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ORIGINAL RESEARCH

Association Between the Severity of Femoral Condylar Cartilage Erosion Related to Knee Osteoarthritis by Ultrasonographic Evaluation and the Clinical Symptoms and Functions

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Abstract

Objective: To determine the association between the severity of femoral condylar cartilage erosion resulting from knee osteoarthritis (OA) by an ultrasonographic grading system and the clinical symptoms and functions.

Design: Cross-sectional study.

Setting: A tertiary center.

Participants: Participants (N=101) with and without subjective complaints of knee discomfort were consecutively enrolled. Patients who had ever received knee arthroplasty, who had inflammatory arthritis, and whose knee flexion range of motion was <90° were excluded. A total of 194 knees were evaluated.

Interventions: Not applicable.

Main Outcome Measures: A semiquantitative ultrasonographic grading system was used to evaluate the severity of femoral condylar cartilage erosion. The clinical symptoms and functions were evaluated with the visual analog scale (VAS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), and Lequesne index. The association of the VAS/WOMAC/Lequesne index with the ultrasonographic grading was assessed.

Results: Positive linear associations were found between the ultrasonographic grading and the following: the VAS and the total scores and pain subscales of both the Lequesne index and WOMAC. Multivariate logistic regression analysis revealed grade-dependent association between VAS and ultrasonographic grading after adjusting for age, sex, and body mass index. The WOMAC and Lequesne index scores were associated with the ultrasonographic grading in more severe degrees, particularly in the pain subscales.

Conclusions: This semiquantitative ultrasonographic grading system may well reflect the clinical symptoms and functions related to knee OA as evaluated by the VAS, WOMAC, and Lequesne index. This method provides a more comprehensive description and measurement of knee OA.
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Knee osteoarthritis (OA) is a musculoskeletal disease of high prevalence.[1] The common symptoms of knee OA, including pain, joint stiffness, deformity, and muscle weakness, limit the ability of patients to achieve daily activities and influence their quality of life and social participation.[2-4] Therefore, early diagnosis and early treatment, or even prevention, would be of great benefit.

Currently, various diagnostic tools for knee OA are available, including noninvasive approaches, such as radiography, ultrasonography, and magnetic resonance imaging (MRI), and invasive approaches, such as arthroscopy. Radiography is most widely used

in clinical practice for its convenience and good detection of bony changes,[5] but it is less sensitive for evaluating the early changes of soft tissue structures.[6] Additionally, the measurement of joint space narrowing by radiograph is being debated,[7] and the radiograph is less sensitive for longitudinal follow-up of minor changes in cartilage thickness.[8] MRI provides a reliable assessment of the morphologic changes of articular cartilage in knee OA[9] and has potential for evaluating disease progression[10]; however, it is less accessible and more time-consuming and has a higher cost. Arthroscopy provides a direct and thorough inspection of articular cartilage surface defects, but it is an invasive procedure, limiting its use in routine assessments.[11]

Ultrasonography is a noninvasive imaging tool that is increasingly studied for its validity and reliability in evaluating periarticular soft tissue and cartilage changes in knee OA.[12-14] Ultrasonography involves no exposure to radiation and is generally accepted by patients. The changes in echogenicity in the earlier stages of cartilage erosion can be detected by ultrasonography, while the radiograph is less sensitive for detecting early cartilage change. A semiquantitative grading system was established using ultrasonography to evaluate the femoral condylar cartilage, while the patella cartilage and tibial cartilage were not included.[15] This semiquantitative grading system has been demonstrated to correlate quite well with histologic grading. The interobserver reliability was moderate, with a weighted kappa value of .67.[15] Other studies[16,17] also reported good interobserver reliability for the measurement of cartilage thickness. The usefulness of ultrasonography in knee OA to grade changes in articular cartilage semiquantitatively has also been validated by arthroscopic grading.[18]

According to the *International Classification of Functioning, Disability and Health* (ICF), a comprehensive description and measurement of health and disability status should take into account not only structural damage but also functioning and the impact related to the dysfunction and disability.[19] The severity of knee OA can be determined by imaging features,[20] clinical features,[21] or both. A suitable imaging tool for use in clinical measurement and the follow-up of patients with knee OA should correlate well with the clinical symptoms and functional evaluation.

The clinical features of knee OA are more often assessed with a pain scale such as the visual analog scale (VAS),[22] and questionnaires such as the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)[21] and the Lequesne index.[23] The WOMAC was first proposed and validated by Bellamy et al[21] in 1988 for the clinical evaluation of hip and knee OA. The Lequesne index was first developed by Lequesne et al[23] for evaluating the severity of hip and knee OA.

List of abbreviations:

ADL	activities of daily living
BMI	body mass index
ICF	*International Classification of Functioning, Disability and Health*
GEE	generalized estimating equation
MRI	magnetic resonance imaging
OA	osteoarthritis
VAS	visual analog scale
WOMAC	Western Ontario and McMaster Universities Osteoarthritis Index

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The association between image grading and clinical presentations has been discussed widely. The concordance between clinical and radiographic knee OA remains controversial.[24-26] Similarly, the correlations between MRI findings, knee OA clinical features, and the WOMAC remain inconclusive.[9,27,28] Previous studies[14,29,30] have linked ultrasonographic features to clinical symptoms, but mainly the known secondary features of knee OA. Kazam et al[31] first assessed the correlation between knee pain and ultrasonographic characteristics of femoral trochlear cartilage change. However, the clinical features evaluated remain limited.

In this study, we aimed to determine more comprehensively the association between the ultrasonographic grading of femoral condylar cartilage erosion related to knee OA and the clinical symptoms and functions of participants with varying degrees of knee discomfort. We also aimed to prove that this semiquantitative ultrasonographic grading system correlated well with the clinical presentation, thus providing additional evidence that ultrasonography can be used as an adjuvant clinical assessment tool for evaluating articular cartilage health.

Methods

Participant selection

Participants with and without subjective complaints of knee discomfort presenting to a health examination clinic and rehabilitation clinic in a tertiary center were consecutively enrolled and evaluated. Participants who had ever received knee arthroplasty or those with inflammatory arthritis were excluded. Both knees of the same participant were treated as independent examined knees in this study. Examined knees with knee flexion range of motion of <90° were excluded. The study was approved by the Institutional Review Board of Kaohsiung Medical University Hospital. One hundred fifty-one eligible participants were approached, and 50 subjects declined to participate. In total, 101 participants were included. Every participant gave informed consent before being enrolled in the study.

Clinical symptoms and functional evaluation

General demographic features, including sex, age, height, body weight, and treatments received in the past 3 months, were obtained during patient interviews. The clinical symptoms and functional evaluation using the VAS and the WOMAC and Lequesne index questionnaires were recorded by a well-trained research assistant who was familiar with these questionnaires.

The severity of self-reported knee pain was evaluated by a 0- to 10-point VAS, with "maximal pain" scored as 10 and "no pain" as 0. Each knee was evaluated for VAS after 5 minutes of standing and average VAS in the past 3 months.

The WOMAC questionnaire assesses 3 subscales: pain, stiffness, and physical function. The total WOMAC score ranges from 0 to 96, with a pain subscale score from 0 to 20, stiffness subscale score from 0 to 8, and physical function subscale score from 0 to 68. Higher scores represent worse symptoms or functions. Each knee was evaluated independently for the pain subscale; for the stiffness and physical function subscales, in which the score of each question represented the global performance, both knees of the participant were given the same score.

The Lequesne index also includes 3 subscales: pain, maximum distance walked, and activities of daily living (ADL). The total