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Epidemiology of Groin Injuries in Athletes

Groin injuries may occur in various anatomical structures such as bone, muscle, tendon, and ligament. Injuries to the hip joint and stress fractures in the femur/acetabulum or the pelvic ring usually refer pain to the groin, and can therefore be mistaken for a groin injury. Abdominal or gynecological disorders, referred pain and nerve entrapment can also cause groin pain and may therefore also be misinterpreted as a groin injury. Groin injuries can be a major diagnostic challenge, with a number of differential diagnoses for the clinician to consider.

The typical groin injury involves one or more muscle-tendinous structures in the groin region, usually involving the adductors, the iliopsoas, or the abdominals [1–4]. The injury can be located

in the tendon or in the entheses of the tendon where the tendon inserts into the bone, close to the muscle-tendinous junction or in or near the common aponeurotic plate in front of the symphysis joint [1, 5].

Most epidemiological studies on groin injuries in the athletic population do not differentiate between anatomical structures, and, therefore, existing studies are difficult to compare, as injuries in the region are mainly reported as a groin injury/strain/tendinitis or likewise [3, 6, 7]. Furthermore, some studies also report the existence of groin injuries using broad and nonspecific terms such as athletic pubalgia, osteitis pubis, and sports hernias, without any clear definition of these terms, which again makes it difficult to compare between studies. Some studies may report hip and groin injuries combined, whereas other studies will distinguish between these regions [2–4]. Comparing epidemiological studies is, therefore, not an easy task, and should always be considered within the limitations just described [6]. Most studies on groin injuries have been conducted on male adult athletes whereas information concerning the problem in other important subgroups such as female and adolescent athletes is limited.

Injury Mechanism

Groin injuries often happen during forceful action such as kicking, sprinting, and sudden change of direction, and other sporting movements where

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the muscle is being highly activated and/or stretched during forceful contraction [8, 9].

In elite soccer it has been reported that the majority of injuries (90 %) in the hip and groin region recover within 4 weeks [3]. However, if the initial injury is not treated appropriately in the first place or if an athlete is returned to sport too quickly these injuries might develop into a more long-standing or chronic state [3]. This type of injury can take months to recover from. What started out as minor acute strain can develop into a long-standing problem, where important and decisive sporting movements such as maximum kicking, acceleration, deceleration, and change of direction becomes so problematic and painful that the athletes performance is significantly impaired [1, 10]. Also, secondary injuries can develop as other muscle groups are recruited and are at risk of overuse. It has been shown in a number of studies that more than one entity can be identified as a cause of the groin pain in up to one-third of athletes with long-standing groin injury [1, 2].

Risk Factors

Age, previous injury, and low levels of off-season sports-specific activities are significant risk factors for sustaining a groin injury [2, 11–14]. In Australian Rules football (AFL), young players who reported a previous hip or groin injury at the draft medical assessment demonstrated a rate of hip/groin injury in the Australian Football League (AFL) >6 times higher than players without a pre-AFL hip or groin injury history [15]. Other factors such as decreased hip adduction strength and [14, 16] decreased hip flexibility [12, 17, 18] have been suggested to be predictive of sustaining a groin injury; however, contradictive findings in this area exist [11, 14, 19].

Groin Injury Epidemiology

Groin injuries are especially reported in sports such as the different types of football and in ice hockey [7, 20], with an incidence of 0.8–1.3

injuries/1,000 h of athletic activity. Only limited information exists on acute groin injuries. The only study looking exclusively at acute groin injuries in soccer reports a groin injury incidence of 0.8 injuries/1,000 h of play [21].

Soccer

In male soccer a prospective study of the elite teams in UEFA during seven seasons found a total of 628 hip/groin injuries accounting for 12–16 % of all injuries per season. The total injury incidence was 1.1/1,000 h (3.5/1,000 match hours and 0.6/1,000 training hours). This means that a male professional soccer team will suffer an average of seven groin injuries per season, with more than half of them leading to at least 1 week injury time. Of the 18 different diagnostic entities that were registered, adductor-related ($n=399$) and iliopsoas-related ($n=52$) groin injuries were the most common [3]. The mean absence per injury was 15 days and 15 % of the injuries were re-injuries. Groin injuries are less common among female soccer players [7].

In line with the UEFA study a prospective study following 998 Danish male sub-elite soccer players registering all groin injuries found that the most common entities were also adductor-related groin injuries followed by iliopsoas-related and abdominal-related injuries [2]. The incidence at the sub-elite level was lower (0.40 injuries/1,000 h) [2]. In studies with a comparative cohort from the Nordic countries the injury incidence ranged from 0.6 to 0.8/1,000 h, suggesting that players at the sub-elite level may suffer from fewer groin injuries than the elite [2, 12]. Severe injuries (injury time >28 days) accounted for 33 % of all groin injuries. In line with the finding in ice hockey by Emery and Meeuwisse [11] that abdominal groin problems add to injury time, it was found that having an adductor-related groin injury doubles the injury time compared to injuries with no adductor and no abdominal pain. If it is combined with an abdominal-related injury, the injury time is more than quadrupled compared to injuries with no adductor and no abdominal pain [2].

The groin injuries in soccer are mostly over-use injuries. In the UEFA study 27 % were traumatic injuries and the sub-elite study found 39 % traumatic injuries [2, 3]. Very interestingly, in only one of five situations was contact with another player involved in the injury mechanism, implying that the majority (80 %) of the traumatic injuries are probably happening as the result of kicking, sprinting, or sudden changes of direction, movements where the groin-related muscles are involved at high speed, often with a forceful eccentric element [2]. Hip and groin injuries account for one-third of the injuries in goalkeepers in soccer [22]. Adductor strains are the most common subtype with a mean lay off time 2.5 times longer than for hamstring strains. The incidence of hip and groin injuries was higher in goalkeepers than in field players [22].

Ice Hockey

Groin injuries are also frequent in ice hockey. A retrospective epidemiological study found 617 groin/abdominal injuries in the National Hockey League (NHL) during six seasons [20]. The majority of injuries reported were adductor groin muscle strains; however, abdominal groin injuries had a significantly longer time loss (10.6 sessions) compared to other groin injuries (6.6 sessions) [11].

In a recent database study including injury surveillance data of NHL players from the years 2006 to 2010, a total of 890 hip or groin injuries were identified in a cohort of 1,441 players participating in at least one game [23]. The differential diagnosis of the groin injuries are not reported but 94 intra-articular hip injuries in 49 athletes (10.6 %) were reported [23].

American Football

In the National Football League (NFL, American football) the most common injuries related to the groin over a 10-year period were rectus femoris strain, adductor strain, fracture/dislocation of the hip joint, and labral tears of the hip joint.

However, no clear definitions of how the injuries were diagnosed were reported. No injuries related to the abdominal muscles were reported [24].

A retrospective study focusing on injuries to kickers in the NFL over a 20-year period (1988–2007) utilizing the injury surveillance database found a total of 488 injuries in kickers. Of those, 19 % were groin injuries with the adductor-related strains being by far the most common, especially for those located to the pelvis. However, no clear definitions of how the injuries were diagnosed were reported. No injuries related to the abdominal muscles were reported [25]. A study focusing on one NFL team from 1998 to 2007 registered all injuries sustained during the teams training camps; 696 different players participated in the camps, with approximately 90 players in camp each year. In total 728 injuries were registered and 10 % were groin injuries including groin, hip flexor, and abdominal strain. The abdominal strains accounted for ten injuries during the 10-year period. However, no clear definitions of how the injuries were diagnosed were reported [24].

How Many Injuries?

Soccer is one of the most popular sports in the world, and it is estimated that more than 500 million people play some kind of football worldwide, which means that groin injuries are frequently encountered in countries where football is a popular sport.

While the incidence of groin injuries seem to vary between 10 and 20 %, the problem is not sufficiently described by incidence alone, as many players will report having groin pain, even though this will not keep them from training and playing. This means that these “injuries” will not be included in the registration of injuries because these registrations are usually based upon injuries causing absence from training and match play—also known as time-loss injuries. Recent studies focusing on all injuries including injuries without time loss have shown that the prevalence of pain in the hip and groin in male football has been documented to be up to 70 %, which means

that two out of three male players will have problems in this region during the soccer season [26, 27]. Focus on hip and groin pain and function, will, therefore, be important information to obtain in the future, instead of solely focusing on time-loss injuries. The Copenhagen Hip And Groin Outcome Score (HAGOS) is a measure of pain and function in athletes, and reference values have already been obtained in soccer players, so that decreased hip and groin function can be determined [28, 29].

Clinical Entities

The taxonomy regarding groin injuries is still somewhat confusing and regional differences exist depending on the current focus [6]. Very few well-established diagnosis regarding groin injuries in athletes exist. In recent years the clinical entity approach has been found very useful [3, 30–36]. In this approach a standardized clinical examination with reproducible examination techniques is used [1]. The main goal of the examination is to locate the anatomical structures causing the pain. This is done with palpation, functional testing, and stretching. Combining the results of these tests the clinical entities can be defined. The most commonly affected structures are the adductors, iliopsoas, abdominal muscles, and hip joint.

Adductor-related groin pain is characterized by pain medially in the groin often located around the insertion of the adductor longus at the pubic bone, and may radiate distally along the adductor group. The clinical signs of the diagnostic entity “adductor-related groin pain” are defined as: (1) tenderness at the origin of the adductor longus and/or the gracilis at the inferior pubic ramus and (2) groin pain on resisted adduction [1, 5]. A decline in adductor muscle strength and groin pain on full passive abduction is also frequent signs. Ultrasonography and MRIs can often show pathologies at the enthesis.

It is not reported how many of these injuries become long-standing or chronic. Interestingly, it has been reported that if an elite player sustain a re-injury in their groin, the recovery period for the re-injury is almost twice as long compared to

the index injury [3], emphasizing the importance of getting the injury sorted properly the first time. In adductor-related injuries in elite male soccer the re-injury rate has been reported to be 15 %, which must be considered high [3]. Injuries classified as enthesopathies are not commonly reported in elite soccer, but these injuries can take very long time to recover from [3].

A number of case reports about total adductor longus ruptures have been published; fortunately, this does not seem to be a common injury [37–40]. In the NFL, the mean time for return to play in players treated conservatively for an acute adductor longus rupture was 6.1 ± 3.1 weeks (range, 3–12 weeks) [40]. However, recent case studies on both operative and conservative treatment seem to suggest that strength is not normalized before 8–10 weeks, and that strength recovery may vary considerable from rupture to rupture [37, 38].

Iliopsoas-related groin pain is characterized by pain in the anterior part of the proximal thigh, more laterally than adductor-related groin pain, and is, therefore, a differential diagnosis for hip joint problems. The clinical signs of the diagnostic entity “iliopsoas-related groin pain” are defined as: (1) tenderness when palpating the muscle through the lower abdominal wall and (2) pain on passive stretching of the muscle during the Thomas test [1, 5]. Additionally, the iliopsoas muscle can be tight and tenderness is frequently found when palpating the muscle just distal to the inguinal ligament. Resisted isometric testing of the muscle with 90° of hip flexion often results in muscle weakness and pain. Ultrasonography can often show pathologies in the area of the distal part of the muscle or the tendon as thickening of the tendon, small calcifications of the tendon, or tissue disruption suggestive of specific injury to the muscle–tendon complex.

Injuries to the iliopsoas seem to be the second most common injury related to the groin region; however, it is much less frequent than adductor-related injuries [2, 3, 25]. Iliopsoas-related injury is also a common problem in runners and dancers. In elite male soccer it has been reported that for every seven to eight adductor-related injuries occurring, one psoas-related injury also occurs [3].

The iliopsoas also tends to become sensitized in patients with other kinds of hip and groin injuries. Iliopsoas-related groin pain, therefore, often seems to coexist with intra-articular hip problems, but is also seen coexisting with adductor-related groin problems. Whether this clinical entity always represents an injury in itself, or just a protective response, with increased tenderness and pain during palpation and stretching is unknown.

Rectus abdominis-related pain is characterized by pain located over the pubic bone and just proximal to the upper edge. It is often radiating to the medial part of the groin. The clinical signs of the diagnostic entity “rectus abdominis-related groin pain” are defined as: (1) tenderness at the insertion of the rectus abdominis at the superior pubic ramus and (2) groin pain on resisted abdominal flexion [1, 5]. Ultrasonography can show pathologies in the area of the distal tendon.

Injuries related to the abdominals are less common than adductor-related injuries. In male elite soccer, rectus abdominis tendinopathy shows an injury incidence of 0.2/1,000 h of soccer play [3]. Again, only about 10 % of these injuries in male elite soccer take more than 4 weeks to recover and the re-injury rate seems low with this kind of injury [3]. A recent study, however, has shown that soccer players with a combined adductor and abdominal injury take longer to recover than players with only one of these injuries [2]. Abdominal injuries account for 17 % of all groin/abdominal injuries in ice hockey [20]. The 83 % of groin injuries that were not abdominal injuries were, however, not further specified [20].

The clinical entity of this book: “sports hernia” has been described with many different names including “abdominal wall weakness,” “sports hernia,” “athletic pubalgia,” “Gilmore’s groin,” and “incipient hernia.” No standardized description using the principles of the clinical entity approach has been published yet. However, pain over the inguinal canal and the pubic tubercle often radiating to the medial groin and the scrotum are characteristic complaints. The clinical signs of the diagnostic entity “inguinal-related groin pain” could be defined as: (1) tenderness at the insertion of the conjoint tendon at the pubic

tubercle and (2) pain when palpating the external orifice of the inguinal canal through the scrotum with the patient standing [1]. No manifest hernia can be palpated, but the external orifice can be enlarged on palpation. Dynamic examination using ultrasonography can be used to visualize the weakness of the abdominal wall during maneuvers that increase intra-abdominal pressure [41]. Entrapment or damage perhaps as a result of pressure on various regional nerves, most frequently the genital branch of the genitofemoral nerve, can be seen.

Sports hernia is not a common injury in the groin region, and only accounts for up to 4 % of all injuries to the hip and groin in male elite soccer players [3]. The injury incidence is 0.04/1,000 h of soccer play at the elite level [3]. Sports hernia can, however, be a very troublesome condition, which takes a long time to recover from, and may not resolve by conservative treatment [3]. In elite male football with sports hernia, almost 50 % of players are missing more than 4 weeks training and match play, and the injury time is almost double that of the injuries to the adductors [3]. It is not clear whether this is due to operative procedures keeping players out for a longer period, or due to the nature of the injury itself [3].

Hip Joint-Related Groin Injuries

Intra-articular hip injury and overuse are the most frequent source of groin pain in athletes that are not related to the musculotendinous structures in the groin. In elite football these injuries account for up to 10 % of all hip and groin injuries [3]. Intra-articular hip injuries and overuse include femoroacetabular impingement (FAI), labral and chondral injuries, and synovitis [3]. Intra-articular injuries of the hip joint have in recent years been recognized as an important differential diagnosis in athletes with groin pain. This is reflected in the AFL injury report of 2012 [42], where the incidence of hip-related injuries seems to have gone up during the last 10 years. In clinical situations with signs of synovitis and with no sign of any intra-articular injury this may reflect

overuse and will often tend to resolve fairly quickly with the proper rest combined with specific exercise therapy. In situations where there are specific intra-articular injuries with damage to the labrum/cartilage, conservative treatment may not resolve this and operative procedures may be relevant to introduce.

It has been suggested that symptomatic intra-articular hip pathology and extra-articular injuries related to the muscles and tendons may be associated [30, 43]. This association is not proven, but it may be possible that range-of-motion restrictions due to FAI morphology create compensatory patterns that affect the muscles and tendons related to the pelvis. Whether the correction of this problem is a specific exercise program strengthening the relevant and at-risk muscle groups or that surgery to treat the FAI is a better solution is not known. It is, however, probably important to be aware of the interaction that may exist between the FAI morphology and the risk of groin injuries related to the muscles and tendons [30, 43–45].

Other Causes of Groin Pain in Athletes

Stress fractures in the hip and pelvis are most common in female runners, but should not be missed as a possible differential diagnosis that may present as a groin injury. Stress fracture is an important differential diagnosis including stress fracture of the femoral neck, the sacrum, the pubis, and the ischium. Avulsion fractures about the pelvis are most common in the adolescent patient. The apophyses are prone to overuse or a traumatic overload causing a painful lesion. The most frequent locations in the groin and hip region are at the anterior superior iliac spine caused by the sartorius muscle especially during jumping activities, and at the anterior inferior iliac spine caused by the rectus femoris muscle during kicking. In elite male soccer, stress fractures constitute less than 5 % of all hip and groin injuries [3].

Bursitis, either traumatic or inflammatory, should also be considered. The bursae are usually

localized between tendons and muscles and over bony prominences. The iliopectineal bursa was earlier considered a major contributor to groin pain in athletes, but recent imaging techniques such as ultrasound and MRI have shown that this is not the case.

Peripheral nerves may become entrapped after direct trauma or due to an overuse condition of the neighboring fascia, tendons, or muscles leading to an inflammatory condition. Nerves most commonly affected are the ilioinguinal, genitofemoral, and lateral cutaneous femoral nerves. The diagnosis can be difficult but localized tenderness at the site of penetration through the fascia is common. The pain is usually experienced with hyperesthesia or hypoesthesia of the skin along the specific nerve innervation areas. The characteristics of the pain may vary considerably.

Even in seemingly healthy athletes *neoplasms* should be kept in mind as a possible cause of hip and groin pain. Osteosarcomas, chondrosarcomas, and other tumors have been diagnosed at a late stage, due to both patient's and doctor's delay.

In elite male soccer players who all are examined by club doctors and which have a professional sports medicine setup, 5–10 % of the investigated hip and groin injuries are classified as nonspecific groin pain [3]. This means that in these cases it was not possible to provide a specific diagnosis, and that other sources of pain need to be considered.

Hip and Groin Injuries in Athletes: As Presenting in the Clinical Setting

Three studies of larger cohorts of athletes with hip and groin pain presenting in the clinical setting have been published [1, 46, 47]. These studies mainly include athletes with symptoms for a longer period of time that did not settle within the first few weeks. In the first study by Lovell [46], 189 athletes with chronic groin pain were clinically diagnosed. In this study, one-third of patients had clinical indications of multiple pathologies [46]. This finding has been supported by other studies and finding more than one possible pathological

structure is not uncommon in athletes with long-standing groin pain. In the study by Lovell, more than 50 % were diagnosed with sports hernia. In more recent cohort studies [1, 47], this finding has not been confirmed, which may suggest that this finding was either specific to the athletes seen at the that particular sports medicine center, or reflecting that this diagnosis may have been thought to be the main cause of groin injury at that time, in that part of the world.

The second cohort investigated by Hölmich [1] was predominantly considered to have adductor-related groin pain, with psoas-related groin pain as the second most common clinical entity. The cohort by Hölmich [1] mainly consisted of soccer players and runners which may explain the high prevalence of these two injury types, with very few abdominal injuries and sports hernias identified (<5 %). The finding of this study is very much in agreement with the proportion of these injuries in both sub-elite and elite male soccer players [2–4].

The most recent cohort studies seem to agree that sport hernia is not a common finding [2, 3].

In a study by Zoga et al. [47], which is the only study using MRI for deciding the clinical diagnosis, a large proportion of patients with rectus abdominis injuries and combined adductor and rectus injuries were found. However, it was not possible to derive any clinical signs accompanied by the MRI findings from that study. It is, therefore, difficult to compare the results with other studies [47]. The proportion of athletes also differ, as Zoga et al. [47] see a lesser proportion of soccer players (24 %) with the main proportion being American footballers, ice hockey players, and baseball players which theoretically may put greater stress on their abdominal muscle structures than soccer players and thus make them more prone to injuries in the abdominal structures. There is, however, no epidemiological evidence to support this contention. The clinical significance of MR findings also need to be better investigated, as several recent studies have indicated that MR findings thought to be pathological are also prevalent in asymptomatic athletes [48–50]. In asymptomatic athletes MR findings of pubic bone marrow edema and secondary cleft sign are present in up to

one-third of these athletes [49]. In soccer players MR findings indicative of FAI can be seen in 70–95 % of soccer players [48, 50], making it difficult to use MR as the gold standard for establishing a positive diagnosis.

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