Relationship between ultrasonographic findings and subscales of the Knee Injury and Osteoarthritis Outcome Score in patients with early knee osteoarthritis: a multicenter study

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INTRODUCTION:
Knee osteoarthritis (KOA) is a degenerative joint disease that negatively affects activities of daily living (ADL) and quality of life (QOL). As the number of individuals affected by KOA continues to increase globally, the need for early detection and intervention has become increasingly important. To address the necessity of early diagnosis, the concept of “early KOA” was introduced in 2018. Early KOA refers to patients who experience knee symptoms that interfere with daily life yet are classified as Kellgren–Lawrence (K-L) grade 0 or 1. These cases suggest that degenerative structural changes in joint tissues such as the meniscus and cartilage may precede radiographic findings. Magnetic resonance imaging (MRI) has traditionally been considered valuable for detecting such subtle changes, but it is not routinely used due to cost and accessibility. Ultrasonography (US), in contrast, is more accessible and less expensive, and is gaining attention as a diagnostic modality. Nevertheless, the diagnostic relevance of US in early KOA remains unclear. In particular, there is limited information on characteristic US findings in early KOA and how they relate to clinical symptoms. This study aimed to identify US features typical of early KOA and to evaluate their association with patient-reported outcomes using the Knee Injury and Osteoarthritis Outcome Score (KOOS) subscales.
METHODS: This prospective study included 98 patients (98 knees; 35 men and 63 women; mean age, 60.3 ± 11.5 years; BMI, 24.1 ± 5.7 kg/m²) who presented with medial knee pain and tenderness between August 2022 and March 2024. All participants were radiographically graded as K-L 0 or 1. Each patient underwent a standardized US evaluation and completed the validated Japanese version of KOOS (J-KOOS), which includes five subscales: symptoms, pain, ADL, sports, and QOL. US was used to assess 11 items: synovial hyperplasia in the suprapatellar bursa, knee joint effusion, horizontal tear of the medial meniscus (MM), osteophytes of the medial condyles of the femur and tibia, blood flow signals in the suprapatellar synovium, medial collateral ligament (MCL) bursa, and infrapatellar fat pad, MM extrusion (MME) in both supine and upright positions, and the difference between those (ΔMME). KOOS scores ranged from 0 to 100, with higher scores indicating better status. Correlations between US findings and KOOS subscale scores were evaluated using Spearman’s rank correlation coefficients. Statistical significance was defined as $p < 0.05$.
RESULTS: Among all patients, synovial hyperplasia in the suprapatellar bursa and joint effusion were observed in 9.2% and 38.8%, respectively. Horizontal MM tears were found in 60.2%, while osteophytes were identified in 48.0% (femoral condyle) and 61.2% (tibial condyle). Mild or greater blood flow signals were detected in 30.6% of the suprapatellar synovium, 45.9% of the MCL bursa, and 24.5% of the infrapatellar fat pad. The mean MME was 2.69 mm in the supine and 3.12 mm in the upright position (Table 2). Mean KOOS scores were as follows: symptoms 65.0, pain 59.2, ADL 73.5, sports 44.3, and QOL 39.7 (Table 3). Statistically significant correlations were found between the presence of synovial hyperplasia, joint effusion, and MME in the upright position and all KOOS subscales. In contrast, MME in the supine position was associated only with pain. All observed correlations were statistically weak (Table 4).
DISCUSSION AND CONCLUSION: Previous studies have reported associations between US-detected synovial abnormalities and KOA-related symptoms, especially pain and reduced function. However, in early KOA, synovial hyperplasia was rare and joint effusion was present in only about one-third of patients, likely due to a shorter disease duration. Although increased blood flow in synovial tissues has been linked to knee symptoms, no such associations were observed in the present study, suggesting that early KOA may involve milder synovitis. The correlation between supine MME and pain supports previous findings. Additionally, this study was the first to report an association between upright MME and all KOOS subscales. Because ADL activities are mostly performed in upright positions, upright MME may better reflect functional limitations. While these associations were weak, they may still offer clinically useful insight. In conclusion, synovial hyperplasia, joint effusion, and upright MME were significantly associated with KOOS subscale scores. These findings suggest that US may provide useful information regarding functional impairment in patients with early KOA.

Table 1. Patients' information

Parameter	
Sex (patients: male and female)	35 and 63
Age (years; mean ± SD)	60.3 ± 11.5
Height (cm; mean ± SD)	161.6 ± 9.4
Weight (kg; mean ± SD)	62.7 ± 13.2
Body mass index (kg/m^2; mean ± SD)	24.1 ± 5.7
Involved side (knee; right and left)	51 and 47

SD: standard deviation

Table 2. Summary of ultrasonographic findings in patients with early knee osteoarthritis

Parameter		Positive rate
Synovial hyperplasia in the suprapatellar bursa (negative and positive)	89 and 9	9.2%
Knee joint effusion (negative and positive)	60 and 38	38.8%
Horizontal tear of the medial meniscus (negative and positive)	39 and 59	60.2%
Osteophyte of the medial condyle of femur (negative and positive)	51 and 47	48.0%
Osteophyte of the medial condyle of tibia (negative and positive)	38 and 60	61.2%
Blood flow signals in the synovium of the suprapatellar bursa (absent, mild, moderate, marked or severe; positive: mild, moderate, marked or severe)	68, 21, 7, or 2	30.6%
Blood flow signals in the MCL bursa (absent, mild, moderate, and marked or severe, positive: mild, moderate, and marked or severe)	51, 23, 14, or 8	45.9%
Blood flow signals in the infrapatellar fat pad (absent, mild, moderate, marked or severe; positive: mild, moderate, marked or severe)	74, 18, 5, or 1	24.3%
MME in supine position (mm; mean ± SD)	2.69 ± 1.19	-
MME in upright position (mm; mean ± SD)	3.12 ± 1.23	-
Amount of change in MME (mm; mean ± SD)	0.43 ± 0.85	-

MCL: medial collateral ligament, MME: medial meniscus extrusion, SD: standard deviation.

Table 3. Summary of Knee Injury and Osteoarthritis Outcome Scores (KOOS) in patients with early knee osteoarthritis

Parameter	mean ± SD (points)	Median	Minimum value	Maximum value
Symptom	65.8 ± 19.3	67.9	14.3	100
Pain	59.2 ± 18.5	58.3	8.3	94.4
ADL	73.5 ± 17.0	75.0	27.9	100
Sports	44.3 ± 26.0	40.0	0	100
QOL	38.7 ± 22.3	37.5	6.3	100

SD: standard deviation; ADL: activities of daily living; QOL: quality of life.

Table 4. Correlation between ultrasonographic findings and Knee Injury and Osteoarthritis Outcome Score (KOOS) subscales in patients with early knee osteoarthritis

	Symptom	Pain	ADL	Sports	QOL
Synovial hyperplasia in the suprapatellar bursa	-0.224*	-0.230*	-0.282**	-0.298**	-0.208*
Knee joint effusion	-0.366**	-0.233*	-0.389**	-0.217*	-0.194
Horizontal tear of the medial meniscus	-0.011	0.022	-0.045	-0.003	0.015
Osteophyte of the medial condyle of femur	-0.104	-0.159	-0.036	-0.058	-0.092
Osteophyte of the medial condyle of tibia	-0.002	0.112	0.158	0.002	0.051
Blood flow signals in the synovium of the suprapatellar bursa	-0.142	-0.138	-0.132	-0.102	-0.098
Blood flow signals in the MCL bursa	0.018	-0.166	-0.044	0.014	0.049
Blood flow signals in the infrapatellar fat pad	0.006	-0.001	0.026	0.001	0.187
MME in supine position	-0.140	-0.194	-0.197	-0.101	-0.188
MME in upright position	-0.359**	-0.334**	-0.270*	-0.248*	-0.265**
Amount of change in MME	-0.156	-0.121	-0.069	-0.083	-0.084

* $p < 0.050$

** $p < 0.010$

ADL: activities of daily living, QOL: quality of life, MCL: medial collateral ligament, MME: medial meniscus extrusion.

All the values in the table indicate correlation coefficients.