Research Paper Review

Evaluation and Treatment of Disorders of the Infrapatellar Fat Pad

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ABSTRACT

The infrapatellar fat pad (IFP), also known as Hoffa's fat pad, is an intracapsular, extrasynovial structure that fills the anterior knee compartment, and is richly vascularized and innervated. Its degree of innervation, the proportion of substance-P-containing fibres and close relationship to its posterior synovial lining implicates IFP pathologies as a source of infrapatellar knee pain. Though the precise function of the IFP is unknown, studies have shown that it may play a role in the biomechanics of the knee or act as a store for reparative cells after injury. Inflammation and fibrosis within the IFP, caused by trauma and/or surgery can lead to a variety of arthrofibrotic lesions including Hoffa's disease, anterior interval scarring and infrapatellar contracture syndrome. Lesions or mass-like abnormalities rarely occur within the IFP, but their classification can be narrowed down by radiographical appearance. Clinically, patients with IFP pathology present with burning or aching infrapatellar anterior knee pain that can often be reproduced on physical exam with manoeuvres designed to produce impingement. Sagittal MRI is the most common imaging technique used to assess IFP pathology including fibrosis, inflammation, oedema, and mass-like lesions. IFP pathology is often successfully managed with physical therapy. Passive taping is used to unload or shorten an inflamed IFP, and closed chain quadriceps exercises can improve lower limb control and patellar congruence. Training of the gluteus medius and stretching the anterior hip may help to decrease internal rotation of the hip and valgus force at the knee. Gait training and avoiding hyperextension can also be used for long-term management. Injections within the IFP of local anaesthetic plus corticosteroids and IFP ablation with ultrasound guided alcohol injections have been successfully explored as treatments for IFP pain. IFP pathology refractory to physical therapy can be approached through a variety of operative treatments. Arthroscopic partial resection for IFP impingement and Hoffa's disease has showed favourable results; however, total excision of the IFP performed concomitantly with total knee arthroplasty (TKA) resulted in worse results when compared with TKA alone. Arthroscopic debridement of IFP fibrosis has been successfully used to treat extension block following anterior cruciate ligament reconstruction, and arthroscopic anterior interval release has been an effective treatment for pain

associated with anterior interval scarring. Arthroscopic resection of infrapatellar plicae and denervation of the inferior pole of the patella have also been shown to be effective treatments for refractory infrapatellar pain.

ANALYSIS

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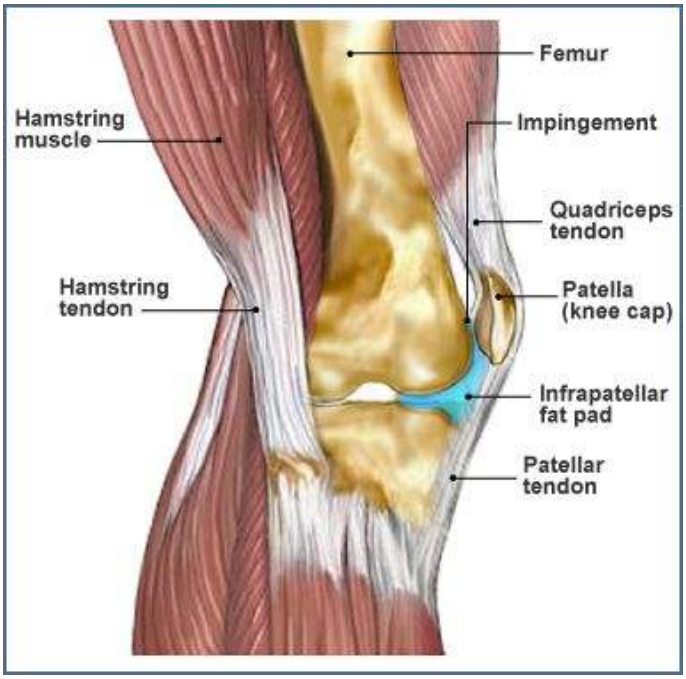
ANATOMY

The infrapatellar fat pad (IFP) is an intracapsular, extrasynovial structure that fills the anterior knee compartment and can extend posteriorly into the joint. It can have connections with the intracondylar notch of the femur, ACL, proximal patellar tendon, inferior pole of the patella, menisci (both medial and lateral), retinaculum and tibia. It is a variable structure.



The IFP has a rich vascular supply with branches from the inferior, superolateral, superomedial and middle genicular arteries. Due to its embryological association with the ACL, the vascular supply found in the IFP supports the hypothesis that the IFP can aid with healing the ACL and other nearby structures.

The IFP is a potentially potent source of pain, due to its high degree of innervation and close relationship to the (also) highly innervated synovium. Nociceptive nerve fibers within the IFP contain substance-P and Type IVa free nerve endings.

Damage to the IFP could lead to angiogenesis and scarring within the structure, creating local production and release of cytokines in the knee, which would contribute to the progression of

inflammation, fibrosis and pain within the IFP. A viscous cycle can then be established.

To date, clinical research studies have supported the cellular evidence (1). Experimentally injected hypertonic saline into the fat pad has resulted in pain in the inferior patellar and retropatellar regions, along with medial thigh pain. During the period of pain, the coordination of the quadriceps was demonstrated to be altered with a delayed onset of vastus medialus obliqus (VMO) activity. The EMG activity of both the VMO and the vastus lateralis muscles decreased. Interestingly post-surgical patients receiving a local anaesthetic into the IFP had decreased opioid use, decreased pain and facilitated rehabilitation. With regards to function, the precise purpose of the IFP is unknown. It is hypothesized that it serves either a biomechanical role or acts as a reservoir for reparative cells after injury.

CLINICAL EXAMINATION

Patients with IFP pathology describe a burning or aching anterior knee pain, located at the patellar tendon. The pain will occur with full extension, active extension (ex. stair climbing), or prolonged flexion (ex. long sitting).

The key to the physical examination of the IFP is to produce impingement. During the Hoffa test, if there is increased pain in the IFP on either side this would indicate a positive test indicating possible IFP pathology. However, it is important to differentiate IFP from joint line pain because of anterior horn meniscal tearing. To perform the Hoffa test – apply firm pressure with the thumb inferior to the patella, outside the margin of the patellar tendon with the knee in: 1) 30-60° of flexion and 2) with the knee fully extended. Repeat this test on both the medial and lateral sides of the patellar tendon. Increased pain in the infrapatellar fat pad indicates a positive test.

Other tests that elicit pain with IFP pathology include extension overpressure and isometric quadriceps contraction in full extension. Other clinical signs associated with IFP pathology include extension block, decreased patellar mobility, especially in the proximal direction, and a positive patellar tilt test.

It is often difficult to distinguish between IFP pathology and patellar tendinopathy. Patellar tendon pain generally occurs with loaded knee flexion, particularly eccentric quadriceps contraction. Therefore, slow eccentric quadriceps squats on a decline board should bother patients with a patellar tendinopathy – this is a potential way to differentiate from IFP disorders (as long as you avoid full flexion and extension).

FAT PAD DISORDERS

A common fat pad disorder involves inflammation and fibrosis. Whether the traumatic mechanism is acute or repetitive, an initial injury to the fat pad is followed by hemorrhage, inflammation and subsequent hypertrophy and fibrosis. Iatrogenic injury is also possible, and may include fibrosis due to the creation of arthroscopy portals during surgery. Impingement may also occur at the tibiofemoral joint or the lateral aspect of the patellofemoral joint, creating fibrous hyperplasia of the IFP (this is also known as *'Hoffa's disease' (or syndrome)*.

As a result of inflammation and fibrosis, IFP pathology patients have been shown to have altered knee mechanics, including decreased knee extension force of the quadriceps on the tibia. To make up for

such a deficiency, the quadriceps would have to apply a larger force to get the same degree of extension, leading to an increase in patellofemoral force, resulting in pain. Clinically, IFP patients with inflammation and fibrosis can present with infrapatellar knee pain, ROM loss, painful extension, enlargement and firm consistency of the IFP, functional limitations, and effusion.

Other common disorders of the fat pad include synovial disorders/synovitis, Pigmented Villonodular Synovitis (PVNS), Plica irritation and mass-like abnormalities. Synovial tissue is densely innervated and lines the posterior surface of the IFP. Irritation to this structure can cause synovitis which is characterized by pain, inflammation and redness.

Pigmented Villonodular Synovitis (PVNS): PVNS is a relatively rare condition that presents clinically similarly to more common IFP conditions. PVNS can be diffuse or localized, and is typically diagnosed by MRI. The disorder is difficult to identify and is often not diagnosed for several years.

Plica Irritation: The ligamentum mucosum is one of several remnants of synovial membranes separating the embryonic knee into compartments. If present it can become thickened, fibrosed, inflamed and painful.

Mass-like abnormalities: These are rare, but may include lipoma arborescens, glomus tumours, para-articular (osteo)chondromas, synovial lipomas, synovial chondromatosis, synovial haemangiomas and ganglion cysts (all are normally diagnosed by advanced imaging).

TREATMENT

Non-operative treatment typically revolves around some form of physical or manual therapy, and begins with unloading the involved soft tissue that is contributing to the ongoing inflammation and irritation of the IFP (extensor mechanism, knee joint capsule etc.) The overall goal is to restore the biomechanics of the patellar tracking through active interventions (such as quadriceps or VMO retraining) and/or passive interventions (such as realignment procedures like taping, bracing or stretching). From a global prepective, optimizing lower extremity mechanics by improving pelvic control with muscle training of the gluteals and/or improving the foot function (with or without orthotics) can also be extremely helpful in order to fix the problem and prevent future recurrences.

Taping for IFP Disorders:
For taping procedures with IFP problems, the inferior pole of the patella must be tilted out of the fat pad. Unloading the fat pad will create a muffin top – a puffy area in the fat pad region that unloads the irritated structure. I would suggest searching YouTube for patellofemoral taping of the fat pad. There are some good videos to demonstrate how to execute this simple tape job. To start, the patient lies supine with the leg in relaxed extension and a horizontal piece of tape lies over the proximal half of the patella, tilting the distal half of the patella and unloading the fat pad. Further reduction of IFP pain requires unloading of the fat pad with a wide 'V' tape. The first part of the V tape starts at the tibial tubercle and is pulled firmly to the medial epicondyle while the soft tissue is lifted firmly towards the patella. The second part of the V tape starts at the tibial tubercle and runs lateral to lateral epicondyle. Again, the clinician lifts the soft tissue towards the patella. The tape is kept on all day, every day, until the patient is pain free, so the patient must be taught how to tape him/herself.

Rehabilitation:
With regards to rehabilitation exercises, the first objective is to avoid painful extension maneuvers, such as isometric quadriceps contraction in full extension (quadriceps set), straight leg raises etc. Closed chain exercises (when the foot is on the ground) are the most effective. A starting exercise is small range squats with the feet pelvis width apart and the knees kept over the feet during the squat. A 30° squat should suffice at this starting phase. Progression can be instituted by adding weights to these squats. More advanced progressions are necessary depending on the task demands of the patient or athlete (ex. agility drills and plyometric exercises).

Thinking outside the box, it is important to train other muscles during the rehabilitaiton process. For example, a pelvic and core stability program will minimize unnecessary stress on the knee. Training of the gluteus medius (posterior fibres) to decrease hip internal rotation and the consequent valgus vector force that occurs at the knee is necessary to offload the patellofemoral structures such as the infrapatellar fat pad.

Gait retraining and foot control are two other important aspects to rehabilitating infrapatellar fat pad irritations. The patient should be shown how to walk properly, stand so that the knees are not locked and ensuring the knees remain over the feet when getting in and out of a chair. Foot function exercises and proper foot support (adequate shoes and shoe inserts) can eliminate some of the biomechanical dysfunctions that can lead to infrapatellar fat pad disorders.

Operative Treatment:
Operative treatment may include fat pad excision, debridement of hypertrophic fibrosis, release of the scar tissue adhering the IFP to the anterior tibia, synovectomy, infrapatellar plica release or denervation of the inferior pole of the patella. This sort of intervention would be reserved for only ver severe cases on a case by case basis.

CONCLUSIONS & CLINICAL APPLICATIONS

The IFP can be a significant source of knee pain due to its vascularity and innervation. Some of the main pathologies associated with the IFP include inflammation, fibrosis and scarring. Non-operative treatments for IFP pathology have been shown to be fairly successful, if clinicians apply some fundamental physical therapy principles including: off-loading the painful fat pad with tape, strengthening the inhibited muscles that surround the knee, strengthening indirectly involved muscles in the pelvic (gluteal muscles) and core abdominal regions. Other treatments include gait training, foot control measures and more invasive treatments such as injection of steroid and anesthetic and alcohol ablation.

IFP pathology is fairly common in daily clinical practice – you just need to look for it! An accurate diagnosis, specific treatment addressing the targeted pathology along with pin-pointing the root cause of the problem will help our patients get better faster and stay healthy longer. For a more in-depth understanding of the IFP disorders I strongly recommend reading this article. It offers a good foundation for understanding the condition which can aid in the treatment of these disorders.

Additional References

1. Bennell K, Hodges P, Mellor R et al. The nature of anterior knee pain following injection of hypertonic saline into the infrapatellar fat pad. Journal of Orthopaedic Research 2004; 22: 116–121.