Relationship between quantitative magnetic resonance imaging and clinical symptoms in patients with knee osteoarthritis

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To the Editor: Quantitative magnetic resonance imaging (MRI) objectively evaluates the degeneration of cartilage in knee osteoarthritis (KOA) patients by measuring changes in proteoglycans, collagen fibers, and water content, thereby facilitating early clinical diagnosis and treatment.[1] Western Ontario and MacMaster Universities (WOMAC) osteoarthritis index score is used to evaluate the symptoms of KOA patients.[2] Presently, few studies have evaluated the correlation between quantitative MRI findings and clinical symptoms (eg., study performed by Zarins *et al*[3]). This study explored the relationship between quantitative MRI in T1rho and T2-mapping sequence and WOMAC osteoarthritis index scores of KOA patients.

This study was approved by the Ethics Committee of Peking University Third Hospital (IRB00006761-M2017127) and registered at the Chinese Clinical Trial Registry (ChiCTR-ROC-17013790). The authors certify that they have obtained all appropriate patient consent forms. Patients with primary KOA were included.[4] Patients with knee joint pain caused by diseases other than KOA; secondary KOA; serious varus or valgus or flexion contracture; cruciate ligament tear, discoid meniscus, meniscus injury resulting in joint interlocking; and a history of knee surgery and those unable to complete the examination were excluded. For patients with bilateral KOA, the knee joint with more obvious symptoms was studied.

General data were collected and clinical symptoms were evaluated using WOMAC osteoarthritis index score scale, which has 24 questions, with five levels each (0 = none, 4 = severe), including pain, stiffness, and function scores. Patients with total WOMAC osteoarthritis index scores <21, 21 to 48, and >48 were classified into mild, moderate, and severe clinical symptom groups.[2] All scores were evaluated by the same orthopedists.

The conventional MRI sequence (sagittal proton-density weighted images [PDWI], T1 weighted images [T1WI], coronary PDWI, axial PDWI), and quantitative MRI sequence scans (sagittal T1rho and T2-mapping) were performed on a 3.0T MRI scanner (Discovery 750W, GE, USA). The Functool software (GE) was used for post-processing to generate pseudo-color graphs. T1rho and T2 mapping values in five regions were obtained: medial femoral condylar cartilage (MFCC), lateral femoral condylar cartilage (LFCC), medial tibial plateau cartilage (MTPC), lateral tibial plateau cartilage (LTPC), and patella cartilage. The most severe damaged parts of the cartilage in each region were delineated. Supplementary Figure 1, http://links.lww.com/CM9/A241 shows the MRI image of a typical case. All quantitative MRI values were measured twice by the same radiologist at a 1-month interval.

SPSS 18.0 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. Intra-class correlation coefficient (ICC) analysis was performed to evaluate the consistency between two measurements. Tests for normality were conducted by Shapiro-Wilk test. Age, height, weight, and body mass index (BMI) were present as mean ± standard deviation; other variables were presented as medians and interquartile range. The Mann-Whitney *U*-test was used to compare variables in different sexes and clinical symptom groups. Spearman rank correlation was used to analyze the correlation between MRI measurements and other variables. The test level α value is 0.05 on both sides.

Of 53 patients (16 males, 37 females) included from December 2017 to March 2018, 34, 15, and four patients were included in the mild, moderate, and severe clinical

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Table 1: Correlation between the Western Ontario and MacMaster Universities osteoarthritis index scores and quantitative magnetic resonance imaging values on the T1rho/T2-mapping sequence.

Score	Statistics	T1rho/T2-mapping value of MFCC	T1rho/T2-mapping value of LFCC	T1rho/T2-mapping value of MTPC	T1rho/T2-mapping value of LTPC	T1rho/T2-mapping value of PC	Sum of T1rho/T2-mapping values
Pain score	*r*	0.366/0.190	0.116/−0.108	0.234/0.055	−0.005/0.159	0.042/0.035	0.247/0.227
	P	0.007/0.172	0.407/0.443	0.092/0.696	0.972/0.254	0.763/0.801	0.074/0.102
Stiffness score	*r*	0.355/0.262	0.277/0.053	0.249/−0.052	0.112/0.107	0.046/0.047	0.317/0.211
	P	0.009/0.058	0.045/0.706	0.073/0.710	0.424/0.444	0.742/0.739	0.021/0.129
Function score	*r*	0.402/0.338	0.150/−0.076	0.306/0.087	−0.001/0.135	0.094/0.066	0.307/0.306
	P	0.003/0.013	0.285/0.587	0.026/0.537	0.995/0.334	0.501/0.636	0.025/0.026
Total score	*r*	0.369/0.323	0.178/−0.049	0.239/0.030	−0.015/0.141	0.023/0.026	0.246/0.250
	P	0.007/0.018	0.203/0.729	0.085/0.831	0.917/0.315	0.872/0.854	0.075/0.071

MFCC: Medial femoral condylar cartilage; LFCC: Lateral femoral condylar cartilage; MTPC: Medial tibial plateau cartilage; LTPC: Lateral tibial plateau cartilage; PC: Patella cartilage.

symptom groups, respectively. The results of the two quantitative MRI measurements were consistent (ICC > 0.90); thus, the average value was considered as the final result. The quantitative MRI value on the T1rho and T2-mapping sequences and WOMAC osteoarthritis index scores did not show normal distribution ($P < 0.01$). Supplementary Table 1, http://links.lww.com/CM9/A241 shows the demographic characteristics, clinical symptoms, and quantitative MRI values.

The WOMAC osteoarthritis index scores and quantitative MRI values were not significantly different between the sexes ($P > 0.05$). Significant correlations were not found between age, height, weight, BMI, and WOMAC osteoarthritis index scores or quantitative MRI values ($P > 0.05$).

The T1rho value of the MFCC was correlated with the pain score; the T1rho values of the MFCC and LFCC and the sum of T1rho values were correlated with the stiffness score; the T1rho values of the MFCC and MTPC and the sum of T1rho values were correlated with the function score; the T1rho value of the MFCC was correlated with the total score; the T2-mapping value of the MFCC and the sum of T2-mapping values were correlated with the function score; and the T2-mapping value of the MFCC was correlated with the total score (all $P < 0.05$) [Table 1].

No significant differences in sex, age, height, weight, and BMI ($P > 0.05$) existed between the mild clinical symptom group and moderate and severe clinical symptom groups. The T1rho values of the MFCC, LFCC, and MTPC were significantly different between the mild clinical symptom group and the moderate and severe clinical symptom group, while T2-mapping values of MFCC and LTPC were significantly different ($P < 0.05$) [Supplementary Table 2, http://links.lww.com/CM9/A241].

The current study found a correlation between quantitative MRI values of cartilage and WOMAC osteoarthritis index scores in KOA patients, suggesting that quantitative MRI values of the cartilage can reflect clinical symptoms; the clinical symptoms may be caused by cartilage damage. Particularly, quantitative MRI values of the MFCC may be more correlated with clinical symptom than those of other regions of the knee joint. This may be related to the degeneration mechanism of the cartilage, with the medial part of the knee joint more prone to degeneration owing to greater load-bearing pressure than the lateral part.[4] We also found the T1rho values showed stronger correlations with clinical symptoms than the T2-mapping values. This might be attributed to the early stage of cartilage damage, mainly manifested through a decrease in proteoglycans on the T1rho sequence without obvious changes in the collagen fiber content on T2-mapping sequences.[5] The T1rho values of the MFCC, LFCC, and MTPC and T2-mapping values of the MFCC and LTPC were higher in the mild and severe clinical symptoms group than in the mild clinical symptom group, suggesting patients with severe clinical symptoms may develop lateral cartilage lesions based on medial cartilage lesions.

Therefore, quantitative MRI, particularly quantitative MRI values of the MFCC and T1rho sequence, could appropriately reflect clinical symptoms in KOA patients.

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Conflicts of interest

None.

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