Sonoanatomy
Scanning technique and basic pathology of the knee

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IN-DEPTH DISCUSSION II
Depicting a swollen knee with ultrasound
All kinds of intra-articular pathologies may make the synovium react by producing intra-articular fluid. The clinical consequence is knee swelling. Ultrasound of the knee joint can be recommended to perform in all new joint swelling cases without trauma. Ultrasound gives information of the intra-articular existence and extent of effusion better than by clinical means (1), of its echo texture, best puncture site (2), the state of synovium (Doppler signals included) (3,4), loose bodies and signs of osteoarthritis (cartilage abnormalities, osteophytes) (5)

In this section acute traumas such as strains, fractures, meniscus and ligament injuries are not handled. In traumas plain radiography and magnetic resonance imaging are the main imaging methods. Knee osteoarthritis and ultrasound imaging is discussed in in-depth discussion 1.

In case of a swollen knee some basic questions are to be concerned:

- Is the swelling intra- or extra-articular (local)? The prepatellar bursitis and patellar tendinitis, pes anserinus bursitis and Baker’s cyst can be frequent causes of localised swelling and symptoms. Sometimes it is clinically difficult to differentiate by clinical examination erysipelas, arthritis or septic prepatellar bursitis. Here ultrasound is very helpful in the differential diagnostics (VIDEOS 1, 2).

- How old is the patient? In children and young adults’ joint infections, reactive arthritis and rheumatoid diseases have to be considered. Swollen knee can be the first symptom of leukaemia in a child. In middle aged and older people osteoarthritis (OA), rheumatoid diseases and crystal arthropathies give rise to the knee swelling. Does the patient use diuretics?

- How fast did the swelling developed? In OA the swelling is periodic and often related the physical activity. In joint infections, reactive arthritis, rheumatoid diseases (especially crystal arthritides) the symptoms can start fast.

- Does the patient have systemic symptoms, such as fever or does she or he have high ESR, CRP or urate level? Does the patient have extra-articular symptoms? Travelling? Diarrhoea or urinary symptoms? Rash? Conjunctivitis? Is there tophus found? Septic arthritis, crystal and reactive arthritides are often related with high acute phase reaction. However, OA can sometimes cause acute inflammatory joint attack, too.
Video 1. Acute erythema and swelling of the knee in a 50-year-old man. Prepatellar bursitis of staphylococcus aureus was found. See Image library for full video.

Video 2. The case of the first video, ultrasonography in long axis. See Image library for full video.

Depicting knee joint effusion with ultrasound

The patient is supine. A 10-15 MHz probe is chosen. In case of heavy swelling the leg can be straight but in case of mild effusion it is better to depict while the knee is flexed 30 degrees (6). The probe is longitudinally on the knee above the patella and the suprapatellar space is depicted. The probe is moved on the lateral and medial compartments, too. Infrapatellar space should be scanned, too. The fluid is on ultrasound anechoic or echogenic material, which can be replaced with compression of the transducer (7). Normally some fluid (less than 3 mm) can be detected. The pattern of echo texture on ultrasound is in different grey scale shades but it is non-specific. Thus, an exact diagnosis cannot be made using ultrasound alone (Fig 1). Different machine settings such as gain
alter the echogenicity (Fig 2). In gout there is characteristic double sign contour of the cartilage surface to be found (Fig 3). In CPPDD the calcification is inside the cartilage (Fig 4a) or in the meniscus (Fig 4b) (8).

Figure 1. Different echo textures in various experimental and clinical conditions.

Figure 2 (a, b, c and d). Different gain settings alter the echogenicity of the knee joint fluid (a). The same longitudinal suprapatellar scan with different gain settings (b, c and d).
Figure 3 (a,b and c). Intercondylar notch cartilage depicted in a 60-year-old male with knee swelling (knee in maximal flexion, a). The cartilage is covered by the gouty crystals ie. double contour sign (DC, b) (gout verified with joint puncture and microscopy). In fig 3 c a normal cartilage scan.

Figure 4 (a and b). Calciumpyrophosphate deposition disease (cppdd). The arrows show calcification inside the cartilage (transverse scan of the flexed knee, a) or in the meniscus (medial longitudinal scan of the knee joint, b).

With the aid of ultrasound, it is very helpful to aspirate the knee joint especially in obese persons with little fluid and get fluid for laboratory for specific analysis (Fig 5). The macroscopic appearance of fluid gives immediately important information for an experienced sonographer (blood, pus, tophi, inflammatory vs. non-inflammatory...
Ability to scan and perform ultrasound guided punctures combined with in-office microscopy made by the rheumatologist are very fruitful practical procedures, which make the diagnostics of joint swelling fast, exact and handy.

Figure 5 (a and b). Typical arrangement of the probe and needle in aspiration of the knee joint fluid under the US guidance (a). In small amount of fluid, the knee should be flexed 30 degrees. Needle in the suprapatellar joint recess (b).

Depicting proliferative synovitis of the knee joint with ultrasound

The scanning is performed exactly as depicting the joint effusion. Normally the thin synovium can hardly be seen with ultrasound and it does not have Doppler signals. In OA and chronic rheumatoid diseases, the synovium gets thickened and may show more or less Doppler signals in or just around of it. With high resolution transducer minimal synovium thickening can be detected. Grey scale ultrasound cannot differentiate the nature of the changes. Thus, synovium, fat, fibrin, blood cloths, debris, scar tissue etc. can look the same. Intra-articular fat is typically homogenous large and convex mass lining the synovium (Fig 6). Typical proliferative chronic synovitis is nodular, villous or bushy, which swings in the joint fluid while compressing (VIDEO 3). It is fixed on compression (8). Doppler imaging is helpful in showing perfusion in the tissue. In extreme cases the joint space can be filled with masses of synovial proliferations (VIDEO 4). With ultrasound it is possible to take biopsies of the synovium for differential diagnostics (9).
Figure 6. Intra-articular knee joint fat (arrow), which is typically round shaped, homogenous, soft, fixed and does not exhibit Doppler signals. Suprapatellar recess depicted longitudinally.

**Depicting extra-articular swelling of the knee with ultrasound**

If the swelling or symptoms are local the sonography should be focused there. Here again the deep knowledge of anatomy is the basic matter. The probe is longitudinal and transverse on the lesion. One can find patellar tendinitis and enthesitis in proximal (VIDEO 5) or distal end of the tendon (Figs 7,8), prepatellar bursitis (VIDEOS 1,2), superficial infrapatellar bursitis (VIDEO 6 and Figs 9a,b), pes anserinus bursitis (Fig 10), meniscal cyst (Fig 11), quadriceps tendinitis (Fig 12), or the Baker’s cyst (Fig 13). The latter can be found between the gastrocnemius muscle and semimembranosus tendon.

**Video 3. Proliferative synovitis in the knee joint effusion. Suprapatellar recess depicted longitudinally. See Image library for full video.**

Video 5. US of the proximal patellar tendon. On the left panel is a normal scan and on the right a case of enthesitis with swollen tendon, Doppler signals and erosion in the patella. Longitudinal scan of the patellar tendon. See Image library for full video.
Figure 7. (a, b and c). Distal patellar tendon insertitis in a patient with juvenile rheumatoid arthritis (longitudinal scan a). Left panel is normal (b) and on the right panel swollen tendon with Doppler signals found (c). Proliferative deep infra-patellar bursitis found, too (arrow).

Figure 8. (a, b and c). Distal patellar tendinitis in gout (longitudinal scan). Left panel is grey scale (a) and right panel is the same image with Doppler mode (b). On the panel c, a needle is found in the tophus (transverse scan).
Figure 9. (a and b): Acute swelling of the knee in a 55-year old patient (a) and the gouty punctate of the superficial infrapatellar bursa (b).

Video 6. Corresponding US of the superficial infrapatellar bursa (Figs 9). Note: soft tophy (can be compressed=fluid) and hard tophy with acoustic shadow. Longitudinal scan. See Image library for full video.
Figure 10 (a and b). Proliferative pes anserina bursitis with Doppler signals.

Figure 11. US of a meniscal cyst. Longitudinal medial scan
Figure 12 (a, b and c). Longitudinal scan of the suprapatellar recess (a). Quadriceps tendinitis with swollen tendon and Doppler signals (b) and normal side (c).

Figure 13 (a and b). Transverse posterior scan of the knee, a. A small Baker’s cyst, black arrow in b.
References:


