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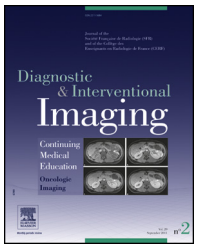

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Imaging of traumatic injury and impingement of anterior knee fat

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Abstract Fat is not just used by the body as bulk tissue. In addition to its role in storing energy and regulating hormone action, fat is used in some parts of the body for its mechanical properties. The anatomy of anterior knee fat is more complex than it appears at first sight and is capable of withstanding considerable compressive and shear stress. Specific lesions occur when such mechanical stress exceeds the physiological limits and are yet little known. Superficial fat can be the site of either acute injury by closed degloving called the Morel-Lavallée lesion or chronic injury, when subject to repeat excessive shear forces, due to more complex and less well-defined disruptions that result in pseudo-bursitis. There are three main anterior, intracapsular and extrasynovial fat pads in the knee joint, which are the infrapatellar fat pad (IFP) or Hoffa's fat pad, the quadriceps fat pad and the prefemoral fat pad. The IFP plays an important role as a mechanical shock absorber and guides the patella tendon and even the patella itself during flexion—extension movements. In response to repeated excessive stress, an inflammatory reaction and swelling of the IFP is first observed, followed by a fibrotic reaction with metaplastic transformation into fibrous, cartilaginous or bone tissue. More rarely, the two other deep fat pads (quadriceps and prefemoral) can, if subject to repeated stress, undergo similar restructuring inflammatory reactions with metaplasia resulting in tissue hardening, anterior pain and partial loss of function.

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Fat is not just used by the body as bulk tissue. In addition to its role in storing energy or regulating hormones, in the foot and the knee, fat is used for its mechanical properties.

Prepatellar subcutaneous fat is subject to considerable shear forces that can damage the fibrous septa and cause it to separate from underlying tissue. A separation plane is clearly visible in acute lesions, such as Morel-Lavallée closed degloving injuries; however, the dissection is more complex and less well defined when repeated and chronically excessive shear stress results in pseudo-bursitis.

There are three main anterior intracapsular but extrasynovial fat pads in the knee joint, which are the infrapatellar fat pad (IFP) or Hoffa's fat pad, the anterior suprapatellar (quadriceps) fat pad and the posterior suprapatellar (prefemoral or supratrochlear) fat pad. Impingement of these fat pads, in particular the IFP, is frequent. In response to impingement, fat pads can swell, undergo inflammatory changes and even fibrosis to become harder and more resistant to excessive mechanical stress. Such changes are associated with knee pain and partial loss of joint movement.

Subcutaneous fat of the anterior knee: acute and chronic traumatic injuries

Just below the skin, subcutaneous knee fat, especially the superficial fat located anteriorly to the patella and patellar tendon, has to accommodate the compressive and shear forces experienced during a fall on the knees or prolonged kneeling (carpenters, tilers, craftsmen, etc.).

Pathological analysis or MR imaging with a dedicated knee coil (Fig. 1) of this anterior superficial fat reveals the presence of multiple fibrous septa that reinforce its adherence to the skin and distribute mechanical stress more evenly. Small vascular and lymphatic structures are located in the vicinity of the fibrous septa. They cannot be visualized by imaging in healthy tissue but are responsible for infiltration of the dermis and hypodermis in certain pathological conditions, such as a lymphedema or lymphangitis. Disruption of these adherence structures results either in an acute lesion, the Morel-Lavallée closed degloving injury, or what we considered to be its chronic counterpart, ''pseudo-bursitis''.

Morel-Lavallée lesion

Morel-Lavallée lesion reflects the formation of a serous fluid-filled space when hypodermic fat is separated from the underlying fascia due to traumatic injury [1]. The shear of the fascia and the fibrous septa that ensure adherence of the fat tissue, as well as the disruption of the hypodermic vascular plexis, result in a virtual cavity that gradually fills with blood or lymph and can contain ''dissected'' fat lobules [1]. An inflammatory reaction secondary to injury can lead to the formation of a pseudocapsule [2,3]. Once formed, patients with a Morel-Lavallée lesion often have a soft painless mass.

Ultrasound is an excellent imaging modality to diagnose Morel-Lavallée lesions (Fig. 2). During the initial acute phase, the lesion can present as -compressible solid hematoma that fills the space between the hypodermic fat and the underlying fascia. More commonly however, the fluid collection covers a greater area, is anechoic, and readily compressible with the transducer, and the weight of the transducer alone or of the operator's hand suffices to disperse the liquid. Small tissue debris, or even free or partially detached fat lobules, are often observed in the fluid [2—4] and sometimes a fluid—fluid level is detected [2]. During the chronic phase, lesions may have a well-demarcated fibrous capsule. In some cases, when the fluid content disappears, only the fibrous area or the internal fat separation plane persists and dynamic manoeuvres are needed to visualize the movement of the fatty layers on either side of the separation plane [1].

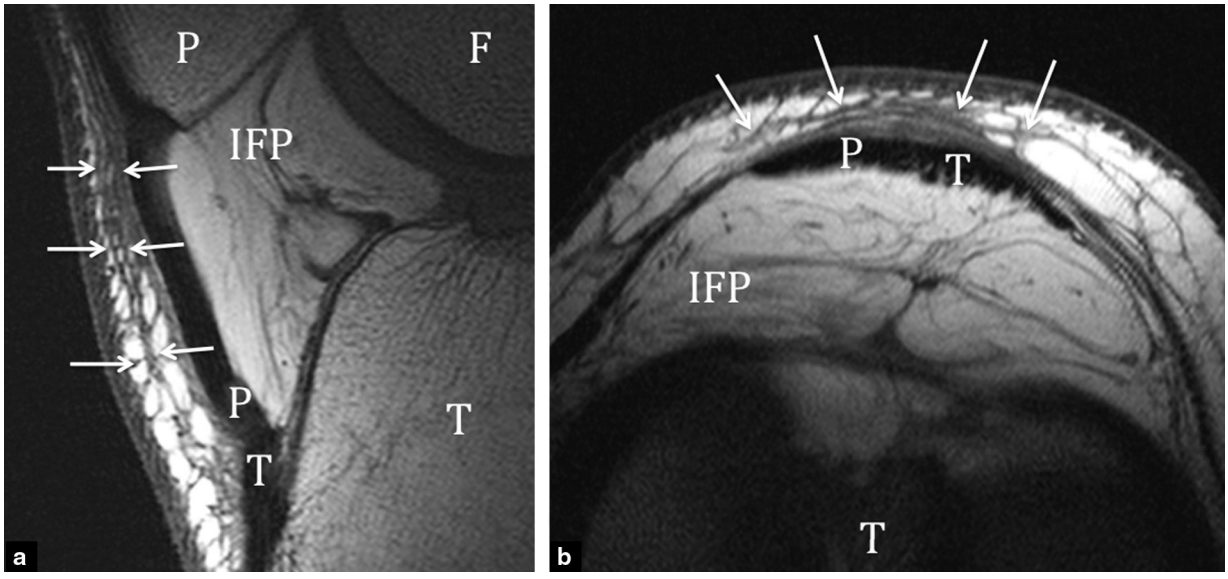

Figure 1. Architecture of prepatellar fat. T1-weighted MR images in the sagittal (a) and transverse (b) planes using a ''skin'' coil. Many hypointense fibrous septa can be seen within the prepatellar fat on T1-weighted images (arrows) reinforcing the cohesion between the fat tissue, skin and underlying patellar tendon (PT). This fibrous scaffold is well suited to support the shear stress exerted on prepatellar fat. The fibrous architecture of the infrapatellar fat pad (IFP) is different since it is subject to compressive stress rather that shear forces. P: patella; F: Femur; T: Tibia.

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