Ultrasound imaging for the rheumatologist XXIX. Sonographic assessment of the knee in patients with osteoarthritis

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Received and accepted on October 8, 2010.

Clin Exp Rheumatol 2010; 28: 643-646.

Key words: Ultrasound, knee, osteoarthritis

Competing interests: none declared.

ABSTRACT

Objective. *To investigate the prevalence and severity of sonographic-detected abnormalities in knee osteoarthritis (OA) and to correlate ultrasound (US) findings with clinical data.*

Methods. *Outpatients with chronic, painful knee OA according to the ACR criteria were consecutively recruited and underwent clinical and US examinations. An expert rheumatologist recorded the presence of knee joint pain, swelling and tenderness, patient's global assessment of knee pain using visual analogue scale (VAS), and Lequesne Index of severity for knee OA. A second rheumatologist, blinded to the clinical data, performed the knee US examination using a Logiq9 machine equipped with a 12MHz linear probe and registering the presence of joint effusion, synovial proliferation, power Doppler (PD) signal, Baker's cyst, osteophytes and femoral cartilage abnormalities.*

Results. *One hundred and sixty-four knees of 82 patients (53 women, 29 men) were studied; mean age was 63.2 ±8.1 SD years, mean disease duration was 4.3±5.6 SD years. All patients complained of at least one knee joint pain during physical activity. Mean patient's VAS for knee pain was 48.4±19.9 SD mm, mean Lequesne Index was 8.2 ±4.4 SD. Knee swelling was present in 39% of the patients and tenderness was found in 65.8%. US showed: joint effusion in 43.3% of the patients, synovial proliferation in 22.1%, PD signal in 2.9%, Baker's cysts in 6.6%, cartilage abnormalities in 79%, osteophytes in 100%. In all patients US findings were present at least at the level of one knee. Statistically significant correlations were demonstrated between a composite inflammatory score and both VAS (p=0.004) and Lequesne Index (p<0.0001).*

Conclusions. *This US study showed both inflammatory abnormalities and structural damage lesions in knee OA. Interestingly, statistically significant correlations were demonstrated between US inflammatory findings and the main clinical tests for OA, confirming that sonography has a relevant role in the global evaluation of patients with knee OA.*

Introduction

Osteoarthritis (OA) is the most common rheumatic disease and the most frequent cause of rheumatic complaints, thus determining a relevant public health problem (1). It is a chronic disorder characterised by a series of abnormalities which involve the whole joint organ with progressive cartilage abnormalities and associated bone and soft tissues changes. The main pathological findings are represented by dysregulation of local turnover with modifications in repairing processes that lead to progressive degeneration and loss of cartilage, and thickening of the subchondral bone, joint margin and capsule (1, 2). Episodic, non-destructive and non-aggressive synovitis often occurs and usually contributes to the presence and worsening of symptoms and cartilage deterioration. In those cases, synovial proliferation, joint effusion and bursitis are frequently present. Usually, OA appears and progressively worsens with age progression, thus having a great social impact, especially in the aging population of industrialised countries (3). The involvement of the knee joint leads to a severe disease phenotype, with evidence of disability

and work impairment that frequently appear prematurely. This is due to joint use-related pain, swelling, stiffness, deformity, reduction of muscle strength and limited joint motion (1, 2).

Musculoskeletal ultrasound (US) represents a new imaging modality, which has been increasingly utilised in rheumatology during recent years. Thanks to progressive technical advances and technological developments, US has markedly increased its ability to image different anatomic structures and their abnormalities in the finest details (1, 4-8). In last few years, most of the interest in the field of US has focussed on inflammatory arthritis and soft tissue disorders and, to date, it has been used for the evaluation of OA less frequently (1, 9-12).

The aims of this study were to investigate the prevalence and severity of sonographic-detected abnormalities in knee OA by using US, and to correlate US-detected findings with clinical and laboratory data.

Methods

This was a cross sectional, multicentre Italian study conducted in 4 rheumatology units. The study was performed according to the Declaration of Helsinki and local regulations, and informed consent was obtained from all patients.

Patients

Outpatients with chronic, painful knee OA were consecutively recruited and underwent clinical and US examinations within a maximum of 4 hours time interval. A single rheumatologist performed the clinical evaluation and patients were subsequently assessed by a different rheumatologist, experienced in musculoskeletal US, who performed the sonographic examination and was unaware of the clinical results. Data were recorded by the investigators on 2 separate case report forms and afterwards evaluated for statistical analysis.

The main inclusion criteria were men or women over 18 years of age with primary knee joint OA according to the American College of Rheumatology (13); with first OA symptoms appearing at least 6 months before; with radiographic signs of OA defined as by Kellegren and Lawrence (14); and with a pain intensity during physical activity in the previous week >20mm on a 100mm visual analogue scale (VAS) (15).

Exclusion criteria were a history of injury to the knees in the 6 months before the study entry; knee joint surgery, including arthroscopy; knee intra-articular injections given during the previous 3 months before the start of the study; and evidence of any other rheumatic diseases.

Clinical evaluation

The clinical parameters collected were demographic data, time duration since symptoms onset, knee joint pain, knee joint swelling, knee joint tenderness, patient's global assessment of knee pain using a 100mm VAS, and Lequesne Index of severity for knee OA (16).

Ultrasound

US examination of both knees was performed in all patients by using a Logiq 9 (General Electric Medical Systems, Milwaukee, WI) equipped with a multi-frequency linear probe, working at 12MHz. Power Doppler (PD) was used for assessing synovial vascularity (PRF 500Hz, Doppler frequency 7.5MHz and Doppler gain at the level that avoided random noise visualisation). Examinations were carried out following international guidelines (17). Synovial hypertrophy and synovial fluid were defined according to Outcome Measures in Rheumatoid Arthritis Clinical Trials (OMERACT) definitions (18), and scored following a semi-quantitative 4 points scale (0 = normal; 1 = mild; 2 = moderate; 3 = severe). Synovial perfusion detected by PD was also scored according to a semi-quantitative, from 0 to 3, grading system (0 = absence of flow; 1 = mild: up to 3 single spots signals or up to 2 confluent spots or 1 confluent spot + up to 2 single spots; 2 = moderate: vessel signals in <50% of the area of the synovium (but more than grade 1); 3 = marked: vessel signals in >50% of the area of the synovium). The presence or absence of a Baker's cyst, defined as an abnormal hypo-anechoic, displaceable and compressible material within the gastrocnemius-semimembranosus bursa, was indicated respectively with a score of 1 or 0. In each patient, the sum of these scores (range 0–10), was used as an indicator of global inflammatory changes at single knee joint level; in each patient, a composite inflammatory score (total US score), derived by summing the single joint scores obtained at both knees, was used as an indicator of total knee joints inflammatory involvement (range 0–20) (19).

Moreover, the presence/absence of osteophytes and abnormalities of the femoral cartilage were registered. Osteophytes were defined as cortical protrusions at the joint margin seen in two planes and visualised as either proximal or distal to the joint. Hyaline cartilage abnormalities were defined as either the loss of cartilage anechoic echostructure, the loss of its sharpness of at least one margin, the presence of irregularities of margins or the thinning of the layer.

Statistical analysis

The statistical analysis was performed with Statistical Package for Social Sciences software 13.0 (SPSS 13.0, Chicago, Illinois, USA). The correlations were performed with the Spearman test. All p-values were two-tailed, and $p \leq 0.05$ were considered to be significant.

Results

Demographic, clinical and US findings are summarised in Table I.

Patient characteristics and clinical findings

One hundred and sixty-four knees of 82 osteoarthritis patients were studied; women/men ratio was 1.82 (53/29), mean age was 63.2±8.1 SD years and mean time duration since symptoms onset was 4.3±5.6 SD years.

All patients were receiving either analgesic or non-steroidal-anti-inflammatory drugs and complained of at least one knee joint pain during physical activity.

Mean patient's VAS for knee pain was 48.4±19.9 SD mm and mean Lequesne Index was 8.2±4.4 SD.

Knee swelling was present in 39% of the patients (29.6% of the joints); knee tenderness was found in 65.8% of the patients (47.6% of the joints).

Table I. Demographic, clinical and ultrasonographic findings.

Number of patients	82
Number of knees	164
Gender: Female/Male (ratio)	53/29 (1.82)
Age: mean ± SD, years	63.2 ± 8.1
Time since symptoms onset: mean ± SD, years	4.3 ± 5.6
VAS pain: mean ± SD, mm	48.4 ± 19.9
Lequesne Index : mean ± SD	8.2 ± 4.4
Swollen joints: number of patients* (%)	32 (39)
Swollen joints: number of joints (%)	48 (29.6)
Tender joints: number of patients* (%)	54 (65.8)
Tender joints: number of joints (%)	78 (47.6)
Ultrasonographic evaluation	
Synovial effusion : number of patients* (%)	35 (43.3)
Synovial effusion : number of joints (%)	60 (36.6)
Synovial proliferation: number of patients* (%)	18 (22.1)
Synovial proliferation: number of joints (%)	30 (18.3)
Power Doppler signal: number of patients* (%)	2 (2.9)
Power Doppler signal: number of joints (%)	3 (1.8)
Baker cyst's: number of patients* (%)	5 (6.6)
Baker cyst's: number of joints (%)	5 (2.7)
Total US score : mean ± SD	2.87 ± 2.8
Cartilage abnormalities: number of patients* (%)	64 (79)
Cartilage abnormalities: number of joints (%)	124 (75.6)
Osteophytes: number of patients* (%)	82 (100)
Osteophytes: number of joints (%)	164 (100)

*Patients presented with US involvement of either one or both knees.
VAS: visual analogue scale; US: ultrasound.

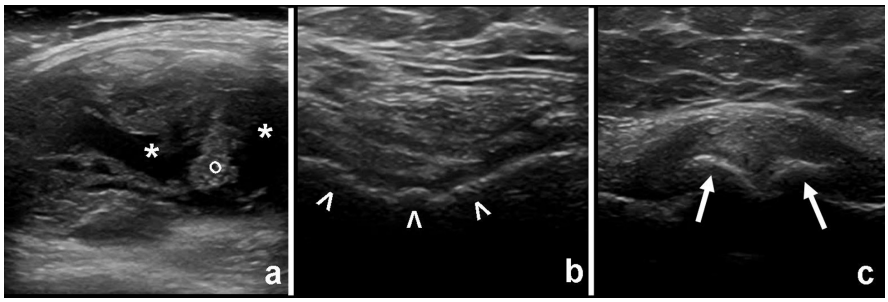

Fig. 1. Grey-scale sonographic findings in knee osteoarthritis. (**a**) Anterior para-patellar longitudinal scan showing the presence of local effusion (*****) and synovial proliferation (**o**). (**b**) Anterior supra-patellar transverse scan showing the femoral hyaline cartilage (arrowhead) abnormalities with evidence of loss of cartilage anechoic echostructure, loss of margins sharpness, irregularities of margins and thinning of the layer. (**c**) Longitudinal scan at the level of the medial aspect of the knee joint showing the presence of large osteophytes (arrows) visualised both proximal (femoral side) and distal (tibial side) to the joint.

Ultrasonographic findings

US showed the presence of joint effusion in 43.3% of patients, the signs of synovial proliferation in 22.1%, the evidence of increased vascularisation by PD in 2.9% and the finding of a Baker's cyst in 6.6% (Fig. 1). The mean total US score was 2.87±2.8 SD.

Cartilage abnormalities were detected in 79% of patients and osteophytes were found in 100% of cases (Fig. 1).

In all patients US findings were present at least at the level of one knee.

Statistically significant correlations were demonstrated between total US score and VAS (p=0.004) as well as between total US score and Lequesne Index (p<0.0001) (Fig. 2).

Discussion

This study demonstrated the presence of inflammatory abnormalities as well as of structural damage lesions in patients with painful, knee OA. A high prevalence of inflamed joints was present, particularly regarding the findings of joint effusion and synovial proliferation. These results, if compared to the rare prevalence of intra-articular PD signal, can probably only be partially explained with the presence of a low inflammatory activity in our patients. In fact, the decreased sensitivity of sonographic equipment in the detection of flow at the level of deep joint sites needs to be taken into account when analysing this particular finding. This phenomenon is, in fact, very well known in the literature and has been demonstrated also at the level of other large joints (20, 21). US showed also a high prevalence of structural damage lesions both at the level of the femoral cartilage and, particularly, at the bony cortex level, where the total of the examined joints showed the presence of osteophytes. This typical and characteristic finding of OA detected by US confirms the high sensitivity of this tool in the assessment of structural damage lesions (22). The statistically significant correlations between total US score and VAS, but also between total US score and Lequesne Index, confirm the importance of the ultrasonographic findings in the global assessment of patients with knee OA. US is, in fact, an imaging modality which can be performed at bedside, immediately after the clinical examination, and is very well accepted by patients. The fact that US findings correlate with the main clinical tests for OA is a relevant result that needs to be taken into account when assessing the osteoarthritic patients.

The role of US in the evaluation of OA has been recently underlined but, to date, only few investigators have concentrated on this topic (1, 22, 23).In particular, while there is clear evidence of the validity of US in detecting synovitis and structural abnormalities in inflammatory arthritis, more work is required to demonstrate the validity of this tool in OA (24). The knee is frequently involved in this disease and US has demonstrated to be a valuable imaging tool for the assessment of joint involvement in this joint (25, 26). Similarly to other research conducted at the level of the hand, the present study showed synovitis changes as well as the typical structural lesions characterised by cartilage and bony cortex abnormalities (23). US is a valuable tool for imaging

musculoskeletal changes in OA: it is a safe and widespread available imaging modality that can be used at bedside, during the global assessment of the patient with OA. The relatively low cost, short duration of single examinations and the possibility of performing a multiregional joint evaluation in the same scanning session further increases its clinical usefulness in the daily practise permitting an extensive evaluation of most joint changes present in patients with OA (1).

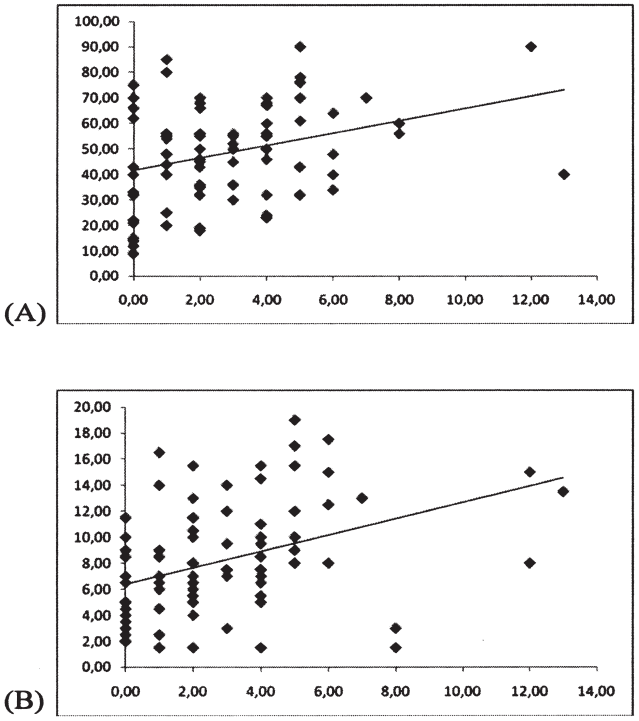

Fig. 2. Correlation between Total US score and VAS pain (**A**, p=0.004) and Lequesne Index (**B**, p<0.0001). VAS: visual analogue scale; US: ultrasound.

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