The groin triangle: a patho-anatomic approach to the diagnosis of chronic groin pain in athletes

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KEYWORDS: ATHLETIC INJURIES; DIAGNOSIS; SIGNS & SYMPTOMS; GROIN; PROBLEM-BASED LEARNING
Abstract
Chronic groin pain is a common presentation in sports medicine. It is most often a problem in those sports that involve kicking and twisting movements whilst running. The morbidity of groin pain should not be underestimated, ranking behind only fracture and anterior cruciate ligament reconstruction, in terms of time out of training and play. Due to the insidious onset and course of pathology in the groin region it commonly presents with well-established pathology. Without a clear clinical/pathological diagnosis, the subsequent management of chronic groin pain is difficult. The combination of complex anatomy, variability of presentation and the non-specific nature of the signs and symptoms make the diagnostic process problematic. The paper proposes a novel educational model based on patho-anatomic concepts. Anatomical reference points were selected to form a triangle, which provides the discriminative power to restrict the differential diagnosis, and form the basis of ensuing investigation. This paper forms part of a series addressing the three dimensional nature of proximal lower limb pathology. The 3G approach (Groin, Gluteal, and Greater trochanter triangles) acknowledges this, permitting the clinician to move throughout the region, considering pathologies appropriately.

Introduction
Chronic groin pain is a common presentation in sports medicine practice. Studies in professional sports have found groin injury the fourth most common injury affecting soccer players,[1] the third most common injury in Australian rules football,[2] and also has a high prevalence in ice hockey[3] and rugby.[4, 5] This gives an incomplete portrayal however, as the morbidity attached to chronic groin pain means it is behind only fracture and joint reconstruction in terms of lost time from injury.[4, 5]

All these sports involve kicking and twisting movements whilst running. These actions place strain on fascial and musculoskeletal structures that are fixed to a number of bony anatomical points in close proximity. The resultant tissue damage and/or entrapment of anatomical structures may cause pain.

This paper sets out a method based on patho-anatomic principles for a systematic examination of the chronically painful groin, which enables the clinician to discriminate more easily between pathological conditions and target their investigation and subsequent management to specific diagnoses.

The groin triangle
The specific anatomical landmarks and borders of the groin triangle are set out in Figure 1.

Apex points of the groin triangle
The anatomical apex points of the triangle are as follows;
- Anterior Superior Iliac Spine (ASIS)
- Pubic Tubercle
- 3G point

The 3G point
From anthropometric measurements, the authors defined a new reference point at the apex of the triangle. This point was termed the ‘3G point’ in reference to the three-dimensional pathology and the groin, gluteal and greater trochanteric regions. The relationship of this point in the anterior coronal plane was the mid distance point between ASIS and the superior pole of the patella, and in the posterior coronal plane, double the distance from the spinous process of L5 lumbar vertebrae to the ischial tuberosity in the line of the femur.
Anatomical relations of the borders of the groin triangle

Superior border of the groin triangle
The line between the pubic tubercle and the ASIS forms the superior border of the triangle. This corresponds to the anatomical position of the inguinal ligament, a thickening of the aponeurosis of the external oblique muscle. Superior to this line, working from the pubic tubercle medially to the ASIS laterally the following structures will be encountered:

- Rectus abdominis and rectus abdominis sheath insertions
- Internal oblique, external oblique, and transversus abdominis insertions and aponeuroses.
- Inguinal canal, medially the superficial inguinal ring and conjoint tendon, more laterally the canal and further laterally the deep inguinal ring.
- Ilioinguinal, iliohypogastric and genital branch of the genitofemoral nerve.
- Conjoint tendon of ilio-psoas as it passes under the lateral third of the inguinal ligament
- The visceral contents of the abdomen and pelvis

The insertion of rectus abdominis and its sheath are intimately related to the aponeuroses of the obliques and transversus abdominis. The junction of where these structures converge at the pubic bone revolves around the inguinal canal. The internal inguinal ring is located at a point between the mid-inguinal point (situated midway between the anterior superior iliac spine and the pubic symphysis) and the midpoint of the inguinal ligament.[6]. The transversalis fascia, and the conjoint tendon, a confluence of internal oblique and transversalis fasciae form the posterior wall of the canal. The superficial inguinal ring, the opening in the external oblique aponeurosis is situated a centimetre above and lateral to the pubic tubercle. The anatomy of the ilioinguinal and iliohypogastric and genital branch of the genitofemoral nerves is extremely variable, between them they supply the skin of the lower abdomen, medial thigh and scrotum.[7]

Medial Border of the groin triangle
The line from the pubic tubercle to the 3G point inferiorly, forms the medial border of the triangle. Though neither the medial or lateral borders of the triangle comprise of a muscular line, in both instances they work to separate the clinically important ‘groups’ of structures that lie on either side of them. Medial to the border lie the adductor muscles, from superficial to deep
- Adductor longus
- Gracilis
- Adductor brevis
- Adductor magnus

The adductor longus and gracilis tendons are the most commonly affected and lie in an almost continuous site of origin along the body of the pubis. The other adductor muscles (brevis and magnus) arise more posterolaterally along the inferior pubic ramus. The ramus forms a direct continuum between the pubic body and the ischial tuberosity. The obturator nerve divides in the obturator canal (2-3 cm long canal situated in the anterosuperior aspect of the obturator foramen containing the obturator nerve, artery, and vein) to anterior and posterior divisions. The anterior branch innervates adductor longus, brevis, gracilis, and, occasionally pectineus, it supplies sensory innervation to the skin and fascia of the inner distal thirds of the medial thigh.[8]

Lateral Border of Triangle
The line from the ASIS superiorly to the 3G point forms the lateral border of the triangle.
- Femoro-acetabular joint
- Trochanteric bursa
- Tensor fasciae latae & iliotibial band
Though the surface marking of the femora-acetabular joint lies within the triangle, pathology of the joint is usually referred to the greater trochanter, as such it is considered in this section. Gluteal bursae underlie gluteus maximus and gluteus medius tendons proximal to their insertions. The iliobibial band (ITB) or tract is a lateral thickening of the fasciae latae in the thigh. Proximally it splits into superficial and deep layers, enclosing tensor fasciae latae and anchoring this muscle to the iliac crest.

**Within the Triangle**

Within the triangle the following structures are encountered;

- Conjoint tendon of iliopsoas muscle
- Rectus femoris muscle
- Femoral canal

Psoas arises as a series of slips each of which arise from the adjacent margins of the vertebral bodies and the intervening discs from the lower border of T12 to the upper border of L5. Iliacus arises from the upper two-thirds of the concavity of the iliac fossa and the inner lip of the iliac crest, as well as the ventral sacro-iliac and iliolumbar ligaments and the upper surface of the lateral part of the sacrum. The two muscles converge and pass downwards and medially beneath the inguinal ligament over the hip joint and into the lesser trochanter of the femur. The passage of this conjoined tendon over the hip joint is facilitated by the iliopsoas bursa, which is in some cases in direct communication with the hip joint. Rectus femoris arises via a direct head from the anterior inferior iliac spine and a reflected head arising from the superior acetabular rim and joint capsule. The femoral ring is the base of the femoral canal. Its surface marking is medial to the femoral artery, palpable at the mid-inguinal point. The femoral ring is bounded in front by the inguinal ligament, behind by the pectineus, medially by the crescentic base of the lacunar ligament, and laterally by the fibrous septum on the medial side of the femoral vein.

**Nerve entrapment,**

The classic distribution of the cutaneous innervation of the area incorporated in the triangle and their potential neuropathies is shown in figure 2; these however, must serve as a guide only, as in vivo considerable variation occurs. The clinician will appreciate that in addition to paraesthesias, a compressed nerve can give rise to pain. The additional possibility of referred or radicular pain from T12, L1, L2, and L3 must also be considered.

A patho-anatomic approach using the groin triangle

The diagnostic process of history and examination is often abbreviated. There is a growing tendency to rely on investigational studies as the initial diagnostic step (e.g. proceeding to magnetic resonance imaging of a painful groin in the absence of a clear differential diagnosis). The authors propose a four-step approach to the diagnostic process emphasising history and examination and limiting investigation to the final step as follows:

**Step 1; Define & Align**

Define the anatomical points and borders of the triangle on the patient (ASIS, pubic tubercle, and 3G point).

**Step 2; Listen & Localise**

Listen to the patient’s history and obtain as many localising factors as possible then pinpoint the pain in relation to the groin triangle.

**Step 3; Palpate & Re-create**

Carefully palpate the identified area and determine which anatomical structures are painful. The use of provocative manoeuvres/examinations (e.g. exercise) to re-create the patient’s pain can be a critical diagnostic step. To describe all of the manoeuvres in detail is beyond the scope of this text, readers are referred to reviews on this topic.

**Step 4; Alleviate & Investigate**
Where a number of anatomical structures are in close proximity, clinical presentations can be very similar. The manner in which pain can be removed may be very helpful. A decrease in pain following abstinence from aggravating activity is revealing. If a distinct structure can be identified, the elimination of symptoms following guided injection of local anaesthetic into the structure is invaluable. The authors recognise that a number of conditions discussed in this text may only be diagnosed definitively following radiological investigation, in these instance the most discriminative, evidence based investigation is recommended.

Specific scenarios using a problem oriented approach

The diagnostic stepwise approach using the groin triangle is summarized in tables 1-5. The triangle is used to localise the pathology to a particular area. We refer the reader to the specific table relating to that border of the triangle. This provides a differential diagnosis, and clarifies the most discriminative evidence based tests.

Pubic tubercle

Because many potentially anatomical structures converge at this point, we propose a marking of the structure in similar fashion to a clock face (Fig. 3). This schematic representation of the anatomy of the area serves as a guide to what may be palpable following invagination of the scrotum. The examining clinician can therefore ‘walk their finger’ around the tubercle assigning each part of the clock face to relevant attachment as highlighted in Fig. 3. The authors recognise the variability of structures in this area, having based diagrams on cadaveric studies performed prior to this paper.[15] We have employed the term ‘pubic bone stress injury’ for what is often in the literature called ‘Osteitis Pubis’. We feel this is a better reflection of the clinical picture in the absence of any evidence of an inflammatory process. The topic of incipient hernia is included as disorders of the posterior and anterior inguinal walls. These are diagnoses of exclusion and, outside of the most experienced hands, probably inseparable. These may represent different ends of a spectrum of pathology in the area owing to differing sporting activity.[3, 16-19]

Insert <Figure 3 The Pubic tubercle schematic>
Table 1: Patho-anatomic approach; Pubic tubercle region, (diagnoses appear in order of frequency in an athletic population).

<table>
<thead>
<tr>
<th>Define &amp; Align</th>
<th>Pathology</th>
<th>Listen &amp; Localise</th>
<th>Palpate &amp; Recreate</th>
<th>Alleviate &amp; Investigate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pubic Tubercle</strong></td>
<td>Adductor tendon enthesopathy</td>
<td>Insidious onset, warms up with exercise</td>
<td>Guarding on passive abduction,[20] weakness,[21]</td>
<td>Magnetic resonance imaging[22]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pubic ‘Clock’; 6-8</td>
<td></td>
</tr>
<tr>
<td>Rectus abdominis enthesopathy</td>
<td>Well localised to insertion, acute or insidious onset</td>
<td>Pain from resisted sit-up,[21] Pubic ‘Clock’; 12</td>
<td>Bone tenderness predominates[23, 24] Diagnosis of exclusion</td>
<td>Magnetic resonance imaging[22]</td>
</tr>
<tr>
<td>Pubic bone stress injury</td>
<td>Non-specific diminished athletic performance, loss of propulsive power</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degenerative pubic symphysis</td>
<td>Central pain, associated with stress through symphysis- stair climbing</td>
<td>Tender over symphysis. Pubic ‘Clock’; 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incipient hernia; conjoint tendon tear</td>
<td>Insidious onset, diminished performance, warms up.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incipient hernia; external oblique aponeurosis tear</td>
<td>Acute onset, related to sport specific movement eg ‘slap shot’. [17]</td>
<td></td>
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<table>
<thead>
<tr>
<th>Nerve entrapment; Ilioinguinal nerve</th>
<th>Altered skin sensation</th>
<th>Superficial pain ± hyper/dysaesthesia to skin over pubis.[33]</th>
<th>Relief of pain by ultrasound-guided local anaesthetic infiltration[34]</th>
</tr>
</thead>
</table>

**Medial**

Adductor longus pathology is the most common cause for pain in this area, differentiation of enthesis-related problems from those at the musculi-tendinous junction is important. The abnormal mechanics that arise due to adductor dysfunction play a critical role in the generation of a chronic pain/dysfunction cycle in the area.

**Insert <Figure 4 Medial to the triangle>**
Table 2: Patho-anatomic approach; Medial to the groin triangle, (diagnoses appear in order of frequency in an athletic population).

<table>
<thead>
<tr>
<th>Define &amp; Align</th>
<th>Pathology</th>
<th>Listen &amp; Localise</th>
<th>Palpate &amp; Recreate</th>
<th>Alleviate &amp; Investigate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Medial to Triangle</strong></td>
<td>Adductor/gracilis enthesopathy</td>
<td>Insidious onset, diminished performance, warms up</td>
<td>Proximal adductor pain, at enthesis. Guarding, weakness[20, 21]</td>
<td>Magnetic resonance imaging[22]</td>
</tr>
<tr>
<td></td>
<td>Adductor longus pathology at Musculotendinous junction</td>
<td>Acute onset, worse during exercise.</td>
<td>Pain in proximal adductor.[21] (2-4cm distal to enthesis), guarding, weakness.[20, 21]</td>
<td>Magnetic resonance imaging[22]</td>
</tr>
<tr>
<td></td>
<td>Pubic bone stress injury</td>
<td>Pain primarily at pubis radiating to proximal thigh</td>
<td>Bone tenderness, lack of point muscular tenderness</td>
<td>Magnetic resonance imaging [22, 35]</td>
</tr>
<tr>
<td></td>
<td>Stress fracture inferior pubic ramus</td>
<td>Insidious onset, heavy training load</td>
<td>Hop test,[14] associated deep buttock pain</td>
<td>Plain x-ray, Magnetic resonance imaging[36]</td>
</tr>
<tr>
<td>Nerve Entrapment;</td>
<td>I. Obturator nerve</td>
<td>Claudicant-type pain of medial thigh which settles on resting[37]</td>
<td>Exercise-related adductor weakness, superficial dysaesthesia of mid-medial thigh[38]</td>
<td>Electromyography of adductor longus[39]</td>
</tr>
<tr>
<td></td>
<td>II. Ilioinguinal nerve</td>
<td>Altered skin sensation Post inguinal surgery?</td>
<td>Dyasaesthesia/ hyperaesthesia over area of skin supplied by nerve in question[32, 33]</td>
<td>Guided local anaesthetic injection to obturator foramen[40]</td>
</tr>
<tr>
<td></td>
<td>III. Genitofemoral nerve (Genital branch)</td>
<td></td>
<td></td>
<td>Relief of pain by ultrasound-guided local anaesthetic infiltration[34]</td>
</tr>
<tr>
<td></td>
<td>External Iliac Artery Endofibrosis</td>
<td>Thigh discomfort post high-</td>
<td>Exercise related lower limb weakness, Exercise-</td>
<td>Doppler ultrasound[42]</td>
</tr>
</tbody>
</table>

Adductor/gracilis enthesopathy: Insidious onset, diminished performance, warms up
Adductor longus pathology at Musculotendinous junction: Acute onset, worse during exercise.
Pubic bone stress injury: Pain primarily at pubis radiating to proximal thigh
Stress fracture inferior pubic ramus: Insidious onset, heavy training load
Nerve Entrapment; I. Obturator nerve: Claudicant-type pain of medial thigh which settles on resting
II. Ilioinguinal nerve: Altered skin sensation Post inguinal surgery?
III. Genitofemoral nerve (Genital branch): Dyasaesthesia/ hyperaesthesia over area of skin supplied by nerve in question
External Iliac Artery Endofibrosis: Thigh discomfort post high-
Superior Rectus abdominis pathology tends to be well localised to its insertion at the pubic tubercle, often making it the most clear-cut diagnosis in this area. This may arise as a primary diagnosis, or develop secondary to pubic overload originating from adductor or iliopsoas pathology.

Insert <Figure 5 Superior to the groin triangle>
Table 3: Patho-anatomic approach; Superior to the groin triangle, (diagnoses appear in order of frequency in an athletic population).

<table>
<thead>
<tr>
<th>Define &amp; Align</th>
<th>Pathology</th>
<th>Listen &amp; Localise</th>
<th>Palpate &amp; Recreate</th>
<th>Alleviate &amp; Investigate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior To Base</td>
<td>Rectus abdominis Tendinopathy</td>
<td>Well localised to insertion, acute or insidious onset</td>
<td>Pain from resisted sit-up.[21, 44] Pubic ‘Clock’; 12</td>
<td>Magnetic resonance imaging[22]</td>
</tr>
<tr>
<td>Nerve Entrapment; Ilioinguinal nerve Iliohypogastric nerve Genitofemoral nerve (genital branch)</td>
<td>Altered skin sensation</td>
<td>Dyseaesthesia/hyperaesthesia over area of skin supplied by nerve in question.[7, 10]</td>
<td></td>
<td>Relief of pain by ultrasound-guided local anaesthetic infiltration.[34] Nerve conduction studies[7]</td>
</tr>
</tbody>
</table>
Lateral femoral cutaneous nerve

Lateral
As a cause of recalcitrant groin pain, pathology of the femoro-acetabular joint should not be underestimated. The joint is prone to degenerative, inflammatory and infective processes. The long-term contribution of acute or repetitive trauma to the development of degenerative conditions such as osteoarthritis is of particular concern in the sports setting.

Insert <Figure 6 Lateral to the groin triangle>
Table 4: Patho-anatomic approach; Lateral to the groin triangle, (diagnoses appear in order of frequency in an athletic population).

<table>
<thead>
<tr>
<th>Define &amp; Align</th>
<th>Pathology</th>
<th>Listen &amp; Localise</th>
<th>Palpate &amp; Recreate</th>
<th>Alleviate &amp; Investigate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral to Triangle</td>
<td>Impingement/Labral pathology, Femoro-acetabular joint.</td>
<td>Mechanical signs, clicking in joint and/or catching</td>
<td>Impingement test[46]</td>
<td>Magnetic resonance imaging, Arthrogram[47]</td>
</tr>
<tr>
<td>Trochanteric bursitis</td>
<td>Persiant lateral hip pain worse on lying on affected side</td>
<td>Pain on transition between lying/standing[49]</td>
<td></td>
<td>Ultrasound,[50] Relief of pain by ultrasound-guided local anaesthetic injection</td>
</tr>
<tr>
<td>Stress fracture Neck of Femur</td>
<td>Heavy training load, biomechanical/gait abnormality</td>
<td>Hop test,[52] fulcrum test[53]</td>
<td></td>
<td>Plain film x-ray, Magnetic resonance imaging[36]</td>
</tr>
</tbody>
</table>

Within the triangle
Pathology of the iliopsoas muscle may cause pain that is referred in the area superior to the triangle but the conjoint tendon is the most palpable structure within the triangle when the hip is flexed. This is a common, though under-diagnosed, cause of groin pain.[55] It is particularly prone to irritation when overloaded secondary to dysfunction of other muscular structures around the groin, such as the adductors.

Insert <Figure 7 Within the triangle>
Table 5: Patho-anatomic approach; Within the groin triangle, (diagnoses appear in order of frequency in an athletic population).

<table>
<thead>
<tr>
<th>Define &amp; Align</th>
<th>Pathology</th>
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<th>Palpate &amp; Recreate</th>
<th>Alleviate &amp; Investigate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Femoral hernia</td>
<td>Painful lump infero-medial to pubic tubercle</td>
<td>Minimal relationship to exercise</td>
<td>Ultrasound scan,[28] Hemiography.[45]</td>
</tr>
<tr>
<td></td>
<td>Nerve entrapment; Genitofemoral nerve (femoral branch)</td>
<td>Altered skin sensation</td>
<td>Dyseaesthesia/ hyperaesthesia over area of skin supplied by nerve in question.[8]</td>
<td>Relief of pain by local anaesthetic infiltration[34] Nerve conduction studies[7]</td>
</tr>
<tr>
<td></td>
<td>Medial femoral cutaneous nerve</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Intra-abdominal pathology

Discussion of this topic is beyond the scope of this paper, gastrointestinal and genitourinary pathology may mask as groin discomfort or pain. Key discriminating symptoms may be signs of systemic illness, systemic inflammatory response and no correlation between exercise and symptoms or signs. Any or all of the above in conjunction with a negative musculoskeletal examination serve to alert the examining physician to focus their examinations beyond the musculoskeletal system.

Conclusion

This paper presents a method of teaching the causes of chronic groin pain. By offering a systematic means of limiting the differential diagnosis through history examination, diagnostic manoeuvres and where necessary, directed investigation, this method may help the less experienced clinician the diagnostic process. The groin triangle is one section of the ‘3G’ approach to teaching the causes of chronic pain in the proximal lower limb. This paper should therefore be read in conjunction with the gluteal
and greater trochanter triangle papers to fully address the three-dimensional nature of the region.

Experience and a thorough knowledge of the anatomy of the region remain vital in any complete understanding of groin pain. By providing a means of focusing the differential diagnosis in a structured manner, practitioners who lack expertise may approach this problem with more confidence.

Competing interests – No competing interests

What this paper adds.

This paper outlines a novel educational approach to the categorisation of pathologies in the groin area in an athlete.

Pain generating structures are categorised according to their anatomical position, around a triangle based on easily located anatomical landmarks.

This categorisation, with accompanying high-quality diagrams, focuses the diagnostic process. Discriminative questioning and evidence-based examination presented in tabular form facilitate accurate differential diagnosis.

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Legend to figure 1; The groin triangle

TFL = tensor fasciae latae, IlioPS = iliopectineus, Pec = pectinius, AL = adductor longus, Sar. = sartorius, Gr = gracilis, RF = rectus femoris, VL = vastus lateralis, VM = vastus medialis, ASIS = anterior superior iliac spine, 3G = the 3 G point.

Legend to figure 2; Neuropathy of the proximal lower limb

Gr = gracilis, VL = vastus lateralis, VM = vastus medialis, RF = rectus femoris, ASIS = anterior superior iliac spine, 3G = the 3 G point.

Legend to figure 3; The pubic clock

Legend to figure 4; Medial to the triangle

AL = adductor longus, AB = adductor brevis, AM = adductor magnus, S = sartorius, Gr = gracilis

Legend to figure 5; Superior to the triangle

Legend to figure 6; Lateral to the triangle

TFL = tensor fasciae latae, VL = vastus lateralis, RF = rectus femoris

Legend to figure 7; Within the triangle
External Iliac Artery Endofibrosis
Pubic bone stress injury
Enthesopathy
Musculotendinous junction tear
Obturator nerve entrapment
Adductor pathology