotti et al[42]).

Pathologies	MRI sequences	MRI findings
Secondary superior cleft sign	Coronal STIR; oblique axial PD FS	High signal intensity line in fluid-sensitive sequences extending parallel to the inferior border of the superior pubic ramus shows connection with the symphyseal joint space
Sclerosis of the symphysis	Coronal T1; oblique axial T1	Presence of bone sclerosis along the articular margins of the symphysis. The sclerotic area appears as hypointense bone formation (increased thickness) along the articular margins of the symphysis
Fatty infiltration	Coronal T1; coronal STIR; oblique axial T2 FS; oblique axial e PD FS	Areas of high signal intensity at the level of the symphysis in T1-weighted sequences and areas of low signal intensity in fat sat sequences

PD FS: proton density fat sat; T2 FS: T2 fat sat; STIR: short-tau inversion recovery; MRI: magnetic resonance imaging; FOV: field of view; BME: bone marrow edema.

In the case of GPS of traumatic origin caused by muscle or tendon injuries, conservative treatment is undoubtedly the first choice of treatment[55-57] as the high percentage of positive outcomes in these cases demonstrates[58-60]. Conservative treatment also has its own rationale for application in PPAC injuries[34-36] and adductor tendinopathies[60,61]. On the contrary, conservative treatment is not recommendable for most cases of LSGPS. Indeed, the very definition of LSGPS[32], i.e., "the cohort of symptoms reported by

Table 3. The MRI non-contrast protocol recommended for GPS assessment in consideration of the acquisition planes, sequences, slice maximum height and field of vision (FOV) (table from Bisciotti et al[42]).

Acquisition plan	Sequences	Slice (max)	FOV (max)
Entire pelvis coronal	STIR	5 mm	32-40 cm
Coronal	T1	3 mm	14-18 cm
Axial	T2	3 mm	14-18 cm
Oblique axial	PD FS or Intermediate FS	3 mm	14-18 cm
Sagittal	PD FS or Intermediate FS	3 mm	14-18 cm

PD FS: proton density fat sat; STIR: short-tau inversion recovery; FOV: field of view.

Table 4. MRI sequences and findings suggested for PPAC injuries assessment (table from Bisciotti et al[42]).

Pathologies	MRI sequences	MRI findings
PPAC injuries	T2, STIR, PD FS and intermediate FS sequences in axial, coronal and sagittal plans	Signal hyperintensity in fluid-sensitive sequences

PD FS: proton density fat sat; STIR: short-tau inversion recovery; MRI: magnetic resonance imaging; PPAC: prepubic aponeurotic complex.

the patient continues for a long period (over 12 weeks) and is recalcitrant to any conservative therapy," infers the inapplicability of conservative treatment to this syndrome. Two such cases are examples of LSGPS caused, respectively, either by the weakness of the posterior wall of the inguinal canal or by Cam-femoro-acetabular impingement (FAI), Pincer-FAI, and mixed forms.

In the first case, it is important to remember that the posterior wall is formed by the transversalis fascia, which is strengthened laterally by the interfoveolar ligament of Hesselbach and medially by the ligament of Henle, the ligament of Colles and the conjoint tendon[62]. Therefore, the posterior wall of the inguinal canal represents, from an anatomical point of view, a *locus minoris resistentiae* (a weak spot). But, above all, the total lack of muscle fibers makes its strengthening impossible through conservative treatment[35,37,38]. The inappropriateness of conservative treatment in cases of weakness of the posterior wall of the inguinal canal and, even more so, for inguinal hernias was also strongly underlined by the experts of the Groin Pain Syndrome Italian Consensus Conference update 2023[35].

In the cases of LSGPS caused by Cam-FAI, Pincer-FAI, and mixed forms, it is crucial to follow the conservative treatment guidelines established by the Italian Consensus Conference on FAI Syndrome in Athletes[63]. During this CC, the panelists agreed that conservative programs must be focused on controlling and modifying the articular mechanical loads so as to limit the progression of FAI syndrome. The CC panelists recommended that the patient be made aware of the fact that an FAI conservative program is based on the modification of technical movements and the limitation of functional requests. This strategy must be based on the following four main points: strengthening of hip muscles and improvement of neuromuscular control, ensuring optimal control of core muscles, and reducing the request for extreme range of motion (ROM) movements. Moreover, the patient must be aware of the functional limitations imposed by this clinical condition. The CC particularly recommends that the patient avoid or, at the very least, limit extreme hip rotation, especially when carried out together with a movement of flexion or extension.

The fourth point makes it clear that a conservative program, in the case of FAI, is most probably not compatible with the performance needs of a high-level athlete. Indeed, the positive outcome is <30%[63].

In all other causes of GPS, the prospect of undergoing conservative treatment must be evaluated considering the clinical condition causing GPS.

GPS SURGICAL TREATMENT

As in the case of conservative treatment, it is impossible to summarize the surgical treatment of GPS in a few lines. Furthermore, when opting for surgical treatment, the different clinical circumstances causing GPS must also necessarily be taken into account, and therefore, this assessment requires a multidisciplinary approach. In this paragraph, we will focus solely on the most common surgical treatments in GPS, specifically surgical management of inguinal hernias and weakness of the inguinal canal's posterior wall, surgical intervention for FAI and adductor tenotomy.

Surgical Treatment of Inguinal Hernias and Weakness of the Posterior Wall of the Inguinal Canal

Since inguinal hernia, femoral hernia, weakness of the posterior wall of the inguinal canal and, in general, the inguinal pathologies show a very low rate of positive outcome with conservative treatment[37,38], surgical treatment is necessary. Nowadays, the most utilized surgical treatments for inguinal pathologies are shouldice repair[64], open-suture repair technique[65], Lichtenstein repair[66], transabdominal pre-peritoneal repair (TAPP)[67], total extraperitoneal repair (TEP)[68], transinguinal pre-peritoneal repair (TIPP)[69], minimal repair[70,71], inguinal ligament release procedure[31,72].

Sometimes, these surgical procedures may be completed with a triple or selective neurectomy of the ilioinguinal, iliohypogastric, and genital branches of the genitofemoral nerves[73]. Following surgical repair, independently of the surgical technique used, most of the series report that >90% of the athletes return to full sports activities within 1-2 months after surgery[71,74-76]. For this reason, the choice of surgical technique depends on the surgeon's experience and preference. In any case, the positive outcome of inguinal hernia repair, whether with the open technique (with or without mesh) or laparoscopically, ranges between 87 and 95%[64-72].

Given the relationship between Cam-FAI and inguinal pathologies[77,78], problems arise if an athlete exhibits both pathologies. In these instances, if surgery focuses solely on the inguinal issue, the problem may remain unresolved. The suggested choice, in this case, is a double surgery (i.e., hernia repair and hip arthroscopy) to be carried out separately within a short time frame or double surgery in a single operation[63,78].

The FAI Surgical Treatment

The primary goals of surgical treatment for FAI syndrome in athletes are articular decompression, interruption or slowing down degenerative processes of cartilage tissue, and obtaining an outcome that allows athletes to return to sporting activity[63].

It is important to note that arthroscopic surgery, open surgery, and mini-open technique surgery are equivalent in terms of functional results, biomechanics, and return-to-sport outcomes.

Nevertheless, of the three types of surgery, arthroscopic techniques are associated with fewer complications, lower risks of morbidity[79], and a rapid recovery[80-82]. Thus, they are recommended for both athletes and people performing sports with high functional requests[63]. In the opinion of several authors, the FAI surgical treatment allows about 82% of athletes to return to play at the same pre-injury level[64-72].

Adductor Tenotomy

Adductor tenotomy, mainly of the adductor longus, is advised in the case of PPAC injuries[33-36] and for adductor tendinopathies unresponsive to conservative treatment[83].

Three different types of adductor longus tenotomy are reported in the literature and were analyzed in a systematic review[61], which, to our knowledge, is the only publication of its type to date:

1. Adductor longus total tenotomy (TT)[37,84-88].
2. Adductor longus partial tenotomy of the anterior tendinous fibers performed 2 to 4 cm from the tendon origin (PT1)[89,90].
3. Adductor longus partial tenotomy in which the tendon release is performed just below the pelvic insertion (PT2)[91,92].

A systematic review[61] indicated that adductor longus tenotomy performed by PT2 and TT interventions are reliable techniques for treating GPS caused by adductor tendinopathies. These techniques allow a high percentage (95%) of athletes to return to sporting activities in a relatively short period of time. On the contrary, despite guaranteeing a relatively quick return to play, PT1 is not recommended as it is associated with numerous complications.

CONCLUSIONS

GPS, and especially LSGPS, often represent genuine diagnostic challenges for the clinician. Therefore, a complex and multi-specialist diagnostic approach, capable of assessing all the clinical conditions that give rise to GPS, is necessary. For these reasons, it is imprecise to discuss in broad terms the conservative and surgical treatment of GPS. In fact, each clinical condition that causes GPS requires both a specific diagnostic evaluation and a specific conservative and surgical approach to treatment.

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Informed Consent

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Ethics Approval

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Authors' Contributions

Bisciotti GN: conceptualization; Zini R: methodology; Bisciotti AN: formal analysis; Panascì M: bibliographic research; Bisciotti AL. writing-review and editing; Volpi P: revised the text. All authors have read and agreed to the final version of the manuscript.

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REFERENCES

1. Hölmich P. Long-standing groin pain in sportspeople falls into three primary patterns, a "clinical entity" approach: a prospective study of 207 patients. Br J Sports Med 2007; 41: 247-252.
2. Mosler AB, Weir A, Eirale C, Farooq A, Thorborg K, Whiteley RJ, Hölmich P, Crossley KM. 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: 292-297.
3. Waldén M, Hägglund M, Ekstrand J. The epidemiology of groin injury in senior football: a systematic review of prospective studies. Br J Sports Med 2015; 49: 792-797.
4. Junge A, Dvorak J. Soccer injuries: a review on incidence and prevention. Sports Med 2004; 34: 929-938.
5. Dvorak J, Junge A, Derman W, Schwellnus M. Injuries and illnesses of football players during the 2010 FIFA World Cup. Br J Sports Med 2011; 45: 626-630.
6. Bjørneboe J, Bahr R, Andersen TE. Gradual increase in the risk of match injury in Norwegian male professional football: a 6-year prospective study. Scand J Med Sci Sports 2014; 24: 189-196.
7. Noya Salces J, Gómez-Carmona PM, Gracia-Marco L, Moliner-Urdiales D, Sillero-Quintana M. Epidemiology of injuries in First Division Spanish football. J Sports Sci 2014; 32: 1263-1270.
8. Harøy J, Andersen TE, Bahr R. Groin Problems in Male Soccer Players Are More Common Than Previously Reported: Response. Am J Sports Med 2017; 45: NP32-NP33.
9. Bahr R. No injuries, but plenty of pain? On the methodology for recording overuse symptoms in sports. Br J Sports Med 2009; 43: 966-972.
10. Werner J, Hägglund M, Ekstrand J, Waldén M. Hip and groin time-loss injuries decreased slightly but injury burden remained constant in men's professional football: the 15-year prospective UEFA Elite Club Injury Study. Br J Sports Med 2019; 53: 539-546.
11. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. Int J Soc Res Methodol 2005; 8: 19-32.
12. Anderson C, Yeung E, Tong T, Reed N. A narrative review on cervical interventions in adults with chronic whiplash-associated disorder. Open Sport Exerc Med 2018; 4: e000299. Erratum in: BMJ Open Sport Exerc Med 2018; 4: e000299corr1.
13. Morgan DL. Qualitative content analysis: a guide to paths not taken. Qual Health Res 1993; 3: 112-121.
14. Spinelli A. Una nuova malattia sportiva. La pubalgia degli schermitori. Ortho Trauma App Mot 1932; 4: 111-127.
15. Seifert E. Lead symptom: pain in the inguinal region. Munch Med Wochenschr 1955; 97: 1580-1586.
16. Knoch HG. Pain in the symphysis-inguinal region contribution to differential diagnosis. Beitr Orthop Traumatol 1965; 12: 263-269.
17. Iles JD. Adductor injury: a common cause of groin pain often misdiagnosed as hernia. Can Fam Physician 1968; 14: 58-66.
18. Pollock N, James SL, Lee JC, Chakraverty R. British athletics muscle injury classification: a new grading system. Br J Sports Med 2014; 48: 1347-1351.
19. Bisciotti GN, Volpi P, Alberti G, Aprato A, Artina M, Auci A, Bait C, Belli A, Bellistri G, Bettinsoli P, Bisciotti A, Bisciotti A, Bona S, Bresciani M, Bruzzone A, Buda R, Buffoli M, Callini M, Canata G, Cardinali D, Cassaghi G, Castagnetti L, Clerici S, Corradini B, Corsini A, D'Agostino C, Dellasette E, Di Pietto F, Enrica D, Eirale C, Foglia A, Franceschi F, Frizziero A, Galbiati A, Giammatei C, Landreau P, Mazzola C, Moretti B, Muratore M, Nanni G, Niccolai R, Orizio C, Pantalone A, Parra F, Pasta G, Patroni P, Pelella D, Pulici L, Quaglia A, Respizzi S, Ricciotti L, Rispoli A, Rosa F, Rossato A, Sannicandro I, Sprenger C, Tarantola C, Tenconi FG, Tognini G, Tosi F, Trinchese GF, Vago P, Zappia M, Vuckovich Z, Zini R, Trainini M, Chamari K. Italian consensus statement (2020) on return to play after lower limb muscle injury in football (soccer). BMJ Open Sport Exerc Med 2019; 5: e000505.
20. Harris NH, Murray RO. Lesions of the symphysis in athletes. Br Med J 1974; 4: 211-214.
21. Smodlaka VN. Groin Pain in Soccer Players. Phys Sportsmed 1980: 8: 57-61.
22. Junge H. Recherches sur le resultat des forces considerables agissant sur la ceinture pelvienne anterieure chez les sportifs. Proceedings of the XV International Congress de Sport Sciences, Tokyo 1964; pp. 372-374.
23. Maigne R. Le syndrome de la charnière dorso-lombaire. Lombalgies basses, douleurs pseudo-viscérales, pseudo-douleurs de hanche, pseudo-tendinite des adducteurs. Pascal-Francis. Inist (Eds) 1981; pp. 78-81.
24. Brunet B, Brunet-Guedj E, Genety J, Comtet JJ. A propos du traitement de pubalgies. [The treatment of pubic pain]. Journal de Traumatologie du Sport 1984; 2: 51-55.
25. Durey A, Rodineau J. Les lésions pubiennes des sportif. Ann Med Phys 1976; 9: 282-291.
26. Gilmore J. Groin pain in the soccer athlete: fact, fiction, and treatment. Clin Sports Med 1998; 17: 787.
27. Bouvard M, Dorochenko NP, Lanusse P, Duraffour H. La pubalgie du sportif -stratégie thérapeutique: Revue de la littérature et proposition d'un protocole de rééducation. Journal de Traumatologie du Sport 2004; 21: 146-163.
28. Vidalin H, Neouze G, Petit I, Brunet-Guedj E. Prise en charge chirurgicale des pubalgies du sportif: revue de la bibliographie à propos de la pubalgie du joueur de rugby. [Surgical management of pubic pain in the athlete: observations in a rugby player and a review of the literature]. Journal de Traumatologie du Sport 21; 3: 164-173.
29. Fournier JY, Richon CA. Revue critique de 25 patients traités pour pubalgie par myorraphie inguinale (opération de Nesovic) [Critical review of 25 patients treated for pubic pain with inguinal myorrhaphy (Nesovic operation)]. Helv Chir Acta 1992; 59: 775-778.

30. Omar IM, Zoga AC, Kavanagh EC, Koulouris G, Bergin D, Gopez AG, Morrison WB, Meyers WC. Athletic pubalgia and "sports hernia": optimal MR imaging technique and findings. Radiographics 2008; 28: 1415-1438.
31. Sheen AJ, Stephenson BM, Lloyd DM, Robinson P, Fevre D, Paajanen H, de Beaux A, Kingsnorth A, Gilmore OJ, Bennett D, Maclennan I, O'Dwyer P, Sanders D, Kurzer M. 'Treatment of the sportsman's groin': British Hernia Society's 2014 position statement based on the Manchester Consensus Conference. Br J Sports Med 2014, 48: 1079-1087.
32. Bisciotti GN, Volpi P, Zini R, Auci A, Aprato A, Belli A, Bellistri G, Benelli P, Bona S, Bonaiuti D, Carimati G, Canata GL, Cassaghi G, Cerulli S, Delle Rose G, Di Benedetto P, Di Marzo F, Di Pietto F, Felicioni L, Ferrario L, Foglia A, Galli M, Gervasi E, Gia L, Giammattei C, Guglielmi A, Marioni A, Moretti B, Niccolai R, Orgiani N, Pantalone A, Parra F, Quaglia A, Respizzi F, Ricciotti L, Pereira Ruiz MT, Russo A, Sebastiani E, Tancredi G, Tosi F, Vuckovic Z. Groin Pain Syndrome Italian Consensus Conference on terminology, clinical evaluation and imaging assessment in groin pain in athlete. BMJ Open Sport Exerc Med 2016; 2: e000142.
33. Bisciotti GN, Auci A, Bona S, Bisciotti A, Bisciotti A, Cassaghi G, DI Marzo F, DI Pietto F, Eirale C, Panascì M, Parra F, Zini R. A multidisciplinary assessment of 320 athletes with long-standing groin pain syndrome in keeping with the Italian consensus agreement: the high incidence and the multiple causes of inguinal and hip pathologies and pubic osteopathy. J Sports Med Phys Fitness 2021; 61: 960-970.
34. Bisciotti GN, Auci A, Bona S, Bisciotti A, Bisciotti A, Cassaghi G, DI Marzo F, DI Pietto F, Eirale C, Panascì M, Parra F, Zini R. Long-standing groin pain syndrome in athletic women: a multidisciplinary assessment in keeping with the Italian Consensus Agreement. J Sports Med Phys Fitness 2022; 62: 1199-1210.
35. Bisciotti GN, Zini R, Aluigi M, Aprato A, Auci A, Bellinzona E, Benelli P, Bigoni M, Bisciotti A, Bisciotti A, Bona S, Brustia M, Bruzzone M, Canata GL, Carulli C, Cassaghi G, Coli M, Corsini A, Costantini A, Dallari D, Danelli G, Danesi G, Della Rocca F, DE Nardo P, DI Benedetto P, DI Marzo F, DI Pietto F, Eirale C, Ferretti A, Fogli M, Foglia A, Guardoli A, Guglielmi A, Lama D, Maffulli N, Manunta AF, Massari L, Mazzoni G, Moretti B, Moretti L, Nanni G, Niccolai R, Occhialini M, Panascì M, Parra MF, Pigalarga G, Randelli F, Sacchini M, Salini V, Santori N, Tenconi P, Tognini G, Vegnuti M, Zanini A, Volpi P. Groin Pain Syndrome Italian Consensus Conference update 2023. J Sports Med Phys Fitness 2024; 64: 402-414.
36. Bisciotti A, Bisciotti GN, Eirale C, Bisciotti A, Auci A, Bona S, Zini R. Prepubic aponeurotic complex injuries: a structured narrative review. J Sports Med Phys Fitness 2022; 62: 1219-1227.
37. Dojčinović B, Sebečić B, Starešinić M, Janković S, Japjec M, Čuljak V. Surgical treatment of chronic groin pain in athletes. Int Orthop 2012; 36: 2361-2365.
38. Jorgensen SG, Öberg S, Rosenberg J. Treatment of longstanding groin pain: a systematic review. Hernia 2019; 23: 1035-1044.
39. Weir A, Brukner P, Delahunt E, Ekstrand J, Griffin D, Khan KM, Lovell G, Meyers WC, Muschaweck U, Orchard J, Paajanen H, Philippon M, Reboul G, Robinson P, Schache AG, Schilders E, Serner A, Silvers H, Thorborg K, Tyler T, Verrall G, de Vos RJ, Vuckovic Z, Hölmich P. Doha agreement meeting on terminology and definitions in groin pain in athletes. Br J Sports Med 2015; 49: 768-774.
40. Taylor R, Vuckovic Z, Mosler A, Agricola R, Otten R, Jacobsen P, Holmich P, Weir A. Multidisciplinary Assessment of 100 Athletes With Groin Pain Using the Doha Agreement: High Prevalence of Adductor-Related Groin Pain in Conjunction With Multiple Causes. Clin J Sport Med 2018; 28: 364-369.
41. Heijboer WMP, Weir A, Vuckovic Z, Fullam K, Tol JL, Delahunt E, Serner A. Inter-examiner reliability of the Doha agreement meeting classification system of groin pain in male athletes. Scand J Med Sci Sports 2023; 33: 189-196.
42. Bisciotti GN, Di Pietto F, Rusconi G, Bisciotti A, Auci A, Zappia M, Romano S. The Role of MRI in Groin Pain Syndrome in Athletes. Diagnostics 2024; 14: 814.
43. Besjakov J, von Scheele C, Ekberg O, Gentz CF, Westlin NE. Grading scale of radiographic findings in the pubic bone and symphysis in athletes. Acta Radiol 2003; 44: 79-83.
44. Cunningham PM, Brennan D, O'Connell M, MacMahon P, O'Neill P, Eustace S. Patterns of bone and soft-tissue injury at the symphysis pubis in soccer players: observations at MRI. AJR Am J Roentgenol 2007; 188: 291-296.
45. Zoga AC, Kavanagh EC, Omar IM, Morrison WB, Koulouris G, Lopez H, Chaabra A, Domesek J, Meyers WC. Athletic pubalgia and the "sports hernia": MR imaging findings. Radiology 2008; 247: 797-807.
46. Ducouret E, Reboul G, Dalmay F, Iosif C, Mounayer C, Pesquer L, Dallaudiere B. MRI in chronic groin pain: sequence diagnostic reliability compared to systematic surgical assessment. Skeletal Radiol 2018; 47: 649-660.
47. Rajeev A, Tuinebreijer W, Mohamed A, Newby M. The validity and accuracy of MRI arthrogram in the assessment of painful articular disorders of the hip. Eur J Orthop Surg Traumatol 2018; 28: 71-77.
48. Khan W, Zoga AC, Meyers WC. Magnetic resonance imaging of athletic pubalgia and the sports hernia: current understanding and practice. Magn Reson Imaging Clin N Am 2013; 21: 97-110.
49. Palisch A, Zoga AC, Meyers WC. Imaging of athletic pubalgia and core muscle injuries: clinical and therapeutic correlations. Clin Sports Med 2013; 32: 427-47.
50. Robinson A, Light D, Nice C. Meta-analysis of sonography in the diagnosis of inguinal hernias. J Ultrasound Med 2013; 32: 339-346.
51. 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: 681-691.
52. Lee RK, Griffith JF, Ng WH. High accuracy of ultrasound in diagnosing the presence and type of groin hernia. J Clin Ultrasound 2015; 43: 538-547.
53. Morley N, Grant T, Blount K, Omar I. Sonographic evaluation of athletic pubalgia. Skeletal Radiol 2016; 45: 689-699.
54. Bisciotti GN, Auci A, Di Marzo F, Galli R, Pulici L, Carimati G, Quaglia A, Volpi P. Groin pain syndrome: an association of different pathologies and a case presentation. Muscles Ligaments Tendons J 2015; 5: 214-222.
55. Serner A. Diagnosis of acute groin injuries in athletes. Br J Sports Med 2017; 51: 1709-1710.
56. Serner A, Weir A, Tol JL, Thorborg K, Lanzinger S, Otten R, Hölmich P. Return to Sport After Criteria-Based Rehabilitation of Acute Adductor Injuries in Male Athletes: A Prospective Cohort Study. Orthop J Sports Med 2020; 8: 2325967119897247.
57. Forlizzi JM, Ward MB, Whalen J, Wuerz TH, Gill TJ 4th. Core Muscle Injury: Evaluation and Treatment in the Athlete. Am J Sports Med 2023; 51: 1087-1095.
58. Weir A, Veger SA, Van de Sande HB, Bakker EW, de Jonge S, Tol JL. A manual therapy technique for chronic adductor-related groin pain in athletes: a case series. Scand J Med Sci Sports 2009; 19: 616-620.

59. Weir A, Jansen J, van Keulen J, Mens J, Backx F, Stam H. Short and mid-term results of a comprehensive treatment program for longstanding adductor-related groin pain in athletes: a case series. Phys Ther Sport 2010; 11: 99-103.
60. Bisciotti GN, Chamari K, Cena E, Garcia GR, Vuckovic Z, Bisciotti A, Bisciotti A, Zini R, Corsini A, Volpi P. The conservative treatment of longstanding adductor-related groin pain syndrome: a critical and systematic review. Biol Sport 2021; 38: 45-63.
61. Bisciotti GN, Chamari K, Zini R, Corsini A, Auci A, Bisciotti AL, Bisciotti AN, Cena E, Rodriguez Garcia G, Volpi P, Vuckovic Z, Canata GL. Adductor longus tenotomy in the treatment of groin pain syndrome in athletes: a systematic review. Joints 2023; 1: e602
62. Becker I, Woodley SJ, Stringer MD. The adult human pubic symphysis: a systematic review. J Anat 2010; 217: 475-487.
63. Zini R, Panascì M, Santori N, Potestio D, Di Pietto F, Bisciotti GN. The Italian Consensus Conference on FAI Syndrome in Athletes (Cotignola Agreement). MLTJ 2023; 13: 46-60.
64. Farber AJ, Wilckens JH. Sports hernia: diagnosis and therapeutic approach. J Am Acad Orthop Surg 2007; 15: 507-514.
65. Köckerling F, Koch A, Lorenz R, Reinpold W, Hukauf M, Schug-Pass C. Open Repair of Primary Versus Recurrent Male Unilateral Inguinal Hernias: Perioperative Complications and 1-Year Follow-up. World J Surg 2016; 40: 813-825.
66. Amid PK. The Lichtenstein repair in 2002: an overview of causes of recurrence after Lichtenstein tension-free hernioplasty. Hernia 200; 7: 13-16.
67. Wake BL, McCormack K, Fraser C, Vale L, Perez J, Grant AM. Transabdominal pre-peritoneal (TAPP) vs totally extraperitoneal (TEP) laparoscopic techniques for inguinal hernia repair. Cochrane Database Syst Rev 2005; 2005: CD004703.
68. Shah MY, Raut P, Wilkinson TRV, Agrawal V. Surgical outcomes of laparoscopic total extraperitoneal (TEP) inguinal hernia repair compared with Lichtenstein tension-free open mesh inguinal hernia repair: A prospective randomized study. Medicine 2022; 101: e29746.
69. Koning GG, Koole D, de Jongh MA, de Schipper JP, Verhofstad MH, Oostvogel HJ, Vriens PW. The transinguinal preperitoneal hernia correction vs Lichtenstein's technique; is TIPP top? Hernia 2011; 15: 19-22.
70. Muschaweck U, Berger L. Minimal Repair technique of sportsmen's groin: an innovative open-suture repair to treat chronic inguinal pain. Hernia 2010; 14: 27-33.
71. Muschaweck U, Koch A. Sportlerleiste: Begriffsbestimmung, Differenzialdiagnostik und Therapie [Sportsmen's groin: Definition, differential diagnosis and treatment]. Radiologe 2019; 59: 224-233.
72. Lloyd DM. Sportman's groin and the inguinal ligament release procedure. In: Jacob BP, Chen DC, Ramshaw B, Towfigh S. Editors. The SAGES manual of groin pain. Springer Editions. New York, 2016; pp. 126-132.
73. Elkins N, Hunt J, Scott KM. Neurogenic Pelvic Pain. Phys Med Rehabil Clin N Am 2017; 28: 551-569.
74. Köninger J, Redecke J, Butters M. Chronic pain after hernia repair: a randomized trial comparing Shouldice, Lichtenstein and TAPP. Langenbecks Arch Surg 2004; 389: 361-365.
75. Scheuermann U, Niebisch S, Lyros O, Jansen-Winkeln B, Gockel I. Transabdominal Preperitoneal (TAPP) versus Lichtenstein operation for primary inguinal hernia repair - A systematic review and meta-analysis of randomized controlled trials. BMC Surg 2017; 17: 55.
76. Kajetanek C, Benoît O, Granger B, Menegaux F, Chereau N, Pascal-Mousselard H, Khiami F. Athletic pubalgia: Return to play after targeted surgery. Orthop Traumatol Surg Res 2018; 104: 469-472.
77. Naal FD, Dalla Riva F, Wuerz TH, Dubs B, Leunig M. Sonographic prevalence of groin hernias and adductor tendinopathy in patients with femoroacetabular impingement. Am J Sports Med 2015; 43: 2146-2151.
78. Bisciotti GN, Di Marzo F, Auci A, Parra F, Cassaghi G, Corsini A, Petrera M, Volpi P, Vuckovic Z, Panascì M, Zini R. Cam morphology and inguinal pathologies: is there a possible connection? J Orthop Traumatol 2017; 18: 439-450.
79. Matsuda DK, Carlisle JC, Arthurs SC, Wierks CH, Philippon MJ. Comparative systematic review of the open dislocation, mini-open, and arthroscopic surgeries for femoroacetabular impingement. Arthroscopy 2011; 27: 252-269.
80. Griffin KM. Rehabilitation of the hip. Clin Sports Med 2001; 20: 837-850.
81. Sampson TG. Arthroscopic treatment of femoroacetabular impingement. Am J Orthop 2008; 37: 608-612.
82. Montgomery SR, Ngo SS, Hobson T, Nguyen S, Alluri R, Wang JC, Hame SL. Trends and demographics in hip arthroscopy in the United States. Arthroscopy 2013; 29: 661-665.
83. Gill TJ, Carroll KM, Makani A, Wall AJ, Dumont GD, Cohn RM. Surgical technique for treatment of recalcitrant adductor longus tendinopathy. Arthrosc Tech 2014; 3: e293-e297.
84. Akermark C, Johansson C. Tenotomy of the adductor longus tendon in the treatment of chronic groin pain in athletes. Am J Sports Med 1992; 20: 640-643.
85. Atkinson HD, Johal P, Falworth MS, Ranawat VS, Dala-Ali B, Martin DK. Adductor tenotomy: its role in the management of sports-related chronic groin pain. Arch Orthop Trauma Surg 2010; 130: 965-970.
86. Maffulli N, Loppini M, Longo UG, Denaro V. Bilateral mini-invasive adductor tenotomy for the management of chronic unilateral adductor longus tendinopathy in athletes. Am J Sports Med 2012; 40: 1880-1886.
87. Mei-Dan O, Lopez V, Carmont MR, McConkey MO, Steinbacher G, Alvarez PD, Cugat RB. Adductor tenotomy as a treatment for groin pain in professional soccer players. Orthopedics 2013; 36: e1189-e1197.
88. Sansone M, Ahldén M, Jonasson P, Thomeé R, Falk A, Swärd L, Karlsson J. Can hip impingement be mistaken for tendon pain in the groin? A long-term follow-up of tenotomy for groin pain in athletes. Knee Surg Sports Traumatol Arthrosc 2014; 22: 786-792.
89. Schilders E, Dimitrakopoulou A, Cooke M, Bismil Q, Cooke C. Effectiveness of a selective partial adductor release for chronic adductor-related groin pain in professional athletes. Am J Sports Med 2013; 41: 603-607.
90. Garvey JF, Hazard H. Sports hernia or groin disruption injury? Chronic athletic groin pain: a retrospective study of 100 patients with long-term follow-up. Hernia 2014; 18: 815-823.
91. Robertson IJ, Curran C, McCaffrey N, Shields CJ, McEntee GP. Adductor tenotomy in the management of groin pain in athletes. Int J Sports Med 2011; 32: 45-48.
92. de Queiroz RD, de Carvalho RT, de Queiroz Szeles PR, Janovsky C, Cohen M. Return to sport after surgical treatment for pubalgia among professional soccer players. Rev Bras Ortop 2014; 49: 233-239.