Ultrasound imaging for the rheumatologist XXVII. Sonographic assessment of the knee in patients with rheumatoid arthritis

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ABSTRACT

The aims of our study were to investigate the prevalence of ultrasound (US) pathologic abnormalities and to compare them with the clinical findings in the knee of rheumatoid arthritis (RA) patients.

One hundred RA patients were enrolled in the study. Bilateral US examination of the knee was performed to visualise the presence of effusion, synovial proliferation, bone erosions, femoral cartilage abnormalities, quadricipital and/or patellar enthesopathy. The popliteal fossa and the calf region were also evaluated to detect popliteal cyst.

We observed joint effusion in 140 out of 200 (70%) knees. Synovial hypertrophy was present in 115 out of 140 (82%) knees associated with effusion and in 22 out of 115 (19%) knees intra-articular power Doppler (PD) signal was found. Hyperechoic spots within the cartilage layer, suggestive of pyrophosphate crystals deposit, were detected in the knees of 3 patients. US signs of quadricipital and/or patellar enthesopathy were detected in 53 out 200 (26%) knees. Bone erosions were visualised in 16 out 200 (8%) knees. Popliteal cyst was found in 66 out of 200 (33%) joints.

US examination of the knee is more sensitive than clinical examination in the detection of joint inflammation and allows for the identification of different patterns of pathologic changes at knee level, including morphostructural changes at both cartilage and tendon level.

Introduction

Rheumatoid arthritis (RA) is a chronic autoimmune disorder characterised by inflammation and proliferation of joint synovium. It can lead to articular damage, resulting in chronic pain, loss of function and disability. RA typically affects the small joints of hands and feet but also wrist, shoulder, elbow, hip, knee, ankle and cervical spine joints can become involved (1-3).

At present, musculoskeletal ultrasound (US) is routinely used by many rheumatologists for the diagnosis and in the monitoring of various rheumatic disorders (1-10). In RA it can be a very useful imaging modality to detect joint effusion, synovitis, tendon pathology and bone erosion (1, 11, 12). Whilst the knee joint has been the subject of several US studies in arthritis (13, 14) few have focused on rarer US manifestations in RA patients (*e.g.* frequency of enthesopathy and the signs of cartilage damage) (13-15).

The aims of our study were to investigate the prevalence of US pathologic abnormalities and to compare them with the clinical findings in the knee of RA patients.

Methods and patients

A multicentre study was conducted in 4 different Italian Rheumatology Units: University of Pisa, Università Politecnica delle Marche, University of Pavia, and the Sapienza University of Rome. In each unit, US examinations were performed by a rheumatologist, experienced in musculoskeletal US, who was blind to both clinical and laboratory patients data. A Logiq 9 (General Electrics Medical Systems, Milwaukee, WI) with a linear probe operating at 10 MHz when studying joints and 14 MHz when studying tendons and entheses was used in all the centres involved.

Before the start of the study, an agreement was obtained by the sonographers on both the scanning technique to adopt and the definition of the pathologic findings to detect.

Patients
One hundred RA patients were enrolled. RA was diagnosed according to the American College of Rheumatology classification criteria (16). Patients with previous joint surgery of the knee or who had received corticosteroid injection of the knee within the previous 3 months were excluded. Demographic and clinical characteristics of the study patients are reported in Table I.

Clinical assessment
Prior to US assessment all patients were evaluated by a rheumatologist (not involved in US examination) for the presence/absence of pain, tenderness (elicited by palpation and/or active or passive mobilisation of the knee) and knee swelling according to standard techniques (17). In total, 200 knee joints of 100 patients were studied.

US scanning technique
A multiplanar scanning technique was used to detect morphostructural and perfusion changes at both joint and periarticular level (18). Scans were performed in the three compartments of the knee – suprapatellar, lateral and medial parapatellar compartments – both with the patient in the supine position with knee joint extended and with contracted quadriceps muscle. When synovial proliferation was detected, power Doppler examination was performed and the following settings used: PRF 500 Hz, Doppler frequency 7.5 MHz and Doppler gain to avoid random noise visualisation.
Condylar cartilage was assessed with the knee maintained in maximal active flexion. When large effusion was present, compression with the probe was performed to identify the superficial margin of the hyaline cartilage. The scans adopted to investigate the presence of meniscal calcification were lateral and medial longitudinal views, during flexion-extension of the knee. Quadriceps and patellar tendons and entheses were scanned both with the patient supine and the lower limbs in extended neutral position and then with a 30° knee flexion angle. US measurements of enthesis thickness were performed where it appeared maximal. The popliteal fossa and the calf region were evaluated with the patient lying prone on the examination table. A detailed description of the scans adopted is reported in a previous paper (19).

Table I. Main characteristics of patients with rheumatoid arthritis.

Patient number	M/F	Age (years) mean±SD (range)	Disease duration (months) mean±SD (range)
100	21/79	58±5.74 years (82-22)	96±70 months (288-12)

M/F: male/female ratio; SD. standard deviation.

Table II. Pathological findings detected by US examination of the knee in rheumatoid arthritis patients.

US findings	Involved knees (%)	Patients (%)
Joint effusion	140/200 (70%)	88/100 (88%)
Synovial hypertrophy	115/140 (82%)	68/100 (68%)
Intra-articular power Doppler	22/115 (19%)	18/100 (18%)
Enthesopathy	53/200 (26%)	28/100 (28%)
Bone erosions	16/200 (8%)	13/100 (13%)
Cartilage changes	146/200 (73%)	73/100 (73%)

Table III. Relationship between US and clinical findings indicative of knee joint inflammation.

		Clinical findings		Total
US findings		Presence	Absence	
Knee joint inflammation	Presence	112	28	140
	Absence	8	52	60

US image interpretation
Joint effusion, synovial hypertrophy and enthesopathy together with the presence of bone erosions in the knee were diagnosed by US according to the preliminary definitions provided by the Outcome Measures in Rheumatoid Arthritis Clinical Trials (OMERACT) Special Interest Group for Musculoskeletal Ultrasound in Rheumatology (20).
Tendon thickening associated with intra-substance changes, including loss of fibrillar echotexture and patchy hypoechogenicity, was considered a typical feature of chronic tendinopathy (21). Cartilage changes were diagnosed when thickening or thinning of cartilage layer, loss of definition of chondro-synovial margin and pitting of the articular surface were observed (22). In particular, we looked for the presence of hyperechoic spots within the cartilage layer, suggestive of calcium pyrophosphate dihydrate crystal deposits, and for hyperechoic enhancement of the superficial margin, suggestive of monosodium urate deposition (6, 23). Meniscal calcification was evaluated according to a previous study (23). Baker's cyst was diagnosed when a well circumscribed, localised anechoic and/or hypoechoic area lying adjacent to the medial head of the gastrocnemius and communicating with the knee joint by a neck, was detected (24). When examining the popliteal fossa and calf region, fluid tracking down either beneath the fascia or between the soleus and gastrocnemius muscles, was considered indicative of cyst rupture.

Results

Using US, it was detected that 88 out of 100 patients (88%) had joint effusion with or without synovial proliferation. More precisely, in 52 patients, joint effusion was bilateral and unilateral in 36. Overall, US examination detected joint effusion in 140 out of 200 knees (70%). Synovial hypertrophy was present in 115 out of 140 (82%) knees associated with effusion and in 22 out of them (19%) with PD signal. In 25 knees only slight effusion without synovial proliferation was detected. Popliteal cyst was imaged in 66 out of 200 (33%) knees and signs of cyst rupture were present in two cases. US signs of quadricipital and/or patellar enthesopathy were detected in 53 out 200 (26%) knees (bilateral quadricipital and

patellar enthesopathy in 16 and 5 knees, respectively). Patellar tendon examination revealed chronic tendinopathy only in 3 subjects unilaterally. No tendon or entheses site exhibited PD signal. Bone erosions were visualised in 16 out 200 (8%) knees. Cartilage changes were observed in 146 out 200 (73%) knees. Hyperechoic spots within the cartilage layer, suggestive of pyrophosphate crystals deposit, were detected in the knees of 3 patients. Joint effusion was imaged in 28 out 200 knees which were negative for pain/tenderness and swelling at clinical examination. The pathological findings of RA patient knee detected by US examination are reported in Table II. Table III illustrates the relationship between US and clinical findings indicative of knee joint inflammation.

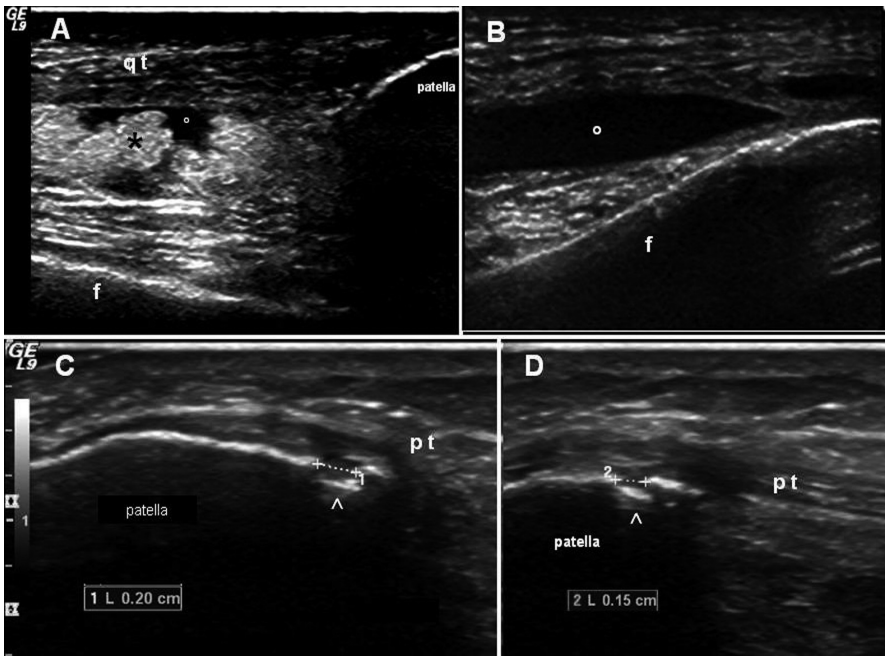

Fig. 1. A. Anterior suprapatellar longitudinal scan showing a marked suprapatellar pouch enlargement with evident signs of synovial proliferation. Grey scale. patella: upper pole of the patella; qt: quadriceps tendon; f: femur; °: synovial fluid; *: synovial proliferation
B. Anterior suprapatellar longitudinal lateral scan showing a marked suprapatellar pouch enlargement with the presence of a septa. Grey scale. f: femur; °: synovial fluid
C. Dorsal transverse scan of knee showing the presence of a patellar erosion. Grey scale. pt: patellar tendon; arrowhead: patellar cortical bone erosion
D. Dorsal longitudinal scan of knee showing the presence of a patellar erosion. Grey scale. pt: patellar tendon; arrowhead: patellar cortical bone erosion

Discussion

RA is the commonest inflammatory joint disorder studied with US and there is evidence supporting the sensitivity of US in the detection of knee synovitis in patients with chronic arthritis (1, 23-27).

In RA patients, treated with tumour necrosis factor blockades (adalimumab, etanercept, infliximab), PD US of the knee has been successfully applied to evaluate the therapeutic response of the patients (28-30).

We imaged knee joints of 100 RA patients in this study and discovered that the majority had joint effusion (70%) mostly associated to synovial proliferation (88%). This is even more important if we consider that in the recruitment criteria, clinical involvement of the knee was not necessary. Previous studies, enrolling a smaller number of RA subjects, had already reported that knee effusion is detected by US in a high percentage of patients, that is, in 38/40 (95%) patients in the study of Frediani *et al*. and in 27/44 (61%) knees in the study of Kane *et al*. (15, 24). The prevalence of knee effusion in our RA patients was lower than that reported in psoriatic arthritis (19) but higher than the prevalence of knee effusion observed in gout and calcium pyrophosphate dihydrate disease (23). On the contrary, synovial hyperthrophy was more frequent in RA than in patients with psoriatic arthritis and crystal-related arthritis (19, 23).

In the present study, intra-articular PD signal was found in only 15% of cases. However, the ability to detect this finding at knee level depends not only on the US equipment and setting, but also on the patient. A thick layer of subcutaneous fat tissue can increase the distance between the probe and the joint cavity reducing PD sensitivity (26).

Popliteal cyst was imaged in 66 out of 200 (33%) knees with a prevalence quite similar to that previously reported by Andonopoulos *et al*. (33,8%) (31). Signs of cyst rupture were present in two cases. In the knees of 3 patients we observed hyperechoic spots within the cartilage layer, clear signs of chondrocalcinosis.

US signs of quadriceps and/or patellar enthesopathy were detected in a number of joints (26%). The term enthesopathy is used to designate any pathology of entheses including inflammatory and degenerative, metabolic or traumatic changes thus it is possible that some entheseal abnormalities visualised in our patients are not due to RA but to factors such as heavy physical work, sport, greater body weight or to concomitant chondrocalcinosis. The prevalence of enthesopathy in RA patients is still under debate. In 2005, Genc *et al*. evaluated by US 5 entheseal sites, including superior and inferior pole of the patella and tibial tuberosity, in 24 patients with RA and 18 with ankylosing spondylitis (AS), concluding that enthesopathy of knee and hindfoot has comparable prevalence in RA and AS (32). Frediani *et al*. found that only 7.5% of 40 RA patients had quadriceps "enthesitis", using this term to describe entheseal abnormalities including thickening or hypoechogenicity of the enthesis, loss of normal fibrillar structure, gross irregularity of the patella and enthesophytes >5 mm (15).

These studies were limited by a lack of clear and largely accepted definition of entheseal abnormalities at that time. In 2005 the OMERACT 7 meeting developed a consensus on broad descriptive US definitions including "enthesopathy" (20).

It is important to note that no patients enrolled in our study showed PD signal at quadricipital and or patellar entheses. Recently, Delle Sedie *et al*. evaluated by US the knee of 83 patients with psoriatic arthritis and reported "enthesitis", defined as hypoechogenicity and/or

thickening of the entheses, as well as the presence of PD signal at entheseal level, in 39 patients with a total of 64 entheses involved. Further studies on large groups of RA patients, using standardised definitions and scanning protocols, will help to clarify the prevalence of enthesopathy in such a disease.

Bone erosions were detected in 16 out of 200 knees (8%) in 13 patients. This would be unexpected and not an easily explainable phenomenon. The anatomical conformation of knee is such that the US beam cannot reach a large portion of femur and tibial profile because of their position inside the joint. We therefore hypothesise that the imaging of only a limited portion of articular bone leads to bone erosions being missed in certain 'hidden' regions of the joint. The mean disease duration in these 13 patients was 10 years (range 3–23 years), only slightly longer than in the other patients. Further studies are needed to provide information on knee erosions topographic distribution, also using other imaging techniques (MRI and CT scans).

Our study detected a larger number of joints with effusion and synovitis using US compared to clinical examination in accordance with data previously reported (11, 24, 27). In particular Kane *et al*., comparing US with clinical examination in the detection of effusion, suprapatellar bursitis, and Baker's cyst of the knee in 22 RA patients, showed that clinical examination underestimates knee inflammation and US is more sensitive than clinical examination in the detection of knee joint abnormalities (24).

In conclusion, US examination of the knee is more sensitive than clinical examination in the detection of joint inflammation and allows for the identification of different patterns of pathologic changes at knee level, including morphostructural changes at both cartilage and tendon level.

Link

For further ultrasound images, please go to www.clinexprheumatol.org

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