Anatomy of the Infrapatellar Fat Pad

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ABSTRACT
Although the infrapatellar fat pad has been implicated in the development of anterior knee pain and loss of knee joint motion, many basic anatomical texts fail to present those features of its anatomy which are of relevance to physiotherapists. The purpose of this paper was therefore to provide a brief update on the clinical anatomy of the infrapatellar fat pad. Swan A, Mercer S (2005). Anatomy of the infrapatellar fat pad. New Zealand Journal of Physiotherapy 33(1) 19-22.
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INTRODUCTION
The infrapatellar fat pad of the knee joint, also known as Hoffa’s fat pad (Hoffa, 1904) is an intra-articular inclusion that separates the antero-inferior synovial membrane from the more anterior structures of the knee joint. It is therefore intra-articular but extrasynovial. Composed of a fibrous scaffold packed with adipose tissue this fat pad acts as a deformable space filler adapting to the changing contours of the articular surfaces during movement of the knee joint. It also facilitates distribution of synovial fluid within the joint and may act as a cushion protecting exposed articular surfaces (Resnick, 1995; Vahlensieck et al, 2002).

The resurgence of interest in the infrapatellar fat pad has arisen from its perceived involvement in anterior knee pain (McConnell, 2002). A number of mechanisms have been proposed for the observed pain and loss of joint motion. These include direct injury to the fat pad, and impingement syndromes resulting from repetitive microtrauma or following acute trauma of the fat pad. It has been reported that the fat pad may hypertrophy and become impinged between the femur and tibia either inferiorly or superolaterally (Saddik et al, 2004). Examples of acute trauma leading to direct injury, to hypertrophy and impingement or to arthrofibrosus, are injury of the anterior cruciate ligament or patellar tendon, patellar dislocation and surgical procedures such as arthroscopy, anterior cruciate reconstruction and total knee arthroplasty (Apostolaki et al, 1999; Duri et al, 1996; Ellen et al, 1999; Kramers-de Quervain et al, 2004; Murakami et al, 1997; Saddick et al, 2004).

As details of intra-articular inclusions of synovial joints are often lacking in continuing education seminars or in undergraduate anatomy courses it seems opportune to review the anatomy of the infrapatellar fat pad. The purpose of this paper is therefore to present the three-dimensional morphology of the infrapatellar fat pad and to discuss its neurovascular supply.

Morphology
The infrapatellar fat pad is located posterior to the lower, deep surface of the patella, the patellar ligament and adjoining fibrous joint capsule. It therefore lies between these structures (anteriorly) and the trochlear surface and medial and lateral condyles of the femur, the deep infrapatellar bursa and the tibia (posteriorly), and so completely fills the potential space between these structures (Figures 1 and 2).

Superiorly the fat pad is attached to the lower border of the inner non-articular surface of the patella (Figure 2). As it extends slightly superiorly and posteriorly it overlaps the inferior articular surface of the patella and the anterior aspect of
the femoral condyles (Figures 2 - 4). In the midline the posterior apex of the fat pad is continuous with the infrapatellar plica that runs posterosuperiorly to attach to the intercondylar notch of the femur (Kim and Choe, 1997).

The fat pad extends downwards immediately behind the patellar ligament and adjoining capsule. Distally it lies between the patellar ligament and the deep infrapatellar bursa with the tibia behind. The inferior attachment is therefore to the periosteum of the tibia and to the anterior horns of the menisci (Figure 3). As described by LaPrade (1998) the deep infrapatellar bursa is partially compartmentalised by a tongue of fat extending down from the infrapatellar fat pad (Figure 4).

**Neurovascular Supply**

Fat pads in general are described as being innervated and vascularised. They also contain lymphatic vessels (Resnick, 1995). The synovial lining covering these fat pads is of adipose type and has a good supply of capillaries (Young and Heath, 2000). This rich vascular supply is related to the role played by the synovium in the production of synovial fluid and removal of debris (Williams et al, 1995). The periphery of the infrapatellar fat pad itself is described as being highly vascularised while more centrally, closer to the patellar ligament, the blood vessels are less plentiful (Kohn et al, 1995). This has been noted in arthroscopic surgery where placement of probes has been modified to miss the blood vessels.
The infrapatellar fat pad is also described as being highly innervated (Biedert and Sanchis-Alfonso 2002; Saddick et al. 2004; Wojtys et al. 1990). Kennedy et al (1982) found multiple fine nerve fibres within the fat pad with some fibres terminating in the synovium. As referenced by Bennell et al (2004) these authors reported that the source of this innervation was the posterior articular branch of the posterior tibial nerve. Interestingly a review of classic anatomy texts reveals that no such nerve exists at the knee joint. The sciatic nerve comprises the common peroneal nerve and the tibial nerve. Three articular branches of the tibial nerve have been described (Hollinshead, 1969; McMinn, 1994; Moore and Dalley, 1999; Williams et al, 1995). Furthermore in one of the most detailed studies of the nerve supply of the human knee joint Gardner (1948) described the innervation of the anteromedial portion of the infrapatellar fat pad to arise from branches of the saphenous, tibial and obturator nerves and the nerve to vastus medialis, while the anterolateral portion is supplied by articular branches from the nerve to vastus lateralis, the tibial, recurrent peroneal and common peroneal nerves. These nerves were noted to accompany blood vessels throughout the fat pad. Such an extensive nerve supply has important clinical implications regarding the variety of patterns of referred pain possible and the number of associated muscles that may develop reflex spasm.

DISCUSSION AND CONCLUSIONS

Having established that the infrapatellar fat pad is innervated it is still necessary to determine whether it may be a defined source of pain. Demonstrating the presence of neural structures by itself does not provide sufficient evidence that the infrapatellar fat pad is the origin of pain as reported by a patient.

Further evidence is supplied by demonstrating that the fat pad may be the source of experimentally induced pain and by successfully providing pain relief when anaesthetising the fat pad in symptomatic patients. Two studies provide evidence that the infrapatellar fat pad may be the source of experimentally induced pain. Dye et al (1998) showed that penetration of the anteromedial capsule, infrapatellar fat pad and synovium by an arthroscopic probe in one healthy subject resulted in severe localised pain. More explicitly Bennell et al (2004) demonstrated that the medial portion of the infrapatellar fat pad when stimulated by a discrete amount of hypertonic saline could be the source of experimentally induced pain. Although all 11 subjects reported local anteromedial pain, pain was also experienced behind the patella and patellar tendon with some subjects experiencing referral of pain into the thigh as high as the groin. Although all 11 subjects reported local anteromedial pain, pain was also experienced behind the patella and patellar tendon with some subjects experiencing referral of pain into the thigh as high as the groin. Interestingly a review of classic anatomy texts reveals that no such nerve exists at the knee joint. The sciatic nerve comprises the common peroneal nerve and the tibial nerve. Three articular branches of the tibial nerve have been described (Hollinshead, 1969; McMinn, 1994; Moore and Dalley, 1999; Williams et al, 1995). Furthermore in one of the most detailed studies of the nerve supply of the human knee joint Gardner (1948) described the innervation of the anteromedial portion of the infrapatellar fat pad to arise from branches of the saphenous, tibial and obturator nerves and the nerve to vastus medialis, while the anterolateral portion is supplied by articular branches from the nerve to vastus lateralis, the tibial, recurrent peroneal and common peroneal nerves. These nerves were noted to accompany blood vessels throughout the fat pad. Such an extensive nerve supply has important clinical implications regarding the variety of patterns of referred pain possible and the number of associated muscles that may develop reflex spasm.

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Key Points

- The infrapatellar fat pad is a large, deformable pad of adipose tissue occupying the space between the patella, tibia and femur.
- The fat pad is vascular and highly innervated.
- No specific pain pattern is diagnostic of pain arising from the fat pad.
- The fat pad is implicated in anterior knee pain and loss of range of motion.

References


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