

ATHLETIC GROIN PAIN

FROM DIAGNOSTIC CHALLENGE TO IMAGE-GUIDED INTERVENTIONS

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INTRODUCTION

The anatomy of the groin is complex, and its assessment should be based on a clinical diagnostic framework¹. Several musculoskeletal and neural structures lie within a relatively small anatomical region, and pathology affecting different structures may produce similar and overlapping clinical presentations. Furthermore, the distribution of pain experienced by an athlete does not always correspond with the anatomical area predicted by classical anatomical knowledge. This is particularly relevant to pain arising from peripheral nerves.

The ilioinguinal nerve is frequently involved in athletic groin pain. Pathology of this nerve may produce symptoms in the inguinal region, but pain may also be experienced over the pubis or in the proximal adductor region. The genital branch of the genitofemoral nerve usually produces pain in the distal inguinal canal but can also produce testicular pain. The iliohypogastric nerve may also be involved. Obturator nerve pathology may involve its anterior division, posterior division, or both and may present with severe pain in the adductor region. The lateral femoral cutaneous nerve can also cause groin or anterolateral thigh pain and is frequently overlooked in athletes.

Neural pain can therefore be mistaken for pain arising from local musculoskeletal structures. This differs from pain arising directly from a tendon. Adductor tendon pain, for example, is generally easy to localise and can be reproduced by palpation of the tendon. Neural pain may be experienced in an anatomical area that is unexpected in relation to the affected nerve. The clinician must therefore distinguish between pain reproduced by palpation of a local structure and pain referred to that region from a nerve.

The diagnostic work-up should be anatomical, targeted and multimodal. The imaging modality must be selected according to the structure requiring examination. MRI provides detailed assessment of the pubic bones and symphysis, the pyramidalis-anterior pubic ligament-adductor longus complex (PLAC), and injuries involving the adductor and pectineus². Dynamic ultrasound provides superior spatial resolution for superficial structures and fascial planes and allows functional assessment of the inguinal canal, peripheral nerves and iliopsoas.

Image-guided injections are an essential component of this work-up. Selective and accurate injection of a suspected structure can help establish whether it contributes

to the athlete's symptoms, particularly when pain is experienced in an unexpected anatomical area or abnormalities involving several structures coexist. Injections may also have a therapeutic role. Their value depends on understanding the anatomy, choosing the appropriate imaging modality, accurately identifying the target and interpreting the response within the complete clinical and imaging assessment.

This article describes the diagnostic and therapeutic roles of image-guided injections in athletic groin pain, with particular emphasis on imaging selection, neural pain patterns, accurate targeting, risk assessment and interpretation of the athlete's response.

SELECTING THE APPROPRIATE IMAGING MODALITY

MRI and ultrasound are complementary investigations, and modality selection should be guided by the clinical question. MRI provides comprehensive assessment of the pubic region, including the pubic bones and symphysis, PLAC, adductor longus and pectineus, and can define the extent and distribution of soft-tissue injury. This is important as adductor injuries may form part of a more complex injury involving the PLAC and adjacent structures.

Dynamic ultrasound offers higher spatial



Illustration

resolution and real-time assessment of the inguinal canal in supine and standing positions and during manoeuvres that increase intra-abdominal pressure. It can delineate individual tissue layers and fascial planes and is particularly useful for assessing posterior-wall abnormalities, including bulging, widening and direct inguinal hernia, which may be difficult to demonstrate on conventional static MRI. Dynamic ultrasound is therefore the preferred modality when posterior-wall pathology is suspected. Indirect inguinal hernias may be visible on MRI, particularly when non-reducible, although ultrasound permits dynamic assessment of movement through the deep inguinal ring.

Identification of an abnormality does not establish that it is responsible for the athlete's pain. Structural abnormalities of

the posterior wall may be asymptomatic. Further findings on MRI such as a cam morphology and labral tear may also be incidental and should be interpreted in the correct clinical context. Imaging findings must therefore be correlated with the clinical assessment and, where appropriate, the response to a selective nerve block.

MRI-ULTRASOUND FUSION IMAGING
MRI-ultrasound fusion imaging, also known as real-time virtual sonography, combines previously acquired MRI data with real-time ultrasound. The MRI and ultrasound images are co-registered and superimposed, allowing the anatomical information from both modalities to be used during the same examination.

Fusion imaging is a superior technique when neither MRI nor ultrasound alone provides all the information required.

MRI demonstrates deep anatomical abnormalities and differences in tissue signal, while ultrasound provides higher spatial resolution, visualisation of fascial planes and real-time assessment. Combining the modalities allows an abnormality identified on MRI to be located and characterised more accurately with ultrasound.

This is particularly useful in post-injury and postoperative assessment of the adductor region. High signal on MRI may represent fluid, but it may also represent granulation or inflammatory tissue. By superimposing the MRI and ultrasound images, the precise area of high signal can be examined with ultrasound, helping to establish what the MRI abnormality represents.

The technique can also influence both whether and where an injection is performed. An athlete may be referred for platelet-rich plasma injection because high signal in the adductor region has been interpreted as fluid or an unhealed defect. Fusion imaging may demonstrate that it represents granulation tissue and that injection is unnecessary.

Conversely, an abnormality may be visible on MRI but not identifiable on ultrasound alone. Once the datasets have been co-registered, the MRI-visible abnormality can be localised during the real-time ultrasound examination and targeted under ultrasound guidance.

Fusion imaging combines the strengths of both modalities. It improves tissue characterisation, allows intervention in areas that cannot be identified using ultrasound alone and contributes to determining the necessity, appropriateness and precise target of an injection.

SELECTIVE NERVE BLOCKS IN ABDOMINAL WALL NEUROPATHY ASSOCIATED WITH INGUINAL CANAL DISRUPTION

Abdominal wall neuropathy associated with inguinal canal disruption is an important cause of athletic groin pain. The ilioinguinal nerve, iliohypogastric nerve and genital branch of the genitofemoral nerve may be involved. Pain arising from these nerves may be experienced in an anatomical area different from that predicted by classical anatomical knowledge and may therefore be attributed incorrectly to the pubis, adductor tendon or another structure within the groin.

The ilioinguinal nerve is the nerve most commonly implicated in our clinical practice. Ilioinguinal neuropathy may produce pain in the inguinal region, over the pubis or in the proximal adductor region. The genital branch of the genitofemoral nerve usually produces pain in the distal inguinal canal but can also produce testicular pain. The iliohypogastric nerve may also contribute to the presentation. Because the territories of these nerves may overlap, ultrasound-guided selective nerve blocks are essential for identifying which nerve or nerves contribute to the athlete's symptoms.

High-resolution ultrasound allows the relevant nerves and surrounding fascial planes to be identified. The needle can be positioned under direct visualisation and the distribution of the injectate observed in real time. The diagnostic value of the procedure depends on maintaining the selectivity of each block. Spread to an adjacent nerve or structure makes the subsequent response more difficult to interpret.

After the block, the athlete should be reassessed in relation to the presenting symptoms. Where possible, the movement or activity that normally provokes the pain should be repeated. Relief of the athlete's familiar pain supports involvement of the blocked nerve. If several nerves are suspected, they should be blocked selectively so that their individual contributions can be assessed.

Selective nerve blocks are particularly valuable in athletes with persistent pain following previous groin surgery. This includes laparoscopic inguinal hernia procedures and open groin repairs in which

mesh has been used. Postoperative pain may result from a neuroma or adherence of a nerve to the mesh or surrounding scar tissue. Ultrasound-guided selective blocks of the ilioinguinal nerve, iliohypogastric nerve and genital branch of the genitofemoral nerve can determine whether one or more nerves contribute to the persistent pain and guide subsequent treatment.

When a selective nerve block confirms abdominal wall neuropathy, selective neurolysis may reduce or abolish the neural pain and allow the athlete to continue competing during the season. The procedure may need to be repeated once or twice to achieve or maintain symptom control. In our experience in athletes undergoing surgical management with selective neurectomy, histological examination demonstrates neuroma formation in over 90% of excised nerves, providing histopathological evidence that the affected nerve is a pain generator.

THE LATERAL FEMORAL CUTANEOUS NERVE
The lateral femoral cutaneous nerve should be considered in athletes with groin or anterolateral thigh pain. It is frequently overlooked because attention is often directed towards the hip joint, inguinal canal or local musculoskeletal structures.

High-resolution ultrasound allows the nerve to be examined and selectively blocked. The clinical response can establish whether the lateral femoral cutaneous nerve contributes to the athlete's symptoms and can prevent the pain from being attributed incorrectly to a coexisting hip or groin abnormality.

SELECTIVE OBTURATOR NERVE BLOCKS

Obturator neuropathy should be considered in athletes presenting with severe pain in the adductor region. The anterior division, posterior division, or both divisions of the obturator nerve may be involved. High-resolution ultrasound allows these nerves to be identified and may demonstrate thickening of the fascial plane through which an affected nerve division passes.

MRI and nerve conduction studies have limited value in diagnosing obturator neuropathy. An ultrasound abnormality alone also does not establish whether the nerve is responsible for the symptoms. Ultrasound-guided selective obturator nerve blocks are therefore essential for the diagnosis in the appropriate clinical context.

Blocking the anterior and posterior divisions separately allows the clinician to determine whether the symptoms arise from the anterior division, posterior division, or both. The athlete should be reassessed after each block, including repetition of the activity that normally provokes the pain whenever practical.

Once the symptomatic division or divisions have been identified, selective neurolysis may be used therapeutically.

ILIOPSOAS TENDON SHEATH INJECTION AND ADHESIOLYSIS

The iliopsoas should be assessed in athletes with persistent groin pain. Dynamic ultrasound provides high-resolution assessment of the iliopsoas tendon and surrounding fascial planes. It allows the individual components to be examined during movement and may demonstrate

Selective and accurate injection of a suspected structure can help establish whether it contributes to the athlete's symptoms, particularly when pain is experienced in an unexpected anatomical area or abnormalities involving several structures coexist.

abnormalities that are not visible on MRI, including small amounts of fluid and loss of normal movement between tissue planes.

The ultrasound findings determine the appropriate intervention. A selective iliopsoas tendon sheath injection can help establish the contribution of the iliopsoas to the athlete's symptoms. When adhesions and restricted movement between fascial planes are demonstrated, ultrasound-guided adhesiolysis may be performed. These are distinct procedures and should be selected according to the structural and dynamic ultrasound findings.

ADDUCTOR INTERSECTION SYNDROME

We have identified a further cause of athletic groin pain, which we have termed adductor intersection syndrome. This is an inflammatory process involving the intersection of adductor brevis, gracilis and adductor magnus.

Athletes typically experience pain during side-to-side movements. The symptoms can be particularly debilitating in sports requiring repeated changes of direction, such as football and tennis. On clinical examination, pain is localised over the posterior aspect of the adductors, adjacent to the inferior ramus of the pubis.

Adductor intersection syndrome is an ultrasound diagnosis. High-resolution ultrasound demonstrates thickening of the fascial planes and adhesions involving the intersection of adductor brevis, gracilis and adductor magnus. These findings explain both an inflammatory component and mechanical restriction between the involved structures. The pain is focal and localised to the specific region, and comparison can be made with the contralateral asymptomatic side.

Treatment consists of ultrasound-guided fascial adhesiolysis. The procedure addresses both components of the condition: the inflammatory process within the affected fascial planes and the mechanical effect of the adhesions. Recognition of the syndrome is important because conventional assessment may instead direct attention towards the proximal adductor longus, pubic symphysis or hip joint.

INTRA-ARTICULAR HIP INJECTION

Hip abnormalities are common in athletes presenting with groin pain, and labral tears are present in the majority of the athletes we assess. There is consequently a risk that

the diagnostic work-up becomes directed towards the hip simply because a labral tear is demonstrated on MRI. The presence of a labral tear does not establish that the hip joint is the principal source of the athlete's symptoms.

In contrast to selective nerve blocks, which are performed primarily to establish a diagnosis, an intra-articular hip injection is generally undertaken with therapeutic intention. Nevertheless, the clinical response also provides diagnostic information. Improvement in the athlete's familiar pain following an accurately placed intra-articular injection supports a contribution from the hip joint⁴.

The response should be assessed in relation to the athlete's specific symptoms and functional limitations rather

than interpreted simply as an overall improvement in pain. A partial response may indicate that the hip contributes to the presentation without being the only symptomatic structure, particularly when intra-articular pathology coexists with inguinal, pubic, adductor or neural pathology.

PUBIC CLEFT INJECTION

Pubic cleft corticosteroid injections may provide therapeutic benefit in selected athletes with groin pain⁵. However, the decision to inject should not be based solely on the presence of groin pain, whether pubic-, inguinal- or adductor-related. Imaging is required both to determine whether the injection is appropriate and to assess its potential structural risk.



Illustration

PRACTICAL APPROACH

The approach can be summarised in five stages:

- 1. Identify the structure or structures requiring investigation from the history and clinical assessment.*
- 2. Select the imaging modality according to the structure being examined.*
- 3. Use the imaging findings to assess the necessity, risk and appropriateness of the proposed intervention.*
- 4. Perform a selective image-guided block or therapeutic procedure.*
- 5. Reassess the athlete using the symptoms and activities that prompted the investigation.*

MRI before a pubic cleft injection is imperative. Particular attention should be paid to the integrity of the adductor longus fibrocartilage and the wider PLAC⁶. A partial tear of the adductor longus fibrocartilage is classified as a type 6 PLAC injury. When this injury is present, corticosteroid injection is frequently followed by progression to complete avulsion. Identification of a type 6 injury may therefore determine that the proposed injection should not be performed.

Previous injections must also be considered. In our clinical experience, repeated pubic cleft corticosteroid injections are associated with subsequent avulsion of the adductor longus fibrocartilage and PLAC injury. The number and type of previous injections should therefore be established before further treatment is considered.

Imaging before a pubic cleft injection provides a risk and appropriateness assessment. It evaluates the integrity of the fibrocartilage attachment, identifies an existing partial tear and helps determine whether intervention is justified. Imaging in this setting is not used merely to identify the needle target; it may establish that an injection is inappropriate.

DIAGNOSTIC AND THERAPEUTIC ROLES

The purpose of an injection must be defined before the procedure. Some injections are principally diagnostic, whereas others are intended to provide treatment but also yield diagnostic information. This distinction influences the choice of target, injectate and assessment of the response.

Selective nerve blocks are primarily diagnostic. Their purpose is to determine whether a particular nerve contributes to the symptoms. Selectivity is essential using a small volume or targeted anesthetic: if several nerves or adjacent structures are anaesthetised simultaneously, pain relief may occur without identifying the responsible structure. The patient should be consented beforehand for the standard injection risks including infection and bleeding/ localised bruising.

Other procedures, including intra-articular hip injections, iliopsoas tendon sheath injections and pubic cleft injections, are generally performed with therapeutic intention. Nevertheless, the response can provide important diagnostic information about the contribution of the injected structure. A partial response may indicate that several structures contribute to the

presentation rather than that the injection has failed.

The diagnostic information provided by an injection must always be interpreted within the complete work-up. The clinical assessment identifies the structures requiring investigation; the imaging modality is selected according to those structures; imaging determines whether intervention is necessary and appropriate; and the response helps establish the relevance of the targeted abnormality.

Platelet-rich plasma (PRP) is increasingly used as an adjunct in persistent adductor and enthesal pathology, including adductor longus tendinopathy, partial-thickness PLAC tears (type 6). PRP delivers concentrated autologous platelets and associated bioactive mediators with the aim of promoting tissue repair and remodelling. However, evidence specific to athletic groin injuries remains limited, consisting predominantly of case reports and small observational studies⁷. Heterogeneity in PRP preparation, injection technique and rehabilitation protocols further limits comparison between studies. Dextrose prolotherapy has a somewhat greater although still limited, evidence base in chronic adductor-related groin pain. Hyperosmolar dextrose is injected into symptomatic tendon or enthesal structures with the aim of stimulating a local proliferative and reparative response⁸.

CONCLUSION

Image-guided injections are an essential component of the work-up and management of athletic groin pain. Their value depends on an accurate understanding of the anatomy,

recognition that neural pain may occur in an unexpected anatomical area, and selection of the imaging modality according to the structure requiring examination.

MRI, dynamic ultrasound and MRI-ultrasound fusion imaging provide complementary information. Fusion imaging offers the additional advantage of combining two modalities, improving tissue characterisation and allowing an MRI-visible abnormality that cannot be identified on ultrasound alone to be targeted during real-time ultrasound guidance.

Imaging is not used only to demonstrate abnormalities or guide needle placement. It is also fundamental to determining whether an injection is necessary, appropriate and sufficiently safe. A successful intervention requires selection of the correct anatomical target, use of the appropriate imaging modality, assessment of structural risk and interpretation of the athlete's response within the complete diagnostic work-up.

Imaging is not used only to demonstrate abnormalities or guide needle placement. It is also fundamental to determining whether an injection is necessary, appropriate and sufficiently safe.

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