APPROACHING GROIN PAIN IN ATHLETICS

"THE FALCON'S PERSPECTIVE"

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Falah the falcon is the mascot of the Doha 2019 Athletics World Championships. Falcons are important in Qatari culture and are renowned for their exceptional vision, even in the dark. For many clinicians, groin pain in athletes is considered as an area of darkness that is difficult to navigate. It seems sometimes that diagnosing in athletes with groin pain is as challenging as qualifying for the World Championship finals.

Doha not only hosts many major sporting events, but we also hosted the first World Conference on Groin Pain in Athletes, which led to the Doha agreement on terminology and definitions in groin pain in athletes[1]. In this article, we aim to be your mascot and provide you with a falcon's eye view of clinically relevant anatomy of the groin area, which should enable you to better examine your patient and recognize common clinical entities.

CLINICALLY RELEVANT ANATOMY OF THE GROIN

Adductor-related groin pain (both acute and long-standing) is by far the most common groin injury in athletes[2–5], so we will start by looking at the adductors in more detail. There are a number of different adductor muscles: adductor longus, adductor brevis, adductor magnus, gracilis, pectineus, and obturator externus. The vast majority of groin injuries affect the adductor longus[3,6] and being able to locate and examine this muscle is a basic skill we all need to have.

ADDUCTOR LONGUS

Aside from its obvious role as a hip adductor, the adductor longus is also a hip flexor when the hip is in extension. It works hard eccentrically to turn hip extension into flexion, which is part of many athletic movements[7].

Adductor longus has a proximal attachment on the pubic bone[8]. Palpation of the proximal tendon can be performed easily and following the tendon proximally with your finger, you can find the insertion[9]. Recognizable injury pain on palpation is one of the key features of adductor-related groin pain[1]. The proximal tendon continues superficially, with the lateral part of the tendon transitioning intramuscularly at approximately 1-2.5 cm from the insertion (Figure 1)[10]. The entire proximal tendon becomes intramuscular at about 5.5-8 cm from the insertion, where it continues as an intramuscular (central) tendon[10]. The total proximal tendon length is anywhere between 7 and 17 cm[11]. While long-standing adductor-related groin pain is usually related to the insertion, acute adductor longus injuries can occur anywhere along the musculotendinous junction (MTJ) of the

Figure 1: Adductor longus. a) Adductor longus: proximal insertion and tendon. One can clearly see the superficially located proximal tendon which becomes an intramuscular tendon a few cm below the insertion and continues within the muscle. b) Palpation of the adductor longus can be reliably performed and you can locate recognizable injury pain at the insertion in most cases of adductor-related groin pain. The tendon can easily be palpated superficially. c) Resistance testing of the adductors.Figure 1a reproduced with permission from Tuite et al 1998.

proximal tendon[6]. Interestingly, there is also a high proportion of acute injuries at the MTJ of the distal tendon. The distal tendon has not yet been examined in anatomical studies, but is considered to extend as a superficial tendon aponeurosis along the muscle from its femoral insertion. In both acute and longstanding adductor-related groin pain, pain at the proximal insertion is considered to be the most severe.

ILIOPSOAS

Iliopsoas is a composite muscle made of the psoas major and iliacus muscles which function together as the most powerful flexor of the hip. The psoas arises from the outside of the vertebral bodies and discs from T12 to L3. The psoas can be palpated deep in the abdomen if your athletes relax their abdominal wall and then gently lift their leg as shown in Figure 3b[9]. If your fingers are in the right place, you will feel the psoas muscle belly contracting under your fingertips as the athlete lifts the leg off the bed. This should be possible in most lean athletes, but can become increasingly difficult in athletes with a high amount of body fat, such as different throwing athletes (shot put/discus etc.)

Iliacus arises from inside the iliac fossa and can merge with the psoas around the level of the inguinal ligament. Anatomical studies show that in the majority of cases there are separate and distinct distal tendons originating from the iliacus and psoas major muscles[15–17]. The psoas major tendon is located more medially on the lesser trochanter, while the primary iliacus tendon is located slightly laterally, and an accessory iliacus tendon might also be present[16]. The iliacus muscle is divided in postero-medial and antero-lateral parts of the muscle[16,18]. The most antero-lateral muscle fibers of the iliacus attach directly on the femur, slightly inferior to the lesser trochanter (Figure 3a)[19].

When palpating the iliopsoas muscles below the inguinal ligament, see Figure 3d[9], it is almost impossible to differentiate between the distal insertions, and we generally record pain as distal iliopsoas-related pain only.

INGUINAL CANAL

The inguinal canal is in the lower anteromedial abdominal wall just above the inguinal ligament. It serves as a pathway for important anatomical structures to pass from the abdomen towards the genitalia. Its floor is the inguinal ligament, which runs from the pubic tubercle at its medial end up to the anterior superior iliac spine laterally. See Figure 4a. The inguinal ligament actually represents the shelving edge of the inferior part of the external oblique aponeurosis. This thickening, which is reinforced by the lacunar ligament on the medial part, can be palpated in athletic subjects. The transversalis fascia forms the posterior wall and the structures from the abdomen pass through the invaginated fascia, at the deep inguinal ring. The deep inguinal ring is located halfway along the inguinal ligament, just superior to it. The following structures pass through the inguinal canal: the ilioinguinal nerve and genital branch of the genitofemoral nerve, spermatic cord in men or the round ligament in women and accompanying vessels. The superficial inguinal ring is just above the pubic tubercle and is the medial end of the inguinal canal. This represents the opening of the inguinal canal in the external oblique facia and you can palpate the ring through the abdominal wall in athletic subjects, as shown in Figure 4b[9]. The best way to palpate the inguinal canal in males is by invaginating the skin from the scrotum. This allows you to place

the finger into the external ring (see Figure 4c), and you can check for inguinal hernias by asking the patient to perform a Valsalva maneuver while you feel the canal.

PUBIC SYMPHYSIS

The pubic symphysis is a non-synovial joint lined with hyaline cartilage and contains a fibrocartilaginous disk[12]. The symphysial joint is surrounded by a dense capsule that is thickened superiorly and inferiorly to form the superior and inferior pubic ligaments (Figure 2a). In athletes, the pubic symphysis undergoes considerable mechanical stress, and the joint may be a source of pain, including the adjacent bone. However, pubic-related groin pain is one of the least frequent clinical entities in adult athletes[13].

It is very important to note that the pubic apophyses are one of the last areas in the body to ossify, only fully fusing around 20 years of age[12,14]. These bony islands of endochondral ossification are often misinterpreted on imaging as being a fragmented or degenerative pubic bone. There is growing attention that groin pain at the adductor insertion on the pubic bone, in athletes in the age group 14-19, is often pubic apophysitis. This should always be considered as a potential differential diagnosis in adductor-related groin pain in younger athletes.

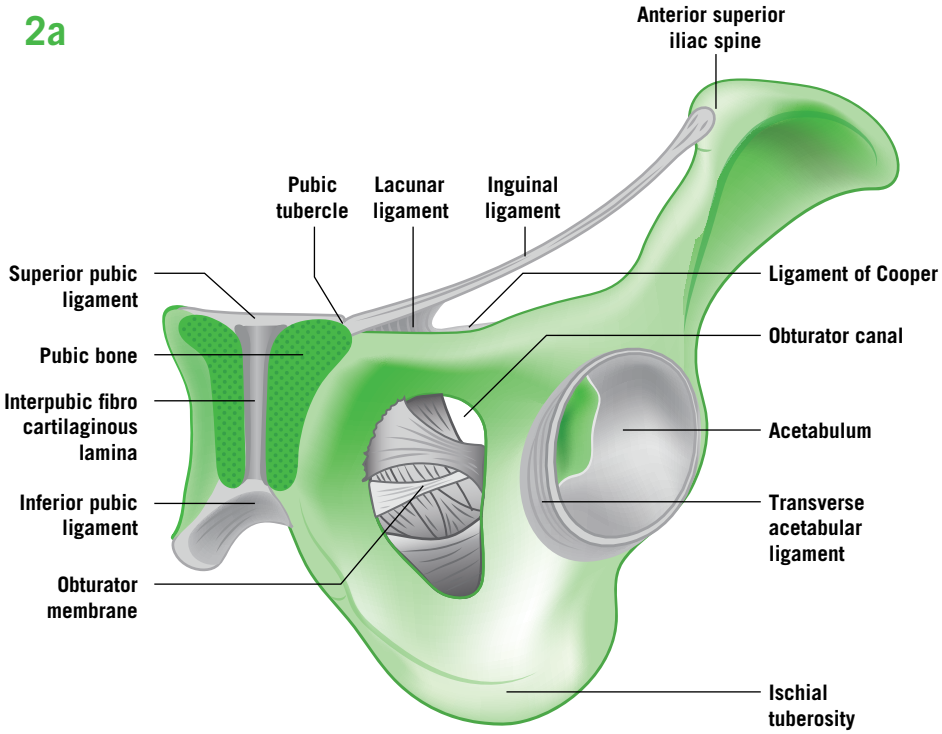
ANATOMICAL CONNECTIONS

Numerous authors have noted the complexity of interconnections around the pubic symphysis[12,20,21]. There is no doubt that there are superficial fascial connections between many structures in the groin, just like any other region of the body. Whether this means that these connections transmit a lot of force is doubtful. A biomechanical study, on 10 embalmed cadavers, used strain gauges to see if traction on the adductor longus resulted in measurable force in the contralateral rectus abdominus[22]. The results showed that the force transmission was really variable. Pulling on the adductor longus resulted in more force, less force or no change at all, in different specimens.

A recent anatomical study serves to remind us of the large insertions of both adductor longus and rectus abdominus onto the pubic bone[20]. It's not surprising that these large force-producing muscles, have large bony insertions, as you would expect anywhere else in the body. This also includes a focus on the pyramidalis muscle, which is often forgotten. This small muscle extends across the pubic bone anteriorly and inserts into the anterior pubic ligament (Figure 5). On imaging the pyramidalis muscle can be mistaken for the rectus abdominis muscle, and this is likely the cause of the mistaken terminology of the rectus abdominis-adductor longus aponeurosis, which we believe is an incorrect term, that should no longer be used. The relationship between the adductor longus, rectus abdominus, and pyramidalis is beautifully shown in Figure 5.

Our current thinking on how to interpret this has changed over the last decade. Where we previously would imagine some kind of loose pre-symphyseal aponeurosis, the contemporary literature and dissections now makes us consider the muscle insertions to be much larger and stronger than before.

Mick Drew and colleagues from Australia has also added a new perspective on connectivity in the groin with their work on experimental referred pain. They had the great idea to use painful injections into the adductor longus insertion and see where healthy athletes felt pain[23]. Aside from the obvious insertional pain where they were injected, one third of the athletes also felt pain in the lower abdomen. They point out that it is important to examine the adductors carefully if athletes present with pain felt in the lower abdomen and not just check the abdominal wall.



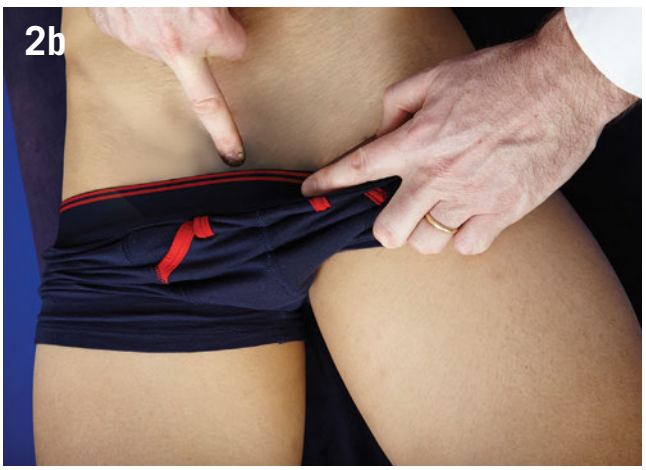


Figure 2: Pubic symphysis. a) The pubic symphysis is a non-synovial joint lined with hyaline cartilage and containing a fibrocartilaginous disk. The joint capsule is thickened superiorly and inferiorly. b) Palpation of the symphyseal joint and immediately adjacent bone is best performed from the superior/cranial side and remember that the joint slopes downwards from superior to inferior.

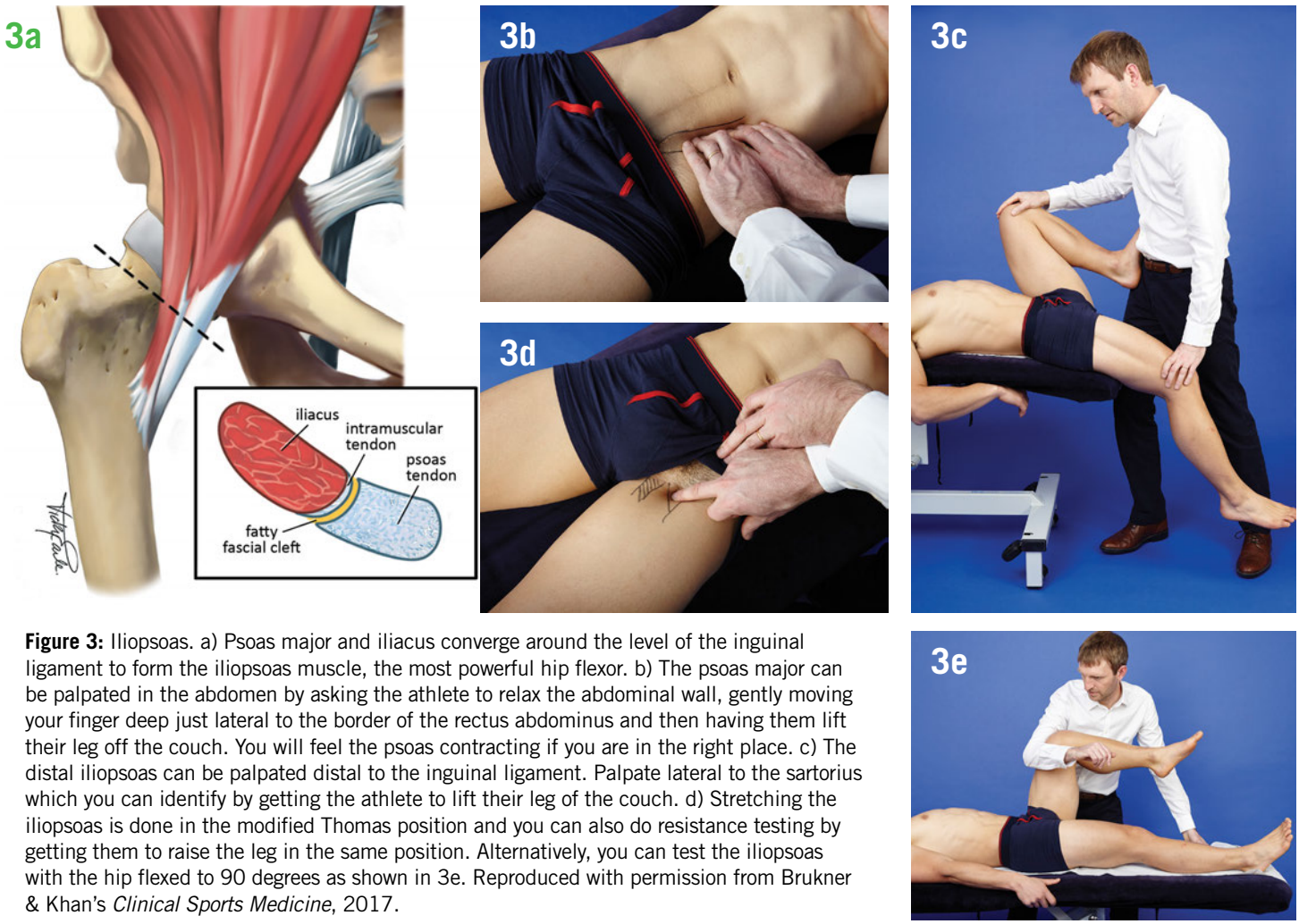


Figure 3: Iliopsoas. a) Psoas major and iliacus converge around the level of the inguinal ligament to form the iliopsoas muscle, the most powerful hip flexor. b) The psoas major can be palpated in the abdomen by asking the athlete to relax the abdominal wall, gently moving your finger deep just lateral to the border of the rectus abdominus and then having them lift their leg off the couch. You will feel the psoas contracting if you are in the right place. c) The distal iliopsoas can be palpated distal to the inguinal ligament. Palpate lateral to the sartorius which you can identify by getting the athlete to lift their leg of the couch. d) Stretching the iliopsoas is done in the modified Thomas position and you can also do resistance testing by getting them to raise the leg in the same position. Alternatively, you can test the iliopsoas with the hip flexed to 90 degrees as shown in 3e. Reproduced with permission from Brukner & Khan's *Clinical Sports Medicine*, 2017.

WE MADE GROIN PAIN COMPLEX!

We, the experts in the field, are partly responsible for groin pains' dark and difficult reputation. Yes, there is complex anatomy and yes, there are numerous organ systems that can cause groin pain, but one of the most confusing aspects of groin pain is the ridiculous number of diagnostic terms introduced over the years.

The team from Sports Groin Pain Centre set out to investigate how bad the problem of terminology was. Using a Delphi method, we sent 2 clinical cases of football players, one adductor-related and one inguinal-related groin pain, to 23 groin experts[24]. These international experts were sports physicians, sports physiotherapists, general surgeons and orthopedic surgeons. For the first case 23 experts used 18 different terms to describe the diagnosis and 22 for the second case! The list for the first case of adductor-related groin pain included: adductor tendinopathy, adductor enthesopathy, adductor strain, adductor tear, adductor tendinitis and adductor teno-osseous defect. These are all pretty closely related, but the same athlete was also diagnosed with pubic ring failure, pubic bone stress, femoroacetabular impingement syndrome and pubic plate tear.

In the second case of inguinal-related groin pain the terminology was extremely heterogeneous. If this athlete had gone to all of the 23 experts, he would have been told he had: sportsman's hernia, inguinal disruption, posterior wall weakness, posterior wall tear, Gilmore's groin, superficial inguinal ring insufficiency, inguinal canal aponeurosis strain, inguinal ligament enthesopathy or transversus abdominus strain. All these point in the direction of the inguinal canal, but other diagnoses were also: core muscle injury, hip labral tear, femoroacetabular impingement syndrome, pubic symphysis pathology and pubic cleft arthritis.

While many different terms do create confusion among clinicians, we should still ask the question; "is this important for patients?" We think it is. There is an emerging body of evidence that what we call medical conditions influences which treatment patients think they should have[25], and in turn which treatment clinicians then select.

> Clinical pearl
>
> The crazy number of diagnostic terms we have coined explains why we think the groin region is complex!

CLASSIFICATION AND DIAGNOSIS OF GROIN PAIN IN ATHLETES

As far as we know, all international experts agree that history and clinical examination remain the cornerstones for diagnosing athletes with groin pain[1,26]. This is not to say that imaging has no role, but imaging should never be done in isolation without a full clinical examination first. The primary role of imaging should be to rule out potential serious problems that might not be immediately obvious.

In 2014, we organized the first world conference on groin pain in athletes. The

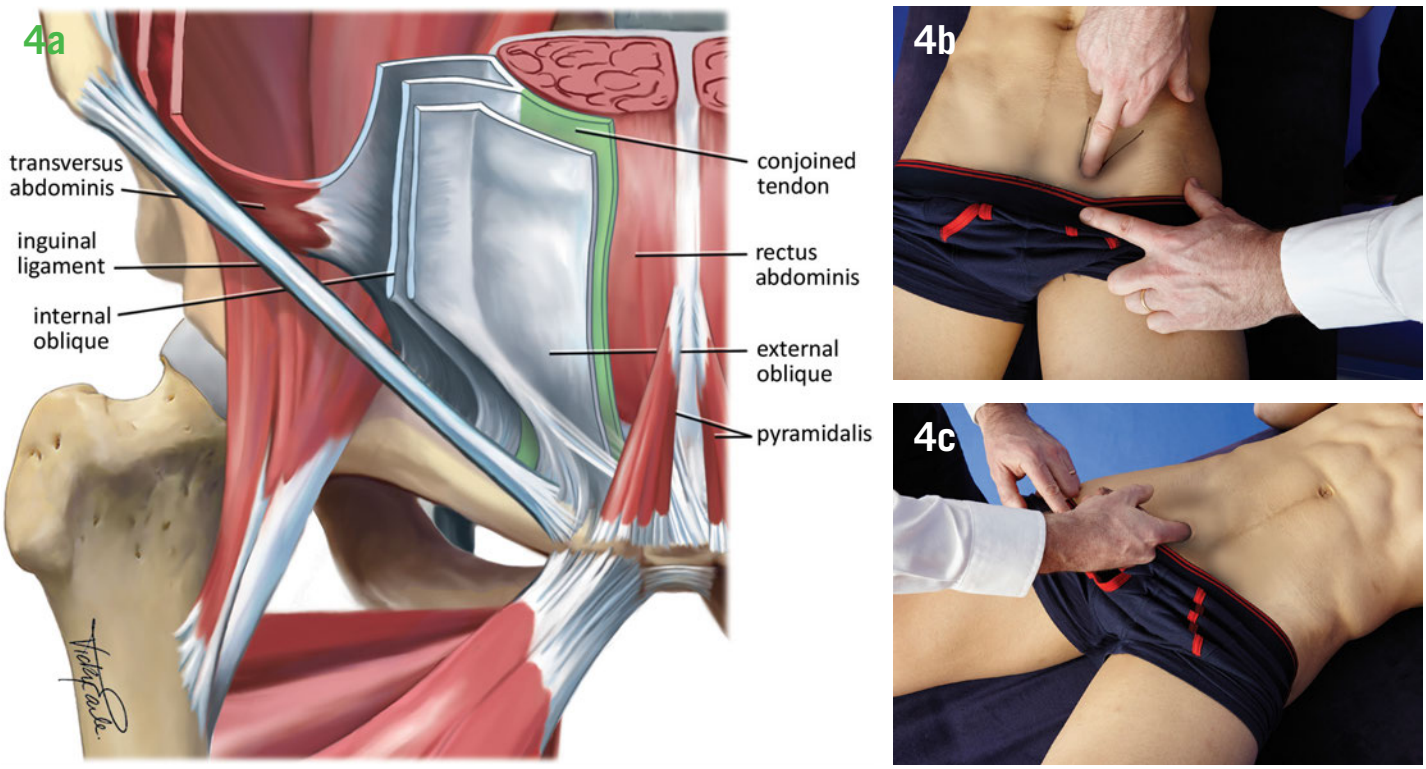


Figure 4: Inguinal canal. a) Inguinal canal anatomy – the different layers of the abdominal muscles – transversus abdominus, internal and external oblique are all parts of the inguinal canal. b) Superficial palpation of the external inguinal ring. Feel just lateral to the rectus abdominus sheath and above the pubic tubercle. In athletic subjects you will find a soft spot, which is the external ring. c) Scrotal invagination: in males you can feel inside the external ring for recognizable injury pain, and also check for an inguinal hernia if you get them do perform Valsalva. Reproduced with permission from Brukner & Khan's *Clinical Sports Medicine*, 2017.

same 23 experts who took part in the Delphi research gathered and agreed on a new set of terminology and definitions[1]. The group comprised people from different specialties, different countries, different ages, clinical and scientific background. We are obviously biased when it comes to our approach in clinical practice having been involved in the Doha agreement. Our aim was to have a system based on clinical examination so that both doctors and physiotherapists can use it to be able to communicate clearly with each other and with patients. The system is aimed at long-standing groin pain cases. We hope clinicians in daily practice find it useful.

Figure 6 shows an overview of the Doha agreement's way of approaching athletes with groin pain.

The main outcome was defining 4 common clinical entities that link with the anatomy discussed in the first half of this article. Most athletes who you see with groin pain will have one or more of these entities. The general examination techniques for groin pain were already described by Prof. Per Hölmich back in 2004, when he showed that these can be done reliably[9]. We also wanted to stress that you should never forget the hip joint as a possible cause of groin pain in athletes.

> Clinical pearl
>
> **Never forget to examine the hip joint in every athlete who presents with groin pain. Clinical examination is very good at ruling out the hip as a cause of pain if the tests are negative.**

Many other organs and conditions can also cause groin pain. Athletes, although they sometimes perform superhuman feats, are also humans. They can get tumors, infections, systemic diseases and every clinician needs to keep a broad differential diagnosis in mind when examining them. It's also good practice to do a brief examination of the lumbar spine and pelvis in all groin pain cases too. This gives the opportunity to briefly zoom out and consider the bigger picture.

We tracked our diagnoses according to the Doha Agreement in 100 athletes who came to the sports groin pain clinic in Aspetar[13]. Adductor-related groin pain was the most common clinical entity (61%) as others have also found in different countries[2,27]. But in more than half of the cases of adductor-related groin pain the athletes also had another groin problem. In fact, multiple causes were found in 44% of all athletes. We also found other causes including hip osteoarthritis, labral tear, nerve entrapment and inguinal hernias. As clinicians we need to be aware of these other possibilities when athletes present with groin pain.

> Clinical pearl
>
> **Always check the whole groin region in athletes with groin pain – multiple causes are frequent.**

ADDUCTOR-RELATED GROIN PAIN

This is by far the most common entity of groin pain. If you don't see many athletes with groin pain, get familiar with adductor-related groin pain as this is what you will see most. The findings are pain on palpation of the adductors along with pain in the adductors on resisted adduction testing. Figure 1 shows the anatomy and how to palpate the adductor and perform resistance

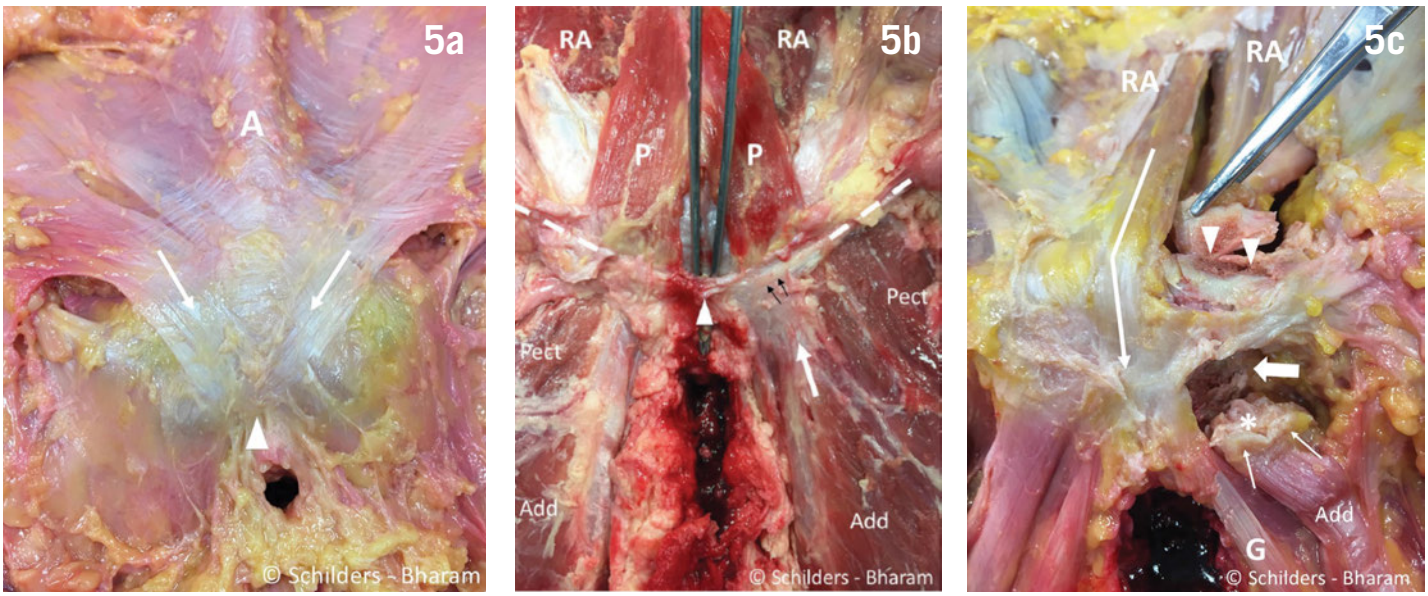
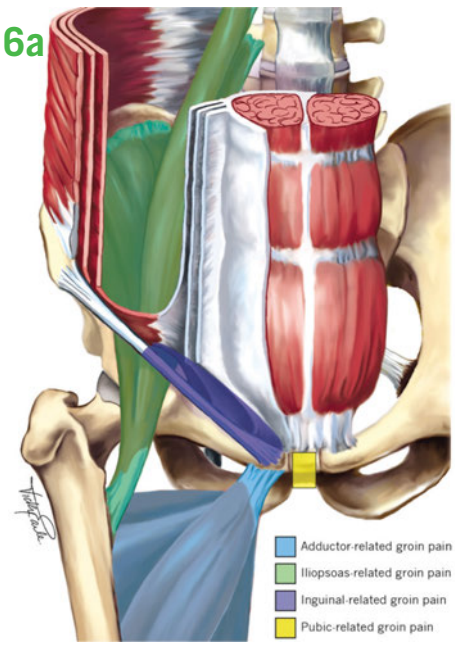


Figure 5: Anterior pubic symphysis connections in a male cadaver. a) After removal of the spermatic cords and the penis. There is a cord-like linea alba (A). The fibers of the external oblique aponeurosis form the medial part of the external inguinal ring (arrow) and are considered to attach to the superficial portion of the anterior pubic ligament (arrowhead). b) Anterior symphyseal area after removal of the entire aponeurosis demonstrates the remnants of the superficial portion of the anterior pubic ligament (white arrowhead). The pyramidalis muscle (P) arises from the pubic crest and the anterior pubic ligament. The proximal adductor longus tendon (white arrow) may partially attach to the deep portion of the anterior pubic ligament (black arrows). c) The anterior symphyseal and peri-symphyseal area after resection of the pyramidalis muscle and the anterior pubic ligament. The rectus abdominis has two attachments; the external tendon of the rectus abdominis at the superior pubic rim (arrowheads) and the internal tendon of the rectus abdominis extending anteriorly across the symphysis (white narrow arrow). There is a separate footprint of the adductor longus fibrocartilage (thick white arrow). The adductor longus tendon (thin arrows) and the fibrocartilage (asterisk) are detached. Images from Schilders et al 2017. Add=adductor longus muscle; Pect=pectineus muscle; G=Gracilis; RA=rectus abdominis muscle.



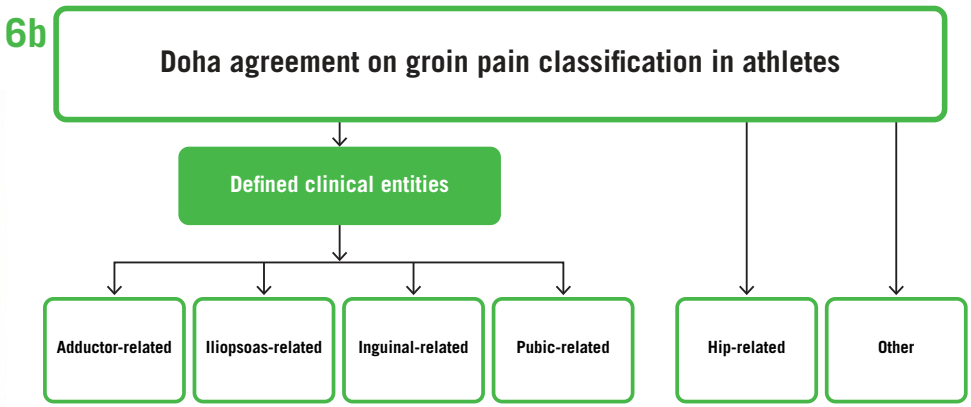


Figure 6: The Doha agreement on groin pain in athletes. Reproduced with permission from Weir et al 2015.

testing. The most common location is the insertion of the adductor longus on the pubic bone. The pain is bilateral in about 1/3 of cases. Both resistance testing and flexibility testing are important. If there is unilateral shortening on the symptomatic side together with high muscle tone, then adding manual soft tissue treatment to the management strategy can be useful.

If adductor pain has been present for a few months, then the ipsilateral iliopsoas often becomes painful too. That may be due to the fact that the painful adductor contributes less to hip flexion and the iliopsoas gets overloaded compensating for this.

The other common combination is adductor- and inguinal-related groin pain at the same time. In our series of 100 athletes inguinal-related groin pain was present in 1/3 of the cases of adductor-related groin

pain[13]. A Danish study showed that the time to return to sport was longer when these two presented together[2].

ILIOPSOAS-RELATED GROIN PAIN

Iliopsoas-related groin pain in isolation is uncommon. It is mainly associated with linear sports, such as long-distance runners, and especially in females. It can also occur as a long-standing problem following an acute injury, but it usually presents along with adductor- or hip-related groin pain. Iliopsoas-related groin pain is diagnosed when there is recognizable injury pain on palpation. This is most common at the distal insertion, see Figure 3. This defined clinical entity is more likely if stretching the muscle or resistance testing produces pain, as also shown in Figure 3.

INGUINAL-RELATED GROIN PAIN

The entity of inguinal-related groin pain is defined as recognizable pain on palpation of the inguinal canal. In men, this is best performed via invagination of the scrotal skin. In practice we usually do the inguinal examination last as this is the most intimate part of the clinical examination. Just as for the pubic symphysis, you need to get your athlete to differentiate between the general discomfort of invagination with palpation and their actual injury pain. In general, athletes distinguish them very well. Pain in the inguinal canal on abdominal muscle resistance testing makes inguinal-related groin pain more likely, and you can get them to do the Valsalva maneuver to provoke their pain too. If you feel an actual inguinal hernia, then they do not have inguinal-related groin pain, but rather a symptomatic inguinal hernia, which is categorized as 'other' according to the Doha agreement. There is always discussion about the bulging of the posterior wall of the inguinal canal. In our opinion this is sometimes present on invagination during Valsalva, but not in all cases. We need to do more work to see if we can reliably classify possible bulging during clinical examination and ultrasound in order to determine its clinical significance in terms of prognosis and management. Inguinal-related groin pain often co exists with adductor-related groin pain, but we found it in isolation around 1/3 of the time.

PUBIC-RELATED GROIN PAIN

Our experience and data show that pubic-related groin pain is the least common clinical entity. It is diagnosed when there is recognizable pain on palpating the pubic symphysis and immediately adjacent bone (Figure 2b). It is really important to differentiate between the normal discomfort of palpating the pubic symphysis from actual recognizable injury pain. This can be seen more commonly in endurance athletes and female athletes.

FUTURE PERSPECTIVES

Our goal within the diagnosis of groin pain should be to further define exact anatomical locations and pathophysiology within the different entities of groin pain. Without this, we are unlikely to be able to examine treatment strategies sufficiently. New scientific studies are needed to provide more detailed overviews of the most common sites of groin pain in different sports. While most clinicians know that the insertion of the proximal adductor longus tendon is the most common site of adductor-related groin pain, the understanding of the importance of specific clinical and imaging findings are still unclear. This could for instance include the association of pubic bone marrow edema (either diffuse or for example localized towards the symphysis

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Table 1

Defined clinical entity	*Symptoms & examination findings*
Adductor-related	*Adductor tenderness & pain on resisted adduction*
Iliopsoas-related	*Iliopsoas tenderness & more likely if pain on resisted hip flexion and/or pain on hip flexor stretching*
Inguinal-related	*Pain in inguinal canal region & tenderness of the inguinal canal* *No palpable inguinal hernia present* *More likely if aggravated by abdominal resistance or Valsalva/cough/sneeze*
Pubic-related	*Local tenderness of the pubic symphysis & the immediately adjacent bone* *No particular resistance tests*

Table 1: Details of the clinical findings of the 4 defined clinical entities.

joint, the insertion of the adductor longus or the pubic apophysis), and insertional palpation pain. A clearer differentiation between adductor-related groin pain and pubic-related groin pain is also needed.

In inguinal-related groin pain, we should attempt to find a way to separate nerve compression-related pain from tendinopathy-type pain in this region (possibly arising from the conjoint tendon or inguinal ligament). Furthermore, studies are needed to demonstrate the general prevalence of inguinal posterior wall weakness in athletes, its possible association with the development of inguinal-related groin pain during sports, as well as the development of potential inguinal hernias later in life. Iliopsoas-related groin pain is currently an almost unexplored clinical entity, so the opportunity for further advances in this area are immense.

There are still many more unanswered questions in relation to the diagnosis of groin pain in athletes, so we encourage everyone to get involved so we can continue advancing the field.

SUMMARY

We hope our article has given you a Falcon-like perspective on the diagnosis of groin pain in athletes. This overview should help you navigate this previously dark region with confidence. It's vital to develop a routine when examining groin pain in athletes. This will stop you forgetting to check the hip and entire groin in all cases. A thorough clinical examination remains the cornerstone for the clinical approach. Examining the adductors, iliopsoas, pubic symphysis, inguinal canal and hip joint in every case will prevent you missing important findings. Using the Doha agreement approach provides a structured framework for your history and physical examination. It can also help you communicate findings with athletes and other medical professionals in a common language. Don't forget that clinical entities can, and often do, present together.

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