

# Ultrasonographic measurement of femoral cartilage thickness in type II diabetic patients

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## Abstract

The aim of this study is to compare the distal femoral cartilage thickness of patients with type II diabetes mellitus with those of healthy subjects using ultrasonography. The study comprised 34 patients and 36 healthy subjects. Demographic characteristics of all the participants were recorded. The thickness of the femoral articular cartilage was measured using a 5-18MHz linear probe. Measurements were performed bilaterally from three points (intercondylar area, medial condyle, and lateral condyle). No significant difference could be found between patients and healthy subjects. Two demographic characteristics correlated positively with diabetic patients.

**Abbreviations:** DM = type II diabetes mellitus, MRI = magnetic resonance imaging, OA = Osteoarthritis.

**Keywords:** diabetes mellitus, femoral cartilage thickness, ultrasound

## 1. Introduction

In the last 2 decades the incidence of diabetes mellitus is increasing. Basically, type II diabetes mellitus (DM) is associated with insulin resistance. This results in decreased insulin level and prolonged hyperglycemia leading to damage involving several vital organs like kidneys, peripheral nervous system, and vascular system.<sup>[1]</sup> Osteoarthritis (OA) is a common cause of joint disease. It causes changes in the articular cartilage together with the subchondral bone of the knee joint, ending in long-term disabilities.<sup>[2,3]</sup> M and OA are frequently associated with each other. Many risk factors are shared between DM and OA, like increased body weight, old age, lack or decreased physical

activity. These factors may indicate that DM and even hyperglycemia could lead to cartilage changes in the knee joint.<sup>[4]</sup>

Arthroscopy is a reliable and sensitive non radiographic tool for assessment of the articular cartilage, but its invasive nature minimizes its role. In the past, conventional radiography was considered the main radiological modality for assessment of joint damage in osteoarthritic patients. However, it is not sensitive for subtle changes that involve cartilage thickness. Magnetic resonance imaging [MRI] is a noninvasive imaging tool with good soft tissue contrast, and multiplanar capability. However, MRI is an expensive modality, with limited availability, and not tolerated by many patients due to claustrophobia. High resolution ultrasound proved to be a reliable and valid radiological tool for evaluation of the femoral cartilage thickness. Ultrasound is a noninvasive, relatively inexpensive, dynamic study, that is known to be safe and well tolerated by patients. Articular cartilage appears in ultrasound as homogeneously anechoic structure with sharp interface with bone.<sup>[5-7]</sup>

The aim of this study is to investigate the relationship between type II DM patients and the femoral cartilage thickness and to evaluate whether the femoral cartilage thickness differed from healthy controls or not.

## 2. Methods

### 2.1. Participants

After institutional review board approval, participants of the study were recruited between September 2018 and April 2019. All the subjects in this study were informed of the study protocol, and written consent was obtained. A sample size of  $\geq 50$  was required, with 25 subjects per group. Considering a dropout rate of 20%, 70 patients were enrolled in the study. This is a cross sectional study including 36 Patients diagnosed with type II DM, on oral medication for 5 years and level (A1C) more than 6.5%, plus 34 healthy subjects. The inclusion criteria for the healthy subjects, being (1) healthy, (2) female or male, and age between 24 and 65. Exclusion criteria included osteoarthritis, rheumatoid

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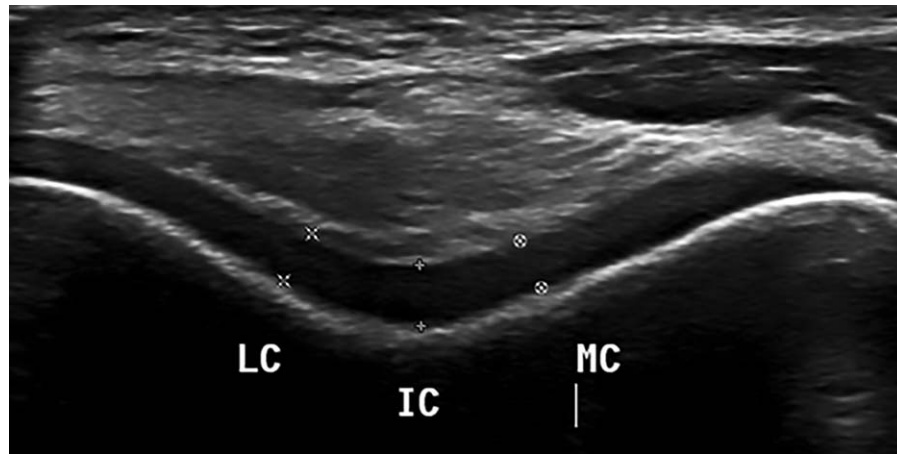
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**Figure 1.** Axial scan of the on suprapatellar region, with demonstration of femoral cartilage thickness measurements. LC=lateral condyle, IC=intercondylar area, MC=medial condyle.

arthritis, inflammatory arthritis, history of knee surgery, or trauma. For each participant, data including age, sex, BMI, weight, and height were acquired.

## 2.2. Technique

L18–5 MHz linear transducer (Epic 7 version 1.5, Ultrasound system: Philips, Bothell, WA). Two experienced radiologists (M. B, 15 years of experience) and (A.E 12 years of experience), performed all ultrasound scans. Each participant in the study was scanned 3 times.

The transducer was positioned in the axial plane on the suprapatellar region. In order to image the femoral cartilage, all subjects were placed in the supine position with maximum knee flexion. Midpoint measurements were taken from each from three locations in each, from the right medial condyle (RMC), right lateral condyle (RLC), right intercondylar area (RIC), from the left medial condyle (LMC), left lateral condyle (LLC), and left intercondylar area (LIC), (Fig. 1).

## 2.3. Statistical analysis

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 21 software (SPSS Inc, Chicago, IL). All data were presented as mean  $\pm$  standard deviation (SD) and range. The differences in the measured values were compared between both sides using the independent samples *t* test. The

correlations between the, age, weight, height, and BMI were evaluated using Pearson correlation coefficient (*r*). A *P* value of  $<.05$  was considered significant.

## 3. Results

Measurements from 68 knees of 34 type II diabetic patients (25 males, 9 females), and 72 knees 36 healthy subjects (13 males, 23 females). The demographic features of diabetic patients and healthy subjects are shown in (Table 1). The intra-observer reliability calculations resulted in an overall intra-class correlation coefficient of 0.85. The interrater reliability calculations showed an overall intraclass correlation coefficient of 0.81. Correlation was considered statistically significant if the *P* value was less than .05. If the *P* value was more than .05, correlation was considered not significant. Measurements of the mean cartilage thickness revealed no significant statistical difference between (DM) patients and healthy subjects ( $P = >.05$ ) (Table 2). The BMI, weight and height did not show positive significant statistical correlation with the femoral cartilage thickness in the healthy subjects ( $P = >.05$ ). In DM patients: no significant statistical correlation was noted between age and BMI and the femoral cartilage thickness. The femoral cartilage thickness correlated positively with weight at the medial condyles bilaterally together with the left lateral condyle and the left intercondylar area. Significant positive statistical correlation of height with the medial condyles bilaterally together with the left lateral condyle (Tables 3–6).

## 4. Discussion

In this study we evaluated the femoral cartilage thickness by ultrasound in (DM) patients and whether this is related to any of the demographic factors. High resolution ultrasound is an inexpensive, reliable, and dynamic study, and has become an important tool to examine the musculoskeletal system, in the last 20 years.<sup>[8]</sup>

The knee joint is a weight-bearing joint commonly affected by OA, ending by irreversible injury of the articular cartilage. Many studies reported the capability of ultrasound to assess the femoral cartilage with some debate on its validity.<sup>[9,10]</sup>

<b>Table 1</b>			
<b>The demographic characteristics of (DM) patients (mean <math>\pm</math> standard deviation).</b>			
	<b>Patients (n=34)</b>	<b>Control (n=36)</b>	<b>P</b>
Age (Years)	46.85 $\pm$ 7.02	32.94 $\pm$ 8.00	.01
Gender, n (%)			
Female	9 (26.47)	23 (63.99)	
Male	25 (73.53)	13 (36.11)	
Weight (Kg)	89.23 $\pm$ 16.30	61.65 $\pm$ 11.99	.01
Height (Cm)	167.67 $\pm$ 11.69	160.02 $\pm$ 8.72	.01
BMI	32.07 $\pm$ 4.94	23.85 $\pm$ 3.27	.01

DM = Type II Diabetes mellitus.

**Table 2**  
**Comparison of the femoral cartilage thickness (cm) Type II DM patients and the healthy controls (mean±standard deviation).**

	Patients (n=34)		Control (n=36)		P
	Female n=9	Male n=25	Female n=23	Male n=13	
RIC (cm)	0.19±0.08	0.23±0.06	0.20±0.04	0.22±0.04	P<.05
RMC (cm)	0.17±0.05	0.22±0.04	0.19±0.03	0.21±0.04	
RLC (cm)	0.24±0.23	0.22±0.05	0.19±0.03	0.21±0.03	
LIC (cm)	0.20±0.07	0.23±0.05	0.20±0.04	0.21±0.04	
LMC (cm)	0.17±0.04	0.21±0.04	0.18±0.03	0.20±0.03	
LLC (cm)	0.16±0.03	0.20±0.04	0.28±0.42	0.21±0.02	

DM=Type II Diabetes mellitus.  
P=P value.

**Table 3**  
**Correlations between demographic factors and femoral cartilage thickness measurements in Type II diabetic patients.**

	RIC (cm)	RMC (cm)	RLC (cm)	LIC (cm)	LMC (cm)	LLC (cm)
Age	0.005	0.115	-0.282	-0.007	-0.047	0.068
Sig	0.979	0.516	0.106	0.968	0.790	0.704
Weight/kg	0.244	0.496*	-0.117	0.346†	0.530*	0.443*
Sig	0.164	0.000	0.511	0.045	0.001	0.009
Height/O	0.279	0.487*	0.012	0.329	0.427†	0.514*
Sig	0.111	0.003	0.946	0.058	0.012	0.002
BMI	0.134	0.220	-0.143	0.177	0.275	0.131
Sig	0.449	0.212	0.420	0.317	0.115	0.461

Diabetic Patients (n=34).  
BMI=body mass index, LIC=left intercondylar area, LLC=left lateral condyle, LMC=left medial condyle, RIC=right intercondylar area, RLC=right lateral condyle, RMC=right medial condyle.  
\* Correlation is significant at the .01 level (2-tailed).  
† Correlation is significant at the .05 level (2-tailed).

Ultrasound could also assess the presence of effusion, medial and lateral collateral ligaments, in addition to the quadriceps tendon and the patellar ligament.<sup>[9-11]</sup>

No significant statistical difference was noted between the mean femoral cartilage thickness DM patients and healthy controls. Although no statistical correlation was found between healthy subjects and demographic factors, weight showed correlation with 3 out of 6 measurements, and height showed correlation with 4 out of 6 in DM patients. Females tend to have thinner femoral cartilage in DM patients at both medial condyles, together with the left lateral condyle. Significant positive correlation was found between cartilage thickness at the medial condyle, with weight, and height, however, our results may be affected by age, BMI and gender which suggests further studies with matched control group to increase validation of our results.

Our study shows that sonographic measurements of the knee femoral cartilage thickness are not useful in separating Type II DM patients from healthy subjects. This is likely due to the controlled glucose levels of our selected sample by our medication. The present study has some limitations. The sample size was relatively small and included only controlled type II diabetes mellitus patients. Also heterogeneity of our population, limits generalization of our results.

In conclusion, our study revealed preliminary results and revealed no significant difference between the mean femoral cartilage thickness in DM patients and healthy controls, some demographic factors correlated in DM patients with cartilage thickness. Future studies with larger sample size are suggested with inclusion of type I DM and uncontrolled type II DM where we expect higher BMI with increased likelihood of osteoarthritis.

**Table 4**  
**Correlations between demographic factors and femoral cartilage thickness measurements in healthy subjects.**

	RIC (cm)	RMC (cm)	RLC (cm)	LIC (cm)	LMC (cm)	LLC (cm)
Age	0.263	0.107	0.251	0.312	0.280	-0.026
Sig	0.122	0.533	0.139	0.064	0.098	0.879
Weight/kg	0.262	0.176	0.124	0.038	0.139	-0.185
Sig	0.123	0.306	0.470	0.825	0.420	0.279
Height/O	0.285	0.299	0.217	0.028	0.308	-0.123
Sig	0.092	0.077	0.204	0.870	0.067	0.473
BMI	0.165	0.009	0.043	0.059	-0.020	-0.224
Sig	0.336	0.957	0.805	0.731	0.906	0.189

Healthy subjects (n=36).  
BMI=body mass index, LIC=left intercondylar area, LLC=left lateral condyle, LMC=left medial condyle, RIC=right intercondylar area, RLC=right lateral condyle, RMC=right medial condyle.

**Table 5**  
Independent samples t test comparing femoral cartilage thickness measurements in males and females in type II diabetic patients.

Gender	N	Mean	Standard Deviation	T	Sig
RIC (cm)					
Female	9	0.19	0.08	1.641	0.111
Male	25	0.23	0.06		
RMC (cm)					
Female	9	0.17	0.05	3.06	0.004
Male	25	0.22	0.4		
RLC (cm)					
Female	9	0.24	0.23	0.559	0.580
Male	25	0.22	0.05		
LIC (cm)					
Female	9	0.20	0.07	1.277	0.211
Male	25	0.23	0.05		
LMC (cm)					
Female	9	0.17	0.04	2.582	0.015
Male	25	0.21	0.04		
LLC (cm)					
Female	9	0.16	0.03	2.764	0.009
Male	25	0.20	0.04		

Type II diabetic patients (n=34).

LIC=left intercondylar area, LLC=left lateral condyle, LMC=left medial condyle, RIC=right intercondylar area, RLC=right lateral condyle, RMC=right medial condyle.

**Table 6**  
Independent samples t test comparing femoral cartilage thickness measurements in males and females in healthy subjects.

Independent samples test					
Gender	N	Mean	Standard Deviation	T	Sig
RIC (cm)					
Female	23	0.20	0.04	1.953	0.059
Male	13	0.22	0.04		
RMC (cm)					
Female	23	0.19	0.03	1.467	0.152
Male	13	0.21	0.04		
RLC (cm)					
Female	23	0.19	0.03	1.509	0.140
Male	13	0.21	0.03		
LIC (cm)					
Female	23	0.20	0.04	0.329	0.745
Male	13	0.21	0.04		
LMC (cm)					
Female	23	0.18	0.03	1.703	0.098
Male	13	0.20	0.03		
LLC (cm)					
Female	23	0.28	0.42	0.603	0.533
Male	13	0.21	0.02		

Healthy subjects (n=36).

LIC=left intercondylar area, LLC=left lateral condyle, LMC=left medial condyle, RIC=right intercondylar area, RLC=right lateral condyle, RMC=right medial condyle.

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