The importance of using ultrasonography in knee osteoarthritis

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Background
Radiographic features of osteoarthritis (OA) do not correlate with its symptoms at the individual patient level; thus, conventional radiography has limitations. Ultrasonography plays an important role in the diagnosis of musculoskeletal disorders. It reveals soft-tissue abnormalities such as pes anserine bursitis, Baker's cyst, effusion, synovial hypertrophy, meniscal tear, and collateral ligament injury.

Aim of work
The aim of this study was to detect changes in the knee that cannot be visualized using conventional radiography and to better understand and manage unexplained pain in OA.

Results
There was a discrepancy between the results obtained by clinical examination and those by ultrasonography. Knee effusion was found in 21 knees (70%); synovial hypertrophy was found in three knees (10%), of them two showed Baker's cyst and marked effusion; Baker's cyst was found in eight knees (27%); and pes anserine bursitis was found in one knee. Results that could not be found by clinical examination were: cartilage degeneration in 27 knees (90%) and meniscal degeneration in 26 (86%). Meniscal degeneration and synovial hypertrophy were correlated significantly with advanced cartilage degeneration ($P<0.001$).

Conclusion
Ultrasonography can be used for diagnosing soft-tissue lesions, for grading the severity of OA, and for guiding and monitoring therapy.

Keywords:
cartilage, guided injection, joints, osteoarthritis, osteophytes, synovitis, ultrasonography

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Introduction

Osteoarthritis (OA) refers to a group of joint disorders that are caused by a variety of factors but with common clinical and pathological features. The disease is difficult to define succinctly because of its complex pathological nature and heterogenous clinical presentation. With regard to epidemiological studies, OA is usually defined according to changes seen on radiography [1].

These changes can be graded according to existing criteria, which generally focus on the presence of joint space narrowing, osteophytes, subchondral bone sclerosis, subchondral bone cysts, and bone-end deformities. However, the radiographic features of OA do not correlate with its symptoms at the individual patient level; thus, conventional radiography (CR) has limitations in the clinical setting. Ultrasonography, in contrast, reveals soft-tissue abnormalities such as pes anserine bursitis, Baker's cyst, effusion, synovial hypertrophy, meniscal tear, and collateral ligament injury [2]. For these reasons, novel imaging techniques are being tested and used as an adjuvant to CR in the investigation and management of OA in the clinical setting.

Materials and methods

This study was conducted on 15 patients (30 knees) who presented to the outpatient Rheumatology clinic with knee pain and were diagnosed according to ACR criteria for OA.

Full clinical examination

Clinical tests included determination of ESR, analysis of CBC and uric acid, and detection of viral hepatitis markers.

Radiographic assessment: All patients were assessed on the basis of posteroanterior, lateral, and sunrise views. Bone erosions, osteophytes, and joint space narrowing were recorded.

Exclusion criteria included: previous history of trauma, gout, and joint injection (6 months earlier).

Equipment

A Philips HDI 5000 linear transducer (Philips ATL Company, Universal Diagnostic Solutions, South California, USA) with color Doppler and power Doppler was used

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at 7.5–12.5 MHz for performing the ultrasonography. Standardized US-defined pathological findings described by OMERACT were also followed [3].

Statistical analysis

The statistical package for social sciences (version 15.0; SPSS Inc., Chicago, Illinois, USA) was used for data analysis. The results are expressed as mean ± SD. The *t*-test was used to compare group results. The χ^2 and Fisher's exact test were used to compare categorical variables. Correlations below 0.05 were considered significant.

Knee examination was performed by acquisition of images of the knee joint according to the recommendations of the European League Against Rheumatism [4]. It was recommended that the knee be imaged initially with patients supine in the neutral or slightly flexed (30°) position for lateral and anterior images and then in the prone position for posterior images. Slight flexion with contraction of the quadriceps aids visualization of the suprapatellar pouch, and maximal flexion aids visualization of the trochlear cartilage. Standard scans should include imaging in the transverse and longitudinal planes of the suprapatellar region, infrapatellar region, and posterior knee (medial and lateral). In addition, the knee should be imaged longitudinally over the medial and lateral aspects of the joint. Cartilage pathology can be appreciated in the trochlea of the distal femur, with the knee in full flexion.

Grades of cartilage affection

Cartilage was assessed and graded on the basis of sharpness, clarity, and thickness.

(1) 0 = normal (no signs of degeneration).
(2) Grade 1 = loss of sharpness of the cartilage margins.
(3) Grade 2 = loss of homogeneity of the articular cartilage.
(4) Grade 3 = thinning of the cartilaginous layer + 1 and 2.

Grades of knee effusion

(1) 0 = effusion less than 4 mm or no effusion.
(2) 1 = mild (more than 4 mm in one recess).
(3) 2 = moderate (effusion in two recesses).
(4) 3 = marked (effusion in three recesses).

Results

Knee effusion: Using ultrasonography, knee effusion was detected in 21 knees (70%) of a total of 30, of which mild effusion was detected in 11, moderate in eight, and marked in two.

Synovial hypertrophy was detected in three knees (10%), two of which showed Baker's cyst and marked effusion. Baker's cyst was found in eight knees (27%) and pes anserine bursitis was found in one knee. Clinical examination could not detect very important structural knee changes: cartilage degeneration in 27 knees (90%), meniscal degeneration in 26 knees (86%), and meniscal extrusion (a bulge more than 3 mm, which pushes on the collateral ligament) in seven knees (23%) (Table 1).

Meniscal degeneration and extrusion related significantly with advanced cartilage degeneration (Table 2).

Osteophytes were detected in all 30 knees (100%), whereas cartilage narrowing was detected in 13 knees (43%), with no difference between those having cartilage narrowing and those who did not.

Although knee effusion did not correlate with synovial hypertrophy in general, advanced knee effusion did significantly ($P<0.05$).

Synovial hypertrophy also correlated with advanced cartilage degeneration ($P<0.001$), meniscal degeneration ($P<0.001$), and meniscal extrusion ($P<0.05$) (Table 4). However, it did not correlate with the weight of the patients nor with the duration of the disease (Table 3).

Discussion

The role of musculoskeletal ultrasonography in various rheumatic disorders is expanding because of the availability of higher-resolution ultrasonographic machines that can be used for visualizing them. Radiographic features of OA do not correlate with its symptoms at the individual patient level; thus, the value of CR has limitations in the clinical setting. Ultrasound detects

Table 1 Ultrasonographic abnormalities in 30 knees

Abnormalities	Number/30 knees	Clinical examination
Synovial hypertrophy	Detected in three knees (10%)	None
Knee effusion	Detected in 21 knees (70%)	Six knees (20%)
Cartilage degeneration	Detected in 27 knees (90%)	Not detected
Meniscal degeneration	Detected in 26 knees (86%)	Not detected
Meniscal extrusion (>3 mm)	Detected in seven knees (23%)	Not detected
Osteophytes	Detected in 30 knees (100%)	Not detected
Baker's cyst	Detected in eight knees (27%)	Zero
Pes anserine bursa	Detected in one knee (3%)	–
Cartilage narrowing	Detected in 13 knees (43%)	Not detected

Table 2 Relation between cartilage degeneration and meniscal lesion in knee osteoarthritis

	Cartilage degeneration grade			
	Grade 1	Grade 2	Grade 3	*P* value
Number of knees	2	3	22	–
Meniscal degeneration	2	3	21	<0.001
Meniscal extrusion	0	0	7	<0.05

Table 3 Demographic characteristics of patients with knee osteoarthritis with and without synovial hypertrophy

	Synovial hypertrophy	No synovial hypertrophy	*P* value
Number of knees	3	27	–
Mean age	52	58	>0.05
Mean weight	75	74	>0.05
Mean duration	6 years	4 years	>0.05

Table 4 Relation between synovial hypertrophy and ultrasonographic findings in knee osteoarthritis

	Synovial hypertrophy	No synovial hypertrophy	*P* value	Significance
Number of knees	3	27	–	–
Number of effusions	0	9	<0.001	HS
Effusion	3	18	>0.05	NS
Grade 1	1	10	>0.05	NS
Grade 2	1	7	<0.05	S
Grade 3	1	1	<0.05	S
Cartilage degeneration	3	24	>0.05	NS
Grade 1	0	2	>0.05	NS
Grade 2	0	3	>0.05	NS
Grade 3	3	19	<0.001	HS
Meniscal degeneration	3	23	<0.001	HS
Meniscal extrusion	2	5	<0.05	S
Cartilage narrowing	2	11	>0.05	NS

HS, highly significant; NS, nonsignificant; S, significant.

soft tissue abnormalities and can be used to describe the typical features of synovial hypertrophy, effusion, osteophytes, and cartilage thinning at the knee joint. In addition, meniscal extrusion and tears may be visualized in association with displacement of the collateral ligaments.

This study was conducted on 15 patients (30 knees), of whom 11 were women and four were men, who presented at the outpatient Rheumatology clinic with knee pain and were diagnosed according to ACR (1986) criteria for OA [5]. Ultrasonography was used to detect changes in the knees of patients having OA.

OA is more common in women as compared with men, and hence our study included 11 women and four men. The number of women was almost three-folds that of men, which is in agreement with the results of Dieppe *et al.* (2008). There was no significant difference between the presence and absence of synovial hypertrophy with respect to the weight of the patients, although it is known that the severity and prevalence of knee OA are higher in obese individuals compared with those of normal weight. In our study, patients having synovial hypertrophy had the disease for a longer duration (6 vs. 4 years) compared with those not suffering from it, although this was not statistically significant ($P>0.05$) (Table 3). It is well known that knee OA is a progressive disease, which means that older populations suffer from a more severe form of the disease. However, in our study, there was no correlation between the age of the patients and the presence of synovial hypertrophy, which may be because of the small number of patients studied [6].

Imaging of the popliteal fossa helps in identification of Baker's cysts associated with OA. These appear as hypoechoic or anechoic masses arising between the semimembranosus and the medial head of the gastrocnemius tendons. They may have a heterogenous echoic appearance as they can be filled with debris from the communication with the knee joint. Leakage of fluid from the cyst is characterized by the presence of fluid within the surrounding tissue and a beaked appearance of the cyst distally. Complete rupture and emptying of the cyst may be indicated only on the detection of residual fluid between the heads of the semimembranosus tendon and the medial gastrocnemius [7].

Pathological changes in the cartilage, such as thinning, heterogeneity, and loss of clarity (described previously), can be observed. These changes, in particular thinning, are generally more pronounced in OA than in inflammatory arthritis. Ultrasonographically detected changes in the hyaline cartilage of the knee are unclear. The peripheral, superficial aspects of menisci can also be visualized using ultrasonography, allowing some meniscal pathological conditions such as cysts, extrusion, or horizontal tears to be detected. Meniscal extrusion has been shown to be significantly associated with symptomatic knee OA. It is a significant component of the joint space narrowing as observed radiographically and has been shown to be associated with ultrasonographically detectable displacement of the medial collateral ligament and some pain parameters [8].

Our results agree with those of Mendieta *et al.* (2006), who compared 81 patients having symptomatic knee OA with 20 patients having asymptomatic knee OA. They found that the frequent ultrasonographic findings in the knees of patients with symptomatic OA were suprapatellar effusions (79%), meniscal lesions (45%), Baker's cysts (37%), infrapatellar bursitis (8.6%), and anserine bursitis (0.6%) [9].

In our study, there was a significant correlation between synovial hypertrophy and severity of effusion, between synovial hypertrophy and cartilage degeneration, and between meniscal degeneration and meniscal extrusion, implying that synovial hypertrophy is found in the severe forms of the disease (Table 4).

Moreover, our results agree with those obtained in the study by Naredo *et al.* [10] on patients with primary knee OA. They found that the more frequent ultrasonographic findings in symptomatic knees were effusion (47%), medial meniscus extrusion (61%), and Baker's cysts (22%). These patients were associated with a significantly higher pain score than those who had no findings at ultrasonography [10]. Ultrasonography can be used not only for diagnosis but also for treating Baker's cysts and monitoring response to therapy. In this series of OA patients, injection of corticosteroids into the knee joint accounted for a reduction in the dimensions of Baker's cyst as well as in cyst wall thickness [11].

Pourbagher *et al.* [12] showed that sonographically guided intra-articular injection of sodium hyaluronate in patients with hip OA is easy to perform and is a safe, economical, and well-tolerated method of treatment. In contrast to

fluoroscopic or computed tomographic guidance, the sonographic technique exposes neither the patient nor the physician to radiation [12]. In our opinion this technique can also be applied to the knee.

Kristoffersen *et al.* [13] demonstrated that primary OA is associated with synovial thickening in 61 of 71 patients, and hyperemia was detected in 51 of them. This confirms that there is a variable degree of inflammation among the patients, and those having inflammation respond to local injections of corticosteroids [13].

Conclusion

Ultrasonography can be used for diagnosing soft-tissue lesions, grading the severity of OA, and for guiding and monitoring therapy.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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