Case resolution

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DIAGNOSIS

Patellar tendon-lateral femoral condyle friction syndrome.

DISCUSSION

Patellar tendon-lateral femoral condyle friction syndrome, also known as "Hoffa's or infrapatellar fat pad (IFP) impingement syndrome", is a common cause of anterior knee pain in active individuals. It is believed to be caused by patellar maltracking or the imbalance of forces between the medial and the lateral vastus muscles that cause the impact of the superior and lateral aspect of Hoffa's fat pad between the inferior patella/inferior and lateral sector of the patellar tendon, and the lateral femoral condyle.

Its clinical presentation involves anterior knee pain intensified during hyperextension and local sensitivity in the inferior patellar pole.

Anterior knee pain is the most common reason for visit to a knee trauma specialist. However, despite the high incidence of this disorder, its etiology is still controversial. On occasion, there is no clear relationship between the objective factors and the subjective complaints about pain. An accurate understanding of the cause of the pain is vital to appropriately select a treatment, whether surgical or not. The often unpredictable treatment results could be explained by the multiple etiological factors of anterior knee pain—and it can be very frustrating for both the patient and the treating doctor, not only because of the uncertainty about results, but also because of the recurrence rate, the restrictions to the patient's daily physical activity, the period of absence from work, etc., which are detrimental to their quality of life. From 70% to 90% of patients with anterior knee pain experience recurrent or chronic pain.

The anterior knee face consists of a complex mesh of ligaments, muscles, an aponeurosis and a joint capsule, which converge and wrap the patella located in the center, and supply a sophisticated fixation system with passive and active elements. Passive fixator soft tissues include the patellar tendon, the patellofemoral medial and lateral ligaments, the meniscopatellar medial and lateral ligaments, and the deep fascia of thigh. The active fixator soft tissues include the quadriceps muscles. Given the delicate balance that there needs to be between these structures to enable normal patellar movement, it is not surprising that patellar pain and anterior knee pain are among the most common reasons for visit in orthopedic centers.

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The most frequent causes of anterior knee pain stem from the soft tissues, particularly, the synovial tissue, Hoffa's fat pad and the lateral retinaculum, because these are the most highly innervated structures.

In this review, we will make emphasis on the pain stemming from Hoffa's fat pad (and, particularly, in its superior and lateral sector). For that purpose, let us begin by reviewing its anatomy—the IFP is one of the three fat pads located in the anterior face of the knee; the other two are the suprapatellar fat pad (quadricipital) and the posterior suprapatellar fat pad (prefemoral). It is an extrasynovial and intracapsular structure that sits in the anterior compartment of the knee, below the patella. Its posterior surface is covered by a synovial membrane. A part of this membrane, the mucous ligament or infrapatellar plica (thickening of the mucous ligament), extends backwards and connects to the femoral intercondylar notch. In some people, the synovial membrane of the mucous ligament extends continuously to the anterior cruciate ligament. Furthermore, the normal fat pad also adheres to the proximal patellar tendon, the inferior patellar pole, the transverse meniscus ligament, the anterior horns of both menisci, the retinaculum and the tibial periosteum.

Kaplan fibers, and medial and lateral patellar and meniscus ligaments present as thickened borders of the IFP when fused with the capsular synovium. The anterior gap has been defined as the space between the IFP, anteriorly, and the anterior aspect of the tibia, posteriorly.

The average volume of the IFP ranges from 21 cc to 39 cc, although it varies significantly across individuals and based on the knee flexion degree.

IFP is vascularized by a rich anastomosing mesh. The branches of the inferior genicular arteries extend vertically through the IFP, just behind the patellar tendon borders. The branches of the superior-lateral and superior-medial genicular arteries wrap posteriorly around the distal half of the patella, and come into the proximal aspect of the IFP and anastomose with the inferior genicular arteries. Two or three horizontal arteries connect the vertical arteries at the level of the femoral condyles, the tibial plateau or the tibial tubercle. A mesh of smaller caliber arteries stems in the inferior genicular arteries and irrigates the rest of the IFP, although the main portion remains the least vascularized.

IFP is an important source of pain due to its rich innervation and its relationship to the synovium, which is also highly innervated. It has been proven that the posterior articular nerve, a branch of the posterior tibial nerve, flows through the lateral part of the menisci, the synovial membrane and the cruciate ligaments, and innervates the IFP. Several nerves that extend near the knee supply divisions that contribute to the IFP innervation, including a terminal branch of the obturator nerve, the nerves of the medial and lateral vastus muscles, the lateral and fibular recurrent arteries, the branches of the common fibular nerve and the infrapatellar branch of the sural nerve.

Histologically, the nerves inside the IFP positively stain for S-100, tyrosine hydroxylase and nociceptive nerve fibers that contain substance P, as well as free nerve endings type IVa. These nociceptive nerves are denser in the central and lateral portions of the IFP, and in the surrounding synovial membrane.

Therefore, the fact that the IFP is a source of pain is probably due to this rich mesh of nociceptive nerve fibers that contain substance P, which have been identified in the whole IFP and the surrounding synovial tissue. It has been demonstrated that substance P alters pain mediation by increasing sensitivity to nociceptive signals and causing inflammation through vasodilation, extravasation of plasmatic proteins and leukocyte adhesion.

IFP produces basic fibroblast growth factor and vascular endothelial growth factor, as well as proinflammatory tumor necrosis factor-alpha and interleukin-6. Apart from causing inflammatory changes, it has been shown that the proinflammatory tumor necrosis factor-alpha induces matrix metalloproteinases and, consequently, cause the extracellular matrix breakdown, that the basic fibroblast growth factor can promote fibrogenesis and that the production of vascular endothelial growth factor could lead to angiogenesis and healing in the IFP. The local production and release of these cytokines can contribute to the progression of inflammation, fibrosis and pain in the IFP.

A soft tissue impingement or an edema in the IFP can cause pain by producing transient ischemia and, as a result, loss of homeostasis, as well as by producing a mechanical stimulation of the nociceptors. A soft tissue impingement can also be associated to increased intraosseous pressure, which can cause transient ischemia and a mechanical stimulation of the nociceptors. The increase in patellar intraosseous pressure happens in patients with anterior knee pain experienced when they sit with knees in a flexed position ("movie sign"). In theory, it is associated to a temporary venous blood flow obstruction. Localized synovial hypertrophy around the inferior patellar pole can also cause anterior knee pain.

While the exact function of the IFP is unknown, many studies have hypothesized that it fulfills a biomechanical function and serves as a reservoir of repair cells after an injury. Biomechanically, the angle between the patellar tendon and the anterior tibial border decreases with flexion, taking the fat pad backwards as the space narrows. The IFP is mobile, and its shape, position, pressure and volume change considerably along the normal knee range of motion.

To assess IFP-related abnormalities through imaging, the MRI is the method of choice and the sagittal plane is the most useful. In T1-weighted sequences, normal appearance of the IFP is similar to the surrounding subcutaneous fat, with additional low-signal localized and linear images that represent fibrous septa. In fat-suppressed T2-weighted sequences, it can be observed that the IFP is isointense to the muscle. On occasion, the mucous ligament can be visualized as a band of hyperintense signal that extends anteriorly to the anterior cruciate ligament and inserts into the intercondylar notch.

Blood vessels can be observed in the T2-weighted image as hyperintense linear structures running vertically through lateral and medial portions of the fat pad.

A T1 or T2-weighted image with a lower signal within the fat pad can indicate fibrosis, which can be distinguished from ossification by means of x-rays and from the deposits of hemosiderin by means of images with gradient echo sequences, which show notably hypointense signal images (by creating magnetic susceptibility artifacts).

On the contrary, a higher signal in T2-weighted and other fluid-sensitive sequences (STIR, fat-suppressed proton density) in the IFP indicates inflammation (acute bleeding or edema).

When reading the MRI, both fibrosis and edema can be the symptomatological expression of intrinsic abnormalities (Hoffa's disease, intracapsular chondroma, localized nodular synovitis, post-operative fibrosis, anterior gap healing) or extrinsic abnormalities (articular, synovial and extracapsular disorders). Mass type injuries are infrequent in the IFP.

When the edema is confined to the superior and lateral sector of the IFP, as in the presented case, a hypothesis states that it can be a result of friction (impingement) between the lateral femoral condyle and the posterior aspect of the patellar tendon. There is a potential association of the knee extensor mechanisms (particularly, patellar alignment) with the edema in the superior and lateral sector of IFP. For that reason, the distance between the patellar tendon and the lateral trochlear facet is significantly shorter in patients with edema in the superior and lateral sector of the IFP compared to those without edema. In this topography, there is a relationship between a high position patella and edema. Lateral tendinopathy in the patellar tendon surface in front of the lateral trochlear facet is also frequently associated to edema in the superior and lateral sector of the IFP. The authors who found these associations also described a greater incidence of edema in patients with increased distance between anterior tibial tuberosity and the trochlear throat. A distance of >15 mm is considered pathological. In addition to that, they found that, of all demographic and degenerative variables, only age was related–younger patients are more likely to have edema in the superior and lateral sector of the IFP (it could be assumed that it is due to young people being more physically active, which entails a higher risk of compression and edema).

Conservative treatment is usually successful, although full recovery can take time. Anti-inflammatory agents and dressing of the superior patellar pole to reduce the pressure of the IFP have been shown to produce high treatment success rates.

However, in cases of persistent anterior knee pain that is not responsive to conservative measures of physical load restriction, cooling and physical therapy, a good option can be a peripatellar synovectomy.

CONCLUSIONS

An IFP is an extrasynovial and intracapsular structure that sits in the anterior compartment of the knee. It is highly vascularized and innervated. Its extent of innervation, the proportion of fibers containing substance P and a close relationship with its posterior synovial membrane involve pathologies that cause anterior and infrapatellar knee pain. Inflammation and fibrosis in the IFP, trauma or surgery-induced, can lead to various arthrofibrotic and inflammatory injuries.

It has been formulated that, when edema in the IFP is located in the superior and lateral sector, it is compatible with a friction-related presentation between the patellar tendon and the lateral femoral condyle.

This has received little attention in the Orthopedics literature and, many times, it is an MRI finding with no clinical suspicion nor awareness of the existence of this friction-related presentation in the superior and lateral sector of the IFP. For this reason, it is important to identify the characteristic imaging findings in order to accurately select the treatment and to differentiate this entity from other causes of anterior knee pain. Although at present there are no final answers regarding this syndrome's etiology, identifying it has important implications both in relation to the diagnosis and the treatment.

Sagittal MRI is the most widely used imaging technique to identify this syndrome, which presents as a localized high signal area in T2-weighted images of the superior and lateral sector of the IFP. In simple x-rays and computed tomographies, it is usually concealed.

Conflict of interest: Authors claim they do not have any conflict of interest.

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