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Ultrasonographic Measurement of Femoral Cartilage Thickness in Patients with Knee Osteoarthritis

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Abstract

The aim of this study was to investigate the femoral cartilage thickness (FCT) by ultrasound in patients with knee osteoarthritis and compare them with those of healthy subjects.

Methods and Results: This cross-sectional study included 44 patients diagnosed with knee osteoarthritis (OA) and 49 healthy subjects. The FCT was measured using an L5-18 MHz linear probe. Measurements were taken from both knee joints in three regions: the medial condyle, lateral condyle, and intercondylar area. Our results showed thinner cartilage in OA patients than in the healthy subjects at the three examined locations bilaterally (medial condyle, lateral condyle, intercondylar area). In OA patients, FCT correlated positively with body mass index at the right lateral condyle, right intercondylar area, and left medial condyle (P<0.05).

***Conclusion*:** Our study revealed thinner FCT in patients with knee OA than in healthy subjects. Further studies considering the stratification of different stages of OA could yield better results.(**International Journal of Biomedicine. 2022;12(1):29-33.**)

Key Words: osteoarthritis • femoral cartilage thickness • ultrasound

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Abbreviations

BMI, body mass index; **FCT**, femoral cartilage thickness; **LIC**, left intercondylar area; **LLC**, left lateral condyle; **LMC**, left medial condyle; **MRI**, magnetic resonance imaging; **OA,** osteoarthritis; **RIC**, right intercondylar area; **RLC**, right lateral condyle; **RMC**, right medial condyle.

Introduction

Osteoarthritis (OA) of the knee is a common degenerative synovial joint disorder and is a significant cause of chronic pain and disability associated with structural and functional loss. It can result in morbidity and socioeconomic loss, particularly in the aging population.[1-4] OA of the knee is characterized by focal degeneration and progressive loss of the articular cartilage.[5] Femoral articular cartilage is hyaline type. It is composed of an extracellular matrix and chondrocytes.[4] The significance of correct assessment of the articular cartilage is increasing, especially with the development of new treatments for OA, like disease-modifying drugs, osteochondral autografting, and autologous chondrocyte implantation.[1,6] Successful assessment of disease progression and response to treatment that could control the course of the OA depend on finding a suitable method for assessing cartilage thickness.[5] The use of plain films was considered the main radiological tool for diagnosing knee OA. It reveals gross joint narrowing, including the meniscus as a proportion of the joint space. Conventional radiography does not directly visualize cartilage surface, and the correlation of the clinical symptoms with the width of the joint space could be misleading. CT can only determine surface defects of cartilage thickness, with the risk of high dose ionizing radiation and relatively high price.[1,4,6] MRI is a safe imaging modality that uses three-dimensional fat-suppressed spoiled gradient-recalled steady-state (3D SPGR), acquisition with high sensitivity to detect focal cartilage defects. However, MRI is an expensive modality, with limited accessibility, in addition to several problems with claustrophobic patients and patients with non-compatible metallic prostheses.[1]

Ultrasonography is also a safe technique, which is well tolerated by patients. It is thought to detect cartilage defects and bone erosions in the early phases of OA.[1] The aim of this study was to investigate the femoral cartilage thickness (FCT) by ultrasound in patients with knee osteoarthritis and compare them with those of healthy subjects.

Materials and Methods

Participants in the study were recruited between March 2020 and May 2020. This cross-sectional study included 44 patients diagnosed with knee OA, according to the American College of Rheumatology criteria. The study also involved 49 healthy subjects. Healthy subjects enrolled in the study had the following features: female or male, and no history of knee pain. For each participant, data including sex, age, weight, BMI, and height were acquired. Written informed consent was obtained from all participants.

Sonographic examination

The patients were investigated using an ultrasound machine equipped with an L5-18 MHz linear probe (Epic 5 Ultrasound system: Philips, Bothell, WA). Two radiologists with 7 years of experience in musculoskeletal ultrasound performed all studies. Three scans were performed for all participants. The probe was placed in the short axis above the patella. All participants were examined in a supine position with flexion of the knee joint. Measurements were taken from both knee joints in three regions: the medial condyle (RMC/LMC), lateral condyle (RLC/LLC), and intercondylar area (RIC/LIC) (Fig.1).

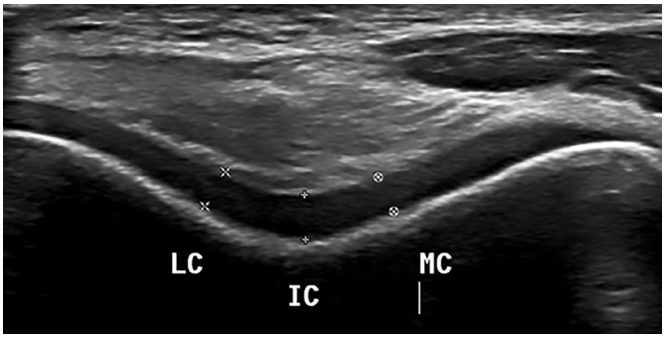

***Fig. 1. S**hort axis image of the femoral cartilage in a healthy subject. LC - lateral condyle, IC - intercondylar area, MC - medial condyle.*

Statistical analysis was performed using the standard Statistical Package for the Social Sciences (IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp). Continuous variables were presented as mean±standard deviation (SD). For data with normal distribution, inter-group comparisons were performed using Student's t-test. The frequencies of categorical variables were compared using Pearson's chi-squared test A probability value of $P<0.05$ was considered statistically significant.

Results

Measurements were taken from 88 knees of 44 OA patients (15 males, 29 females) with a mean age of 51.52±8.77 years [range 33-67], mean height of 160.45±10.03 cm [range 144-184], mean weight of 83.00±17.45 kg [range 56-123], and mean BMI of 32.28±5.50 kg/m^2 [range 24.2-49.9].

A total of 98 knees were included from 49 healthy subjects (30 males, 19 females) with the mean age of 31.73±7.80 years [range 17-62], mean height of 162.20±10.87 cm [range 135-195], mean weight of 65.99±16.54 kg [range 44-125], and mean BMI of 24.93±4.32 kg/m^2 [range 16.6-35.7]. The demographic features of OA patients and healthy subjects are shown in Table 1.

Table 1.

The demographic characteristics of OA patients and healthy subjects

Variable	Patients (n=44)	Control (n=49)	P-value
Age, years	51.52±8.77	31.73±7.80	<0.0001
Female, n (%)	29 (65.90)	19 (38.78)	
Male, n (%)	15 (34.10)	30 (61.22)	
Weight, kg	83.00±17.45	65.99±16.54	<0.0001
Height, cm	160.45±10.03	162.20±10.87	>0.05
BMI, kg/m^2	32.28±5.50	24.93±4.32	<0.0001

Table 2.

FCT (cm) in OA patients and healthy subjects

	Patients (n=44)		Control (n=49)		*P*-value
	Female (n=29) (1)	Male (n=15) (2)	Female (n=19) (3)	Male (n=30) (4)	
RIC	0.22±0.05	0.20±0.06	0.23±0.02	0.24±0.04	P_{1-3}>0.05 P_{2-4}=0.01
RMC	0.19±0.04	0.18±0.07	0.21±0.03	0.23±0.03	P_{1-3}>0.05 P_{2-4}=0.01
RLC	0.20±0.04	0.19±0.05	0.22±0.02	0.22±0.03	P_{1-3}<0.05 P_{2-4}=0.01
LIC	0.21±0.05	0.19±0.06	0.23±0.04	0.23±0.04	P_{1-3}>0.05 P_{2-4}=0.01
LMC	0.19±0.07	0.19±0.05	0.21±0.03	0.22±0.03	P_{1-3}>0.05 P_{2-4}=0.01
LLC	0.20±0.04	0.19±0.04	0.21±0.03	0.22±0.03	P_{1-3}>0.05 P_{2-4}<0.01

Table 3.

Correlations between demographic factors and FCT (cm) in OA patients

	RIC	RMC	RLC	LIC	LMC	LLC
Age	0.065	- 0.101	0.062	0.172	0.048	0.074
Sig	0.718	0.516	0.690	0.264	0.756	0.633
Weight	0.233	0.192	0.276	0.162	0.118	0.212
Sig	0.128	0.212	0.070	0.295	0.444	0.168
Height	0.008	0.024	0.024	0.010	0.009	0.03
Sig	0.959	0.878	0.877	0.950	0.955	0.780
BMI	**0.306**	0.227	**0.347**	0.212	0.155	0.246
Sig	**0.044**	0.138	**0.021**	0.168	0.314	0.107

Table 4.

Correlations between demographic factors and FCT in healthy subjects

	RIC	RMC	RLC	LIC	LMC	LLC
Age	0.064	- 0.013	0.063	0.112	0.074	- 0.080
Sig	0.662	0.928	0.669	0.445	0.612	0.583
Weight	0.270	0.225	0.112	0.046	0.244	0.168
Sig	0.060	0.121	0.444	0.754	0.092	0.248
Height	**0.336**	0.265	0.290	0.005	**0.319**	0.194
Sig	**0.018**	0.066	0.043	0.974	**0.025**	0.181
BMI	0.131	0.164	- 0.048	0.126	0.175	0.114
Sig	0.370	0.261	0.745	0.390	0.230	0.435

The intra-observer reliability was 0.80. Measurements of the mean FCT showed statistically significant lower values in patients with knee OA than in healthy subjects in the six parameters. In OA patients, FCT correlated positively with BMI at the RLC, RIC, and LMC (P<0.05). Other demographic factors showed no significant correlation with FCT in OA patients. In healthy subjects, the FCT correlated positively with height at the RLC, RIC, and LMC (P<0.05). Other demographic factors showed no significant correlation with the FCT in healthy subjects (Tables 2-6).

Table 5.

Independent t-test comparing FCT (cm) in OA patients

	Gender	n	Mean	SD	t-statistic	Sig
RIC	Female	29	0.22	0.05	1.175	0.2468
	Male	15	0.20	0.06		
RMC	Female	29	0.19	0.04	0.605	0.5484
	Male	15	0.18	0.07		
RLC	Female	29	0.20	0.04	0.721	0.4747
	Male	15	0.19	0.05		
LIC	Female	29	0.21	0.05	1.175	0.2468
	Male	15	0.19	0.06		
LMC	Female	29	0.19	0.07	0.000	1.0000
	Male	15	0.19	0.05		
LLC	Female	29	0.20	0.04	0.786	0.4382
	Male	15	0.19	0.04		

Table 6.

Independent t-test comparing FCT (cm) in healthy subjects

	Gender	n	Mean	SD	t-statistic	Sig
RIC	Female	19	0.23	0.02	1.010	0.3177
	Male	30	0.24	0.04		
RMC	Female	19	0.21	0.03	2.274	0.0276
	Male	30	0.23	0.03		
RLC	Female	19	0.22	0.02	0.000	1.0000
	Male	30	0.22	0.03		
LIC	Female	19	0.23	0.04	0.000	1.0000
	Male	30	0.23	0.04		
LMC	Female	19	0.21	0.03	1.137	0.2613
	Male	30	0.22	0.03		
LLC	Female	19	0.21	0.03	1.137	0.2631
	Male	30	0.22	0.03		

Discussion

In this study, we evaluated FCT by ultrasound in knees of OA patients and whether the result is related to any of the demographic factors. Ultrasonography is a cheap, non-invasive diagnostic tool for examining the knee joint. Cartilage appears in ultrasound as homogenously anechoic with a distinct bone margin. Ultrasound can also assess the collateral ligaments and patellar tendon, in addition to effusion and bursitis.[5] The importance of ultrasound in the diagnosis of knee OA has increased over the last twenty years.[1] The knee joint is usually involved by OA, ending with injury of the articular cartilage. Articular cartilage consists of two phases: a fluid phase, and a solid phase. The interactions of the components of these two phases support articular cartilage to resist compressive forces.[7] Several studies reported the FCT assessment in healthy adults and in different sets of diseases.[8-13] Our study focuses on OA as one of the most prevalent disorders affecting the knee joint with significant morbidity and socioeconomic loss. Assessment of cartilage thickness is essential for early detection of OA, follow-up of disease progression, and evaluation of treatment. Cartilage thickness may increase in the earlier cases of OA; however, well-established OA is characterized by narrowed tibiofemoral cartilage, erosions, and cartilage loss in late disease. Accurate measurement of cartilage thickness can be very useful clinically for detecting focal cartilage defects.[6,14] During the course of knee OA, as mentioned in previous studies, cartilage loss starts in the medial tibiofemoral compartment and then progresses to the lateral tibiofemoral compartment.[15] In our study, FCT was thinner in patients with knee OA than in healthy subjects at the medial condyle, lateral condyle, and intercondylar region. Our results showed thinner cartilage in OA patients than in the healthy subjects at the three examined locations bilaterally (medial condyle, lateral condyle, intercondylar area) (Figure 2). BMI showed a correlation with three out of six measurements in OA in our study. Compared to Ozgonenel et al.,[14] our measurements were lower at both condyles together with the intercondylar area. This is likely attributed to the recruitment of early cases of knee OA in that study.

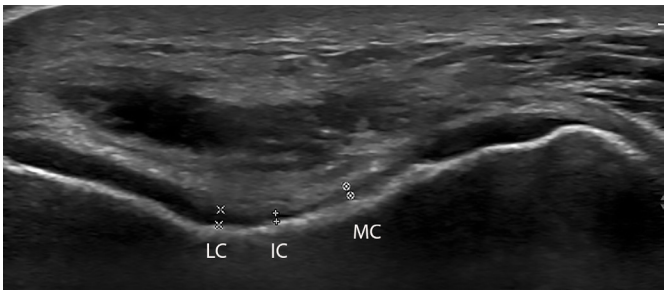

Fig. 2. *Long axis image of the femoral cartilage in an osteoarthritic patient. LC- lateral condyle, IC - intercondylar area, MC - medial condyle.*

The present study has limitations. First, the sample population is heterogeneous, which limits the generalization of the results. Second, the sample size is relatively small.

Conclusion

Our study revealed thinner FCT in patients with knee OA than in healthy subjects. Further studies considering the stratification of different stages of OA could yield better results.

Competing Interests

The authors declare that they have no competing interests.

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