
Vasileios Mitrousias, Dimitrios Chytas, Konstantinos Banios, Apostolos Fyllos, Vasileios Raoulis, Georgios Chalatsis, Kyriaki Baxevanidou, Aristeidis Zibis

PII: S2059-7754(23)00491-1
DOI: https://doi.org/10.1016/j.jisako.2023.05.006
Reference: JISAKO 128

To appear in: Journal of ISAKOS

Received Date: 23 November 2022
Revised Date: 13 April 2023
Accepted Date: 31 May 2023


This is a PDF file of an article that has undergone enhancements after acceptance, such as the addition of a cover page and metadata, and formatting for readability, but it is not yet the definitive version of record. This version will undergo additional copyediting, typesetting and review before it is published in its final form, but we are providing this version to give early visibility of the article. Please note that, during the production process, errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

© 2023 The Author(s). Published by Elsevier Inc. on behalf of International Society of Arthroscopy, Knee Surgery and Orthopedic Sports Medicine.

Vasileios Mitrousias\textsuperscript{1,2}, Dimitrios Chytas\textsuperscript{3}, Konstantinos Banios\textsuperscript{1}, Apostolos Fyllos\textsuperscript{1}, Vasileios Raoulis\textsuperscript{1}, Georgios Chalatsis\textsuperscript{2}, Kyriaki Baxevanidou\textsuperscript{4}, Aristeidis Zibis\textsuperscript{1}

\textsuperscript{1} Department of Anatomy, Faculty of Medicine, University of Thessaly, 41334 Larissa, Greece

\textsuperscript{2} Department of Orthopaedic Surgery and Musculoskeletal Trauma, General University Hospital of Larissa, 41110 Larissa, Greece

\textsuperscript{3} Department of Physiotherapy, University of Peloponnese, 23100 Sparta, Greece

\textsuperscript{4} Department of General Surgery, General Hospital of Larissa, 41221, Larissa, Greece

*Correspondance to:

Vasileios Mitrousias MD, PhD
Aggelakopoulou 67, 41334 Larissa, Greece
tel. +306979051248
vasileiosmitrousias@gmail.com

Abstract
Groin pain is a common symptom in athletes. The complex anatomy of the area and the various terms used to describe the etiology behind groin pain have led to a confusing nomenclature. To solve this problem, three consensus statements have been already published in the literature: the Manchester position statement in 2014, the Doha agreement in 2015 and the Italian consensus in 2016. However, when revisiting recent literature, it is evident that the use of non-anatomic terms remains common and the diagnoses sports hernia, sportsman’s hernia, sportsman’s groin, Gilmore’s Groin, athletic pubalgia and core muscle injury are still used by many authors. Why are they still in use although rejected? Are they considered synonyms, or they are used to describe different pathology? This current concepts review article aims to clarify the confusing terminology by examining to which anatomical structures authors refer when using each term, revisit the complex anatomy of the area including the adductors, the flat and vertical abdominal muscles, the inguinal canal and the adjacent nerve branches, and propose an anatomical approach, which will provide the basis for improved communication between healthcare professionals and evidence-based treatment decisions.

Current Concepts
- Groin pain is a common symptom in athletes, accompanied by a very complex nomenclature which makes diagnosis and treatment challenging.
- Despite publication of three consensus statements, rejected terms are still widely used in the literature.
- Healthcare professional dealing with groin pain should be careful when examining the literature, since the use of various terms in different ways may lead to false conclusions, thus making evidence-based practice difficult.

Future Perspectives
- Adopting results of all the available consensus statements is crucial for clarifying terminology of groin pain.
- A specific anatomical diagnosis accompanying the classification proposed by the Doha agreement meeting, when possible, is strongly encouraged.
- A diagnostic approach and a treatment decision based on anatomy will facilitate evidence-based practice.

Keywords
groin pain; sports hernia; sportsman’s hernia; sportsman’s groin; athletic pubalgia; core muscle injury
Introduction

Groin pain is a common symptom in professional and amateur athletes and a diagnostic challenge for physicians. It could be characterized as an “enigma”, the Greek word describing something which seems impossible to understand completely. For athletes, groin pain is a significant injury, usually associated with major time-loss and sometimes career-ending. For sports specialists (physicians, physiotherapists etc.), the complex anatomy of the area and the multiple causes resulting in pain in the groin, make the diagnosis a real challenge. Cause, appropriate treatment and return to play remains an enigma to both.

Groin pain should be considered as a symptom not a disease, having various pathologies as a cause, just as anterior knee pain being a symptom of various etiologies e.g., patellar tendinopathy. Groin pain is common. In elite athletes, it accounts for approximately 5 to 18% of all athletic injuries. Kicking sports such as football, ice hockey, fencing, handball, and cross-country skiing are thought to produce most of these injuries [1]. Especially in football, the sport in which groin pain has been most investigated, groin injuries account for 4-19% in male and 2-14% in female players and are approximately 14% of all time-loss injuries [2–4]. The average weekly prevalence of all groin problems is 11.7% and the most common cause, as shown by many studies in football, is adductor-related [3,5,6].

Till today numerous terms have been used to describe groin pain. Sportsman’s groin, sportsman’s hernia, sports hernia, athletic pubalgia, Gilmore’s groin, pubic ring failure, inguinal ring insufficiency and core muscle injury are only some of them, describing the same symptom but implying different pathology as a cause. Three major consensus statements have been published the last seven years to help specialists clarify groin pain terminology [2,7,8]. In the 2014 Manchester consensus conference, the term “inguinal disruption” was chosen to describe weakness of the posterior wall of the inguinal canal, namely the transversalis fascia and the conjoint tendon (a fusion of the medial fibers of the internal oblique aponeurosis and the deeper fibers of the transversus abdominis aponeurosis), by a group of British general surgeons and hernia specialists. In this consensus the terms “Sportsman’s hernia” and “Sportsman’s groin” were rejected, since usually a true hernia does not exist [7]. According to the Doha 2014 agreement meeting, groin pain classification has three major categories: 1) Defined clinical entities for groin pain (subclassified in a. adductor-related, b. iliopsoas related, c. inguinal related and d. pubic related), 2) Hip-related groin pain and 3) Other causes. In this meeting, which brought together orthopaedic surgeons, sport physicians, physiotherapists, general surgeons and a radiologist, the use of the terms: adductor and iliopsoas tendinitis or tendinopathy, athletic groin pain, athletic pubalgia, biomechanical groin overload, Gilmore’s groin, groin disruption, hockey-goalie syndrome, hockey groin, osteitis pubis, sports groin, sportsman’s groin, sportsman’s hernia and sportsman’s hernia was discouraged [2]. Finally, in the 2016 Italian consensus conference, groin pain etiology was subdivided in 11 categories by a multidisciplinary team of healthcare professionals: 1. Articular causes, 2. Visceral causes, 3. Bone causes, 4. Musculotendinous causes, 5. Pubic symphysis related causes, 6. Neurological causes, 7. Developmental causes, 8. Genitourinary disease-related causes, 9. Neoplastic causes, 10. Infectious causes and lastly 11. Systemic causes, summarizing the differential diagnosis behind groin pain [8].

Despite the publication of these three consensus statements, terminology in the literature is still confusing given the use of descriptive terms such as sportsman’s hernia or athletic pubalgia. In this way, the goal of this current concepts review is to investigate the use of non-anatomic terms in the literature, revisit the complex anatomy of the area and propose an anatomical approach which will facilitate proper use of each term, thus promoting evidence-based practice.
Groin Pain Terminology

Are the rejected terms still in use in the literature?

To answer this question, a literature search was performed to identify areas of controversy. Databases searched were PUBMED and MEDLINE. The phrases “Sports Hernia”, “Sportsman’s Hernia”, “Sportsman’s Groin”, “Gilmore’s Groin”, “Athletic Pubalgia” and “Core Muscle Injury” were searched in articles’ Title/Abstract using advanced research. Search results were limited in articles published after 2015, namely after publication of the first consensus [7]. A preliminary scrutiny of titles and abstracts was undertaken, and full copies of publications that addressed our definitions were obtained. Following a critical appraisal, studies that did not report relevant outcomes were excluded. Searches were further evaluated and articles addressing paediatric population were also excluded. Finally, articles whose full text was not written in English were not taken into consideration.

In total, 74 articles were found to include the aforementioned terms (Appendix 1). The only term which was not identified in any article title or abstract was the term “Gilmore’s groin” which seem to have been abandoned.

To which anatomical structure authors refer when using each term?

After careful reading of all articles by the authors, each article containing one of the search terms (e.g. athletic pubalgia) was matched with the anatomical – clinical entity described as the cause of groin pain.

The term “Sportsman’s Groin” was identified in 6 articles. In all 6 articles (100%), authors used the term to describe weakness of the posterior wall of the inguinal canal, known as inguinal disruption, based on the Manchester consensus [7].

The term “Sports/Sportsman’s hernia” was identified in 33 articles. In 52% of the articles, authors used the term to describe inguinal disruption, in 24% to describe pathology of the rectus abdominis-adductor longus, in 15% to describe both of the above pathologies, whereas in 9% of the articles the term was used to describe the symptom of groin pain.

The term “Athletic Pubalgia” was identified in 45 articles. In 11% of the articles, authors used the term to describe inguinal disruption, in 47% to describe pathology of the rectus abdominis-adductor longus, in 27% to describe both of the above pathologies, whereas in 15% of the articles the term was used to describe the symptom of groin pain.

Finally, the term “Core muscle injury” was identified in 15 articles. In 73% of the articles, authors used the term to describe pathology of the rectus abdominis-adductor longus and in 27% to describe both inguinal disruption and pathology of the rectus abdominis-adductor longus. Results are summarized in Table 1 of the Appendix and in Figure 1.
Current concepts

It is evident that despite the rejection of the terms sports hernia, sportsman’s hernia and athletic pubalgia by the Manchester consensus and the Doha agreement meeting, the terms are still widely used in the literature [2,7]. This finding is indicative of the fact that part of the confusion regarding terminology in groin pain is caused by healthcare professionals. Other examples which come in accordance with our finding is firstly, the recent article published by Kraeutler et al., which has commented on differentiation of terminology based on geographic distribution [9], secondly the article published by Heijboer et al. highlighting the heterogeneity in diagnostic terminology through a Delphi survey, and lastly, the article by Zuckerbraun, criticized by Thorborg and Hölmich for the use of the term sports hernia in its title [10,11,12].

Shedding light on the way authors use the searched terms, it is easily understood that the terms “Sports/sportsman’s hernia” and “athletic pubalgia” are the most confusing ones. There is a tendency for the term sports hernia to describe inguinal disruption (52% of the authors use it in this way) and for athletic pubalgia to describe pathology of the rectus abdominis-adductor longus (47%). However, a significant percentage uses the term to describe pathology in both of the above anatomical structures (15% for sports/sportsman’s hernia and 27% for athletic pubalgia). Lastly, some of authors use the terms to describe the symptom of groin pain (9% for sports/sportsman’s hernia and 15% for athletic pubalgia). This makes studying of the literature even more difficult, since the title or the abstract of an article does not clearly refer to a specific pathology, but rather to at least two. Similarly, “core muscle injury” is mainly used to describe rectus abdominis-adductor longus pathology (73%), but although less confusing, it is not as clear as “sportsman’s groin”, which is only used to describe inguinal disruption.

Groin Pain Anatomy

Flat Abdominal Muscles and Inguinal Disruption Anatomy

To better understand the complicated use of various terms, a detailed knowledge of the regional anatomy is needed. In figure 2, the complex anatomy of the area is briefly presented. To begin with, the lateral abdominal wall consists of three flat muscles: the external oblique, the internal oblique and the transversus abdominis muscle [13]. The external oblique is the largest and most superficial flat muscle of the abdominal wall. It originates from the 5th-12th rib and inserts into the iliac crest, the anterior superior iliac spine, and the pubic tubercle. The inferior part of its aponeurosis runs from the anterior superior iliac spine to the pubic tubercle thus forming the inguinal ligament, which is the inferior wall of the inguinal canal. The superior part of its aponeurosis continues till the rectus abdominis, thus forming the anterior wall of the inguinal canal [13,14]. The internal oblique muscle originates from the iliac crest, the lumbodorsal fascia and the inguinal ligament and inserts into the 10th-12th ribs and the adjacent rib costocartilage [13]. The transversus abdominis muscle originates from the thoracolumbar fascia, the 7th-12th rib costocartilage, the iliac crest, and the lateral inguinal ligament and attaches to the xiphoid process, the pubic crest and the linea alba. The aponeurosis of the internal oblique and the transversus abdominis fuse to form the conjoint tendon which serves as the superior wall of the inguinal canal and also contributes to the formation of the posterior wall [13,14]. Finally, the deepest structure of the abdominal wall is the transversalis fascia, which also serves as the posterior wall of the inguinal canal. The latter has two openings, the deep or internal ring, just above the midpoint of the inguinal ligament and the superficial or external ring, just superior to the pubic tubercle [13,14]. When inguinal disruption, the term
suggested by the Manchester consensus, or inguinal-related groin pain, as stated by the Doha agreement, is suspected, the above structures should be considered as the region of suspected pathology [2,7].

**Vertical Abdominal Muscles Anatomy**

Moving to the anterior abdominal wall, two vertical muscles can be found. The first is the rectus abdominis muscle, a long, paired muscle, found at either side of the midline, called the linea alba. The lateral boarders of the rectus abdominis are also creating another line, known as linea semilunaris. The rectus abdominis arises from internal and external tendons. The external tendon attaches with a broad insertion on the cranial border of the pubis, between the pubic tubercle and the symphysis. The internal tendon is slender and descends below the inguinal ligament to interlace with the fascia lata and the gracilis [15]. It inserts into the xiphoid process of the sternum and the costal cartilage of the 5th-7th ribs. Its sheath is formed by the aponeuroses of the three flat muscles of the lateral abdominal wall [13]. More specifically, the anterior wall of the sheath is formed by the aponeuroses of the external oblique and half of the internal oblique and the posterior wall is formed by the aponeuroses of half the internal oblique and the transversus abdominis [13]. The second muscle of the anterior abdominal wall is the pyramidalis muscle. It is a small triangular muscle originating from the pubic crest, just medial to the pubic tubercle, and inserting on the linea alba. It is the only abdominal muscle located anterior to the pubic bone, located between the anterior surface of the rectus abdominis and the posterior surface of the rectus sheath [13,15].

**Adductors’ Anatomy**

Just below, the adductors’ proximal insertion, also incriminated in athletes’ groin pain can be found. Adductor longus is the most anteriorly placed muscle of the adductor group. Just behind, the adductor brevis is the shortest of the adductors. Their proximal attachments extend from the anterior surface of the pubic body inferior to the pubic tubercle. The adductor longus insertion partially covers the adductor brevis one, with the latter extending lower to the inferior pubic ramus to fuse with the gracilis proximal insertion. Histologically, their enthesis are fibrocartilaginous [16]. Adductor longus inserts on the middle third of the linea aspera in the femur while adductor brevis into the superior half of the linea aspera [17,18,19]. The adductor magnus is the largest of the adductors with its origin spanning from the femoral surface of the ischiopubic ramus to the lateral part of the inferior surface of the ischial tuberosity. Gracilis is a weak adductor but the most medial and most superficial muscle of the medial thigh compartment. It is the only muscle from this group that crosses two joints, namely the hip and the knee. It extends from the body of pubis and ischiopubic ramus to the medial surface of the proximal tibia. Finally, the pectineus muscle extends from the pubis to a line just below the lesser trochanter [19].

**Pubic Aponeurosis Anatomy – An area of controversy**

The pubic aponeurosis is a combination of the rectus abdominis and external oblique muscle aponeurosis, also thought to connect these structures to the adductor origin [20]. There are several studies examining the possible connection between the proximal adductors and distal rectus abdominis insertion via the pubic aponeurosis. For years, this connection was thought to contribute to the creation of an anatomical pathway across the anterior pubic symphysis which was likely to facilitate the transmission of large forces during multidirectional athletic activities between the two muscle groups, thus explaining the area’s vulnerability in trauma [20,21]. However, according to a recent study by Schilders et al. a strong direct connection between the pyramidalis muscle and the adductor longus tendon via the anterior pubic ligament exists [15]. This finding introduces a new anatomical concept, the PLAC (pyramidalis–anterior
pubic ligament–adductor longus complex), which comes in contrast with older theories supporting a possible strain transmission from the adductor longus, across the anterior pubic symphysis, to the contralateral distal rectus sheath (Figure 2) [15,20].

Anatomy of the Adjacent Nerves

For a complete assessment of the anatomical structures of the area, the nerve components of the inguinal canal and the adjacent nerve branches should not be forgotten. There are two nerves which usually traverse the inguinal canal: the ilioinguinal nerve and the genital branch of the genitofemoral nerve [22,23,24]. The first is usually a branch of the first lumbar spinal nerve root (L1), although contributions from the T12, L2 and L3 roots have been reported [23]. It enters the abdominal wall approximately 3cm medial and 4cm inferior to the anterior superior iliac spine (ASIS), follows the cord structures and exits through the external inguinal ring [23]. It provides motor innervation to the internal oblique and transversus abdominis muscles and sensory innervation to the anterior perineum and medial part of the proximal thigh [22]. The genitofemoral nerve, branch of the first and second lumbar spinal nerve roots (L1-L2), is divided in a medial and lateral branch which further divide in smaller femoral and genital branches [24]. The genital branches follow the cord structures providing sensory innervation to the scrotum in males and labia in females, but also motor innervation to the cremaster muscle. The femoral branches pass below the inguinal canal innervating the skin of the proximal thigh [22,24]. Finally, anatomical course of the iliohypogastric nerve should be kept in mind. The latter commonly arises from the lumbar plexus, pierces the transversus abdominis and internal oblique muscles approximately 3cm medial and 1.5cm inferior to the ASIS and travels between the internal oblique and external oblique muscle to innervate the suprapubic region [21,22]. The nerve anatomy of the area is summarized in Figure 3.

Discussion

Why Adopting a Consistent Terminology is Important?

This current concepts review revealed the wide use of many rejected terms by consensus statements in the literature. Healthcare professionals involved in care of athletes must know that the term “Athletic Pubalgia” is used to describe pathology of the rectus abdominis/ adductor longus and “Sports hernia” to describe inguinal disruption, only in half of the articles found in the literature. These terms are usually considered as synonyms, although they are not and remain a confusing factor in the literature. The same is also true for the less common terms of “Sportsman’s groin” and “Core muscle injury”.

This confusion makes evidence-based treatment decisions difficult. It is not possible to name pathology of different structures (posterior inguinal wall, rectus abdominis insertion, adductor longus insertion, pubic ligament etc.) under perigraphic, non-anatomic terms such as athletic pubalgia or sports hernia. It is clear in the literature that pathology of different structures requires a different treatment strategy, especially when treatment is surgery. Inguinal disruption requires open or laparoscopic trans-abdominal pre-peritoneal (Lap TAPP) or laparoscopic totally extra-pre-peritoneal (Lap TEP) repair [25,26,27,28]. Injury of the rectus abdominis has been treated with direct repair of the muscle back to the pubis, along with lengthening of the adductor longus [29], while other authors emphasize on inguinal ligament release or adductors longus release as a single intervention [30,31]. On the other hand, nerve entrapment is a different story. It may involve additional symptoms such as sensory changes or trigger points, requires additional differential diagnosis strategies, such as nerve blocks and its treatment is focused on nerve
release, neurectomy or radiofrequency ablation to ease the persistent pain [32,33]. Once again the cause of the constant confusion is clear: pathology of different anatomical structures treated with dissimilar surgical interventions is named with the same terms throughout the literature.

Future research may focus on building the evidence base for appropriate treatment of each pathology. Correlation of imaging and clinical findings along with conservative and surgical treatment of all components involved in the groin pain spectrum, including muscle strains, avulsion fractures, inguinal disruption and nerve entrapments, should be examined in depth with high-quality studies. The creation of a clear and consistent algorithm to deal with groin pain could be the next step in an effort to solve the enigma.

The Anatomical Approach

Deep knowledge of the regional anatomy makes clear that the only way to target a successful treatment is to clarify the anatomy behind the pathology. Diagnosis should be made and named based on pathology observed in specific anatomical structures. We strongly encourage future authors of articles on groin pain to abandon the terms sports hernia, sportsman’s hernia, sportsman’s groin and athletic pubalgia supporting the Manchester consensus and the Doha agreement meeting. Sports/sportsman’s hernia should be abandoned since a true hernia is not a common finding in athletes. Sportsman’s groin is a term describing a region (the groin), neither a pathology, nor a symptom. Athletic pubalgia comes from the word pubis and the word ending algia, which derives from the Greek word algos, meaning pain. So, the term describes a symptom, not a specific pathology. However, we discourage authors to use it as a term describing pain around the pubis since its use until today remains confusing. Lastly, core muscle injury is a recently introduced term. Core muscles is a non-anatomic term, describing a group of muscles responsible for strength and stability of the torso including but not limited to the rectus abdominis, the external oblique, the internal oblique, the transversus abdominis, the multifidus, the quadratus lumborum and the lumbar erector spinae muscles. We also discourage future authors to use this term, which may seem more proper than the previous, but still lacks anatomical clarity.

Instead, the use of the Doha agreement classification along with a specific anatomic diagnosis is preferrable, when possible. For example, an athlete may be diagnosed with adductor-related groin pain along with the anatomical diagnosis of avulsion of the adductor longus proximal insertion or another may be diagnosed with hip-related groin pain along with the anatomical diagnosis of a labrum tear. Such pathologies may usually coexist but there is a clear need to be mentioned in detail, just as in knee pain a patient may be diagnosed with an anterior cruciate ligament (ACL) tear, a torn meniscus, and a cartilage defect. Finally, we encourage authors to use the Italian consensus as a guide in differential diagnosis and also, to use the term “inguinal disruption” just as it was described by the Manchester consensus. Sometimes, in sports medicine, it is said that a specific anatomical diagnosis is not always necessary and does not clearly constitute best practice. This is not the case with groin pain. On the contrary, based on the above, a clear and consistent diagnosis can be achieved, providing the basis for improved communication between healthcare professionals, more high-quality studies, and of course evidence-based treatment decisions.

Conclusion

Groin pain terminology is a complex subject, but it will remain an enigma only if we continue using rejected terms as physicians, authors, or reviewers. Going back to anatomy is the key. Adopting the
consensus meetings’ statements is the first step. Aiming at a specific anatomic diagnosis is the second one. Following this approach will eventually lead to better communication between healthcare professionals, but the most important, it will facilitate evidence-based practice and improve our treatment strategy.

**Acknowledgements:** We would like to sincerely thank Mrs. Stella Stergiadou for preparing the anatomical figures included in this article.

**Conflict of interest:** Nothing to declare.

**Funding:** None.

**Figure Legends**

**Figure. 1** An infographic presenting to which anatomical structure authors refer, when using each one of the terms included in the literature search.

**Figure. 2** The anatomical relationship of the rectus abdominis, the pyramidalis the adductor longus and the pubic symphysis. (PLAC: pyramidalis–anterior pubic ligament–adductor longus complex)

**Figure. 3** Skin sensory distribution of the iliohypogastric (yellow), ilioinguinal (orange) and genitofemoral (green) nerves. Their course during surgical approach of the inguinal canal is also presented (1: iliohypogastric, 2: ilioinguinal, 3: genital branch of the genitofemoral nerve).
References


Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐ The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: