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Ultrasound findings in knee osteoarthritis and rheumatoid arthritis compared to MRI

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ABSTRACT

Background: Osteoarthritis is a common musculoskeletal degenerative disease of the cartilage of joints and rheumatoid arthritis is a destructive autoimmune joint disease. The aim of our study was comparing of ultrasound findings in knee osteoarthritis and rheumatoid arthritis with MRI as the gold standard.

Methods: One hundred subjects with chronic knee pain referred for knee MRI were evaluated by ultrasound and MRI on the same day. Two radiologists assessed knee osteoarthritis and rheumatoid arthritis parameters on ultrasound and MRI separately and independently. Agreement between the ultrasound and MRI evaluations was determined using weighted kappa statistics. Intra-class correlation coefficients were used to evaluate agreement using the absolute values of knee osteoarthritis and rheumatoid arthritis parameters.

Results: The overall agreements between the two expert's radiologists were 85% for the knee joint. Taking an agreement in US examination of 2 expert's radiologist the overall k for was 0.69 when comparing assessment of knee osteoarthritis and rheumatoid arthritis parameters between ultrasound and MRI. For the knee joint the overall agreement of US findings with MRI was 89%. The overall sensitivity for US of the knee joint was 95.59%, the overall specificity 81.88% in the detection of knee osteoarthritis and rheumatoid arthritis parameters.

Conclusions: Ultrasound assessment of knee osteoarthritis and rheumatoid arthritis parameters is reliable and, showing good diagnostic performance for the detection of knee osteoarthritis and rheumatoid arthritis parameters compared with MRI.

Keywords: Ultrasound, Knee Osteoarthritis, Rheumatoid Arthritis, MRI.
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INTRODUCTION

Osteoarthritis is a common musculoskeletal degenerative disease of the cartilage of joints and rheumatoid arthritis is a destructive autoimmune joint disease and affected synovium that normally produces lubrication and nutrient fluid for joints.[1,2] Prevalence of knee osteoarthritis and rheumatoid arthritis in aging populations is increasing worldwide caused by decreased quality of life and working disability.[1,2] Besides articular cartilage degeneration, the formation of osteophytes, bone erosion, meniscus atrophy, effusion and synovial inflammation are structural and compositional hallmarks of the osteoarthritis and rheumatoid arthritis.[3]

The importance of diagnostic imaging methods have increased in detection and follow up of the individual parameters in knee osteoarthritis and rheumatoid arthritis.[4] To date, magnetic resonance imaging (MRI) is considered the most accurate imaging modality in the measurement of knee osteoarthritis and rheumatoid arthritis.[4] Despite its best sensitivity, MRI is expensive and not practical and then is not typically used as an imaging technique for detection of knee osteoarthritis and rheumatoid arthritis.[4] In recent times, high-resolution ultrasound has become of great notice in knee osteoarthritis and rheumatoid arthritis study.[5-7] Evidence on ultrasound validity in comparison to traditional knee osteoarthritis and rheumatoid arthritis imaging modalities is increasing.[8-11] Tarhan et al. showed that significant agreement of ultrasound with MRI in the assessment of femoral cartilage and soft tissue deterioration.[8] Consequently, increasing evidence in the scientific literature supports the idea of deploying ultrasound for detection of morphological changes in knee osteoarthritis and rheumatoid arthritis as one of the first-line modalities. The aim of our study, therefore, was comparing of ultrasound findings in knee osteoarthritis and rheumatoid arthritis with MRI as the gold standard.

METHODS

Patients

One hundred patients with knee OA or RA were listed in this study [male: 67, female: 33, mean age 51.3 ± 7.5 yr (range 35–75 yr)]. The minimum age for entry into the study was 35 years. Subjects in this study were considered to have knee osteoarthritis or rheumatoid arthritis symptoms. The severity of pain in each knee was calculated as an average of pain on climbing or descending stairs, nocturnal pain, usage pain and rest pain which was scored 0–100 on a 100 mm visual analog scale (VAS). Informed consent was obtained from all patients

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admitted to the study. Individuals with total knee replacements, and who cannot fully flex the joint were excluded from the study.

Ultrasound examination

The knee joints in all subjects were examined with a real-time ultrasound scanner (Hewlett Packard Image Point, California, USA). US was approved by using a 5-10 MHz electronic linear transducer (Model L7535). Thickness was measured on a grid was marked over the flexed knee, with transverse lines 0.5 and 2.0 cm above the patella. Vertical lines were placed over the intercondylar notch and 1.5 cm to each side.[12] Each intersection of the grid was imaged in the transverse and longitudinal planes. The maximum thickness of the synovial membrane of the anterior wall of the suprapatellar recess and the maximum anterior-posterior width of the effusion was measured on the longitudinal suprapatellar scan (taking care not to squeeze the recess by avoiding firm compression of the probe). A compression test was used for differentiation of joint fluid and synovial membrane. During compression of the suprapatellar recess, moveable fluid disappeared, while the synovial membrane remained in the imaging plane.[13-16]

MRI examination

MRI was obtained in both knees of all patients by Gyroscan Panorama 0.23 Tesla Open MR System (Philips Medical Systems, Helsinki, Finland) and was interpreted by a radiologist experienced in musculoskeletal MRI imaging. The imaging protocol included sagittal, coronal and axial fast spin echo proton density and T2 weighted images (TR 3000, TE 22/110) with a slice thickness of 4.5 mm, a 0.5 mm interslice gap, 2 NEX, field of view 20–25 cm, a matrix of 216 · 256 and echo-train, length of four. The total cartilage thickness of the weight-bearing central portion of the femoral condyles was determined in the central portion of both the medial and lateral compartments of the knees. As with US, the femoral condylar cartilage was assessed at the weight-bearing surface placed at distance of 1.5 cm. from the intercondylar notch to each side. The extent of effusion was assessed on T2 weighted axial images by measuring the maximum anterior-posterior diameter of the suprapatellar recess.[17] Synovial thickening was scored. The presence of the popliteal cyst on T2 weighted images using axial and sagittal views was graded on a semiquantitative scale as described by Hill et al.[12]

Table 1 Clinical, US and radiographic findings in all subject

Clinical findings	
Age (years) (mean, SD)	51.3 ± 7.5
Right knee (n, %)	49%
Left knee (n, %)	41%
BMI (mean, SD)	30.1 ± 4.7
US findings	
Effusion (n, %)	40%
MMP with MCLD (n, %)	60%
Baker's cyst (n, %)	25%
Radiographic findings	
K–L grade	
Grade I (n, %)	25%
Grade II (n, %)	37%
Grade III (n, %)	33%
Grade IV (n, %)	5%

Statistical analysis

Statistical analysis was performed with the SPSS 22 package. Analysis of statistical correlation was performed by the Spearman test of rank correlation. Mann-Whitney U test and chi-square test were used to analyze differences between the groups of the knees and imaging parameters. $P < 0.05\%$ was established as a level of significance.

RESULTS

One hundred patients with knee OA or RA were listed in this study [male: 67, female: 33, mean age 51.3 ± 7.5 yr (range 35–75 yr)]. The minimum age for entry into the study was 35 years. K–L grade was I in 25% knees, II in 37%knees, III in 33% knees and IV in 5% knees. US findings in knees were effusion in 40 %, protrusion of the anterior horn of the medial meniscus (MMP) associated with displacement of the medial collateral ligament (MCLD) in 60% and Baker's cyst in 25%. (Table 1).

Inter-observer agreement

The overall agreements between the two expert's radiologists were 85% for the knee joint. Taking an agreement in US examination of two expert's radiologist as a point of reference, the overall k for was 0.69. The k values for bone lesions, bursitis, and tendon tears were excellent. There was also a moderate k value for the detection of tenosynovitis, but k values were low for the detection of synovitis and effusion.

Overall agreement of US findings compared with MRI

For the knee joint the overall agreement of US findings with MRI was 89%. The overall sensitivity for US of the knee joint was 95.59%, the overall specificity 81.88%. (Table 2)

Table 2 Properties of US finding

Factors	Sensitivity	Specificity	Positive Likelihood Ratio	Negative Likelihood Ratio	Positive Predictive Value	Negative Predictive Value
Effusion	98.36 (CI:91-99)	86.44 (CI:75-93)	7.25 (CI:75-93)	0.02 (CI:0-0.13)	88.24 (CI:79-93)	98.08 (CI:87-99)
Synovitis	96.61% (88-99)	88.52 % (77-95)	8.42 (4-16)	0.04 (0.01-0.15)	89.06% (80-94)	96.43 % (87-99)
Osteophytes	98.36 (CI:91-99)	96.6 (CI:88-99)	29.02 (CI:7.4-113.3)	0.02 (CI:0-0.13)	96.77 (CI:88-99)	98.28 (CI:88-99)
Bursitis	98.31 (90-99)	21.31 (11-33)	1.25 (1.09 - 1.43)	0.08 (0.01 - 0.59)	54.72 (51-58)	92.86 (63-98)
Tendonitis	98.36 (CI:91-99)	98.31 (CI:90-99)	58.03 (CI:8.5-405)	0.02 (CI:0-0.12)	98.36 (CI:89-99)	98.31 (CI:89-99)
MMP	88.14 (77-95)	86.89 (75-94)	6.72 (3.5-12.9)	0.14 (0.07-0.28)	86.67 (77-92)	88.33 (78-93)
MCLD	96.72 (CI:88-99)	98.31 (CI:90-99)	57.07 (CI:8-398)	0.03 (CI:0.01-0.13)	98.33 (CI:89-99)	96.67 (CI:88-99)
Baker, s cyst	94.92% (CI:85- 98)	78.69 (CI:66-88)	4.45 (CI:2.7-7.4)	0.06 (CI:0.02-0.2)	81.16 (CI:72-87)	94.06 (CI:85-96)

DISCUSSION

Our study demonstrated that knee osteoarthritis and rheumatoid arthritis parameters could be reliably identified by ultrasound. For these reasons, our results provide one suggestion that ultrasound is potential in clinical assessment of knee osteoarthritis and rheumatoid arthritis parameters as a complementary tool for a clinician. In line with our results, Koski et al. reported that ultrasound is more sensitive than radiography in the determination of osteophytes in the medial compartment of the knee joint.[18]

According to recent study, a grouping of imaging modalities is needed to detect all features involved in knee osteoarthritis and rheumatoid arthritis especially when a source of pain is not obvious.[3,19] Ultrasound could reveal early morphological knee osteoarthritis and rheumatoid arthritis of individual features when only minor radiographic degeneration is present and then is known to be a strong predictor of knee osteoarthritis and rheumatoid arthritis.[20] There are increasing reports that US has key role in the controlling of patients with knee osteoarthritis and rheumatoid arthritis.[21] But the main limitation of these reports are operator dependency and then limit the widespread use of US.[22-24] Currently, available information about reproducibility, in particular for a large number of observers, is limited. For comparing US results, an inter-observer agreement has so far only been calculated between two observers.[24,25] Although, Naderlo et al. showed that moderate to good correlations between 14 independent observers.[11] In this study, overall k value is higher than reported when two observers were compared (range 0.48–0.68).[25,26] This difference may be due to participants have experienced sonographers and may have paid more attention than usual.

In line with our results, Breitenseher et al., Miller et al., and Fam et al. reported effusion, MMP and Baker's cyst have been the principal findings between in knee osteoarthritis and rheumatoid arthritis parameters in MRI and US finding.[12,27-29] Hill et al.[12] reported a strong association between effusion and pain in knee OA. Also, Naredo et al. reported that effusion was associated with pain intensity on motion and at rest independently of radiographic OA severity, age, disease duration and BMI.[11]

For the knee joint the overall agreement of US findings with MRI was 89%. The overall sensitivity for US of the knee joint was 95.59%, the overall specificity 81.88%. In particular, US was very sensitive in the detection of knee osteoarthritis and rheumatoid arthritis parameters. Nogueira-Barbosa et al. reported excellent performance of ultrasound assessment of medial meniscal extrusion defined by 2 mm threshold in patients with chronic knee pain in comparison to MRI.[30] The differences might be caused by distinct measurement setup as standardized measurement method by ultrasound has not yet been established.

CONCLUSION

Ultrasound assessment of the knee joint is an accurate imaging method for detection of knee osteoarthritis and rheumatoid arthritis parameters in patients with knee osteoarthritis and rheumatoid arthritis. Ultrasound is superior to conventional radiography in the detection of effusion, MMP

and Baker's cyst and can discern effusion, MMP and Baker's cyst directly. Knee ultrasound could be employed as a complementary imaging technique to radiography, especially when MRI is not justified, to possibly clarify tissue-specific structural OA degeneration not depicted by radiographs.

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