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Original Article

Relationship between degenerative medial meniscus lesions and the medial fat tissue thickness of the knee

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Abstract

Aim: It was aimed to investigate the relationship between fatty tissue thickness in the medial of the knee and degenerative meniscus lesion.

Materials and Methods: Images of 300 patients (151 females and 149 males) who had previously taken knee magnetic resonance imaging (MRI) were evaluated retrospectively. The relationship between medial meniscus degenerative lesion (MMDL) and age, sex, side, height, weight, body mass index (BMI), medial fat thickness (MFT), length of medial tibial plateau (MTP) was investigated.

Results: Mean age of 300 patients (144 rights, 156 left knees) was 41.4 ± 11.8 (range 18–67) years and 200 of them had degenerative meniscus lesions, 100 of them were not detected.

Age, weight, height, BMI, MFT, MTP, and MFT/MTP were all correlated with the presence of an MMDL, and the strongest relationship was with age ($p<0.001$). No significant relationship between weight and MMDL was found. However, both MFT and the MFT/MTP ratio were more strongly correlated with the presence of an MMDL. Logistic regression analysis indicated that the presence of an MMDL was 25 times more likely in patients with a high MFT/MTP ratio (odds ratio, 0.040).

Conclusion: In this study, the MFT / MTP ratio was found higher in patients with medial meniscus degenerative lesions than in the healthy population. This study shows that fatty tissue thickness in the medial of the knee can be effective in the formation of degenerative meniscus lesions, as well as BMI. However, this study may form the basis for prospective studies in which factors such as daily activity, profession and sports level are also investigated to create a clearer judgment.

Keywords: Adipose tissue; body mass index; meniscus; meniscus lesion; risk factors

INTRODUCTION

In the knee, the functions of the menisci include load bearing, shock absorption, joint stabilization, joint lubrication, and proprioception (1,2). Meniscus injuries often occur during sports participation in young patients. A degenerative meniscus lesion is a complex rupture of the meniscus, which loses its elasticity in older individuals, with spontaneous or minor traumas. With increasing age, the incidence of degenerative tears, which usually occur in the posterior horn, increases due to deterioration in the elasticity of the meniscus (3,4). Meniscal injury disturbs the joint load distribution, which leads to joint degeneration and osteoarthritis (5).

The excessive weight that characterizes obesity overloads the knee joint, which contributes to the formation of medial meniscus degenerative lesions (MMDL) (6,7). A 2019 consensus study emphasized that obesity negatively affects the prognosis of degenerative meniscus lesions (8). Clinical observation of the authors is degenerative meniscus lesions are also encountered in patients with a low body mass index (BMI), but thick fat tissue in the medial knee. There are no reports on the associations of BMI, fat thickness in the medial knee, and the presence of degenerative meniscus lesions.

Therefore, this study investigated the relationship between knee medial fat thickness (MFT) and MMDL. A secondary aim was to evaluate the effects of age, sex, side, weight, height, BMI, medial tibial plateau (MTP) size, and the MFT/MTP ratio on this relationship. For this purpose, the amounts of adipose tissue and MTP around the knee were measured via magnetic resonance imaging (MRI) and the relationship with the presence of a MMDL was investigated.

MATERIALS and METHODS

Patients who were seen in the orthopedics and traumatology outpatient clinic with knee pain between

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March 2017 and February 2018 (n = 577) were reviewed retrospectively. Age, sex, side, weight, height, BMI, and surgical status were obtained from the hospital records. The study included patients aged 18–67 years who were admitted for knee pain. Patients were excluded if they had an acute traumatic meniscus lesion (n = 47), intra-articular pathologies other than a meniscus lesion (n = 121), Ahlbäck grade 3 or more arthritis (n = 88), a tumor near the knee (n = 14), or genu varum without arthritis (n = 7). Ultimately the study evaluated the MRI images of 300 individuals.

Knee MRI was performed with a 1.5T MAGNETOM Aera (Siemens Medical Systems, Erlangen, Germany) using an extremity coil. The proton density fat saturated sequence in the axial plane was used to measure subcutaneous fat. The imaging parameters were as follows: TR, 1,800 ms; TE, 35 ms; matrix, 256 × 160; slice thickness, 3 mm; spacing, 0.5 mm; and flip angle, 160°.

For the measurements, the widest section of the medial meniscus seen on axial MRI sections was selected. The midpoints of the lateral and medial eminences were taken as the center. From this point to the skin, the longest line medial to the knee joint was identified and marked. We did not go beyond where the posterior muscles began, so that the measurements were not affected by the size of the posterior knee muscles. Subcutaneous fat tissue thickness was measured in this section on this line and recorded as the thickness of the MFT of the knee. Then, the longest anteroposterior length of the MTP was measured. The MFT/MTP ratio was calculated to eliminate the effect of differences in bony morphology among individuals (Figure 1).

The relationships between the presence of MMDL and age, sex, side, weight, height, BMI, MFT, MTP, and the MFT/MTP ratio were investigated. The relationships between BMI and the other parameters were also evaluated.

The statistical analyses were performed using SPSS (ver. 24.0; IBM Corp., Armonk, NY, USA) and MedCalc software (ver. 14; MedCalc Software Ltd., Ostend, Belgium). To compare quantitative data between two independent groups, independent-samples t-tests were used with bootstrapping, while the Mann–Whitney U test was applied to Monte Carlo results. To compare categorical variables, the Pearson chi-square test was used. Quantitative data are provided as the mean ± standard deviation (SD) or median (range), and categorical variables as numbers (%). P-values < 0.05 were considered significant. This study was conducted in accordance with the Declaration of Helsinki and was approved by the local ethics committee (permission date/number: 10.01.2018/61).

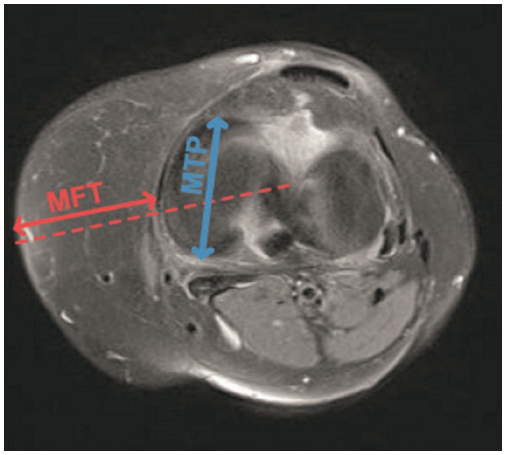

Figure 1. Measurement method. (MFT: medial fat tissue; MTP: medial tibial plateau)

RESULTS

Three hundred enrolled adults comprised 151 females and 149 males with a mean age of 41.4 ± 11.8 (range 18–67) years. MRI was performed on the right knee in 144 patients and the left in 156. The meniscus was normal in

Table 1. Characteristics of the study groups

	MML + (n = 200) Mean ± SD (range)	MML - (n = 100) Mean ± SD (range)	Total (n= 3 00) Mean ± SD (range)	P-value
Age	44.42 ± 10.87 (18–67)	35.22 ± 11.26 (18–61)	41.35 ± 11.81 (18–67)	**0.001**
Weight	79.50 ± 13.98 (49–125)	77.22 ± 14.44 (45–122)	78.74 ± 14.15 (45–125)	0.189
	Median (range)	**Median (range)**	**Median (range)**	
Height	168.00 (145.00–192.00)	172.00 (148.00–195.00)	169.50 (145.00–195.00)	**<0.001**
BMI	27.70 (18.80–48.80)	26.20 (18.30–40.40)	27.10 (18.30–48.80)	**<0.001**
MFT (mm)	29.74 (16.24–76.10)	25.00 (11.42–37.70)	28.22 (11.42–76.10)	**<0.001**
MTP (mm)	48.62 (39.92–60.98)	51.41 (42.22–62.50)	49.83 (39.92–62.50)	**<0.001**
MFT / MTP	0.61 (0.33–1.84)	0.48 (0.23–0.77)	0.57 (0.23–1.84)	**<0.001**
Sex				
Female	**115 (57.5)**	36 (36.0)	151 (50.3)	**0.001**
Male	85 (42.5)	64 (64.0)	149 (49.7)	2.4 (1.5-3.9)*

Side				
Right	90 (45.0)	54 (54.0)	144 (48.0)	0.177
Left	110 (55.0)	46 (46.0)	156 (52.0)	

Independent samples t-test (Bootstrap), Mann–Whitney U test (Monte Carlo), Pearson chi-square test (exact); SD, standard deviation * Odds ratio (95% confidence interval)

100 patients, while 200 patients had an MMDL. Table 1 shows the age, sex, side, height, weight, BMI, MFT, MTP, and MFT/MTP ratio by patient group.

Age, weight, height, BMI, MFT, MTP, and MFT/MTP were all correlated with the presence of an MMDL, and the strongest relationship was with age (p<0.001). When the areas under the ROC curves were compared, both MFT and the MFT/MTP ratio were more strongly correlated with the presence of an MMDL. In addition, MFT/MTP> 0.643 was associated with the presence of an MMDL with a sensitivity of 45% and specificity of 83%. Table 2 shows the cut-off, sensitivity, and specificity values. Logistic regression analysis indicated that the presence of an MMDL was 25 times more likely in patients with a high MFT/MTP ratio (odds ratio, 0.040; Table 3). Weight alone was not associated with MMDL.

The correlations of BMI with the other parameters were examined. There were significant relationships between BMI and age, MFT, and the MFT/MTP ratio (all p<0,001) (Table 4). Age, MFT, and MFT/MTP were higher in patients with a higher BMI.

Table 2. Factors associated with the presence of a medial Meniscus degenerative lesion (MMDL)

MML - / +	Cut-Off	Sensitivity	Specificity	AUC (SE)	P-value
Age<	36.5	0.78	0.56	0.719 (0.031)	**<0.001**
Height>	170.5	0.55	0.695	0.647 (0.034)	**<0.001**
BMI<	28.9	0.42	0.83	0.629 (0.033)	**<0.001**
MFT (mm)<	33.28	0.34	0.91	0.674 (0.032)	**<0.001**
MTP (mm)>	48.47	0.73	0.49	0.624 (0.033)	**<0.001**
MFT/MTP<	0.643	0.445	0.83	0.681 (0.031)	**<0.001**

AUC, area under the receiver operating characteristic curve; SE, standard error; BMI, body mass index; MFT, thickness of the medial fat tissue; MTP, medial tibial plateau length

Table 3. Multiple nominal logistic regression analysis results

	B (SE)	P-value	Odds Ratio	95% Confidence Interval for the Odds Ratio	
				Lower Bound	Upper Bound
Gender (female)	−0.167 (0.400)	0.677	1.181	0.539	2.587
Age	0.059 (0.013)	**<0.001**	0.943	0.919	0.967
Height	−0.018 (0.005)	**<0.001**	1.018	1.009	1.027
MFT/MTP	3.214 (1.381)	0.020	**0.040**	0.003	0.602
BMI	−0.012 (0.038)	0.760	**1.012**	0.939	1.091

B, regression coefficient; SE, standard error; BMI, body mass index; MFT, thickness of the medial fat tissue; MTP, medial tibial plateau length

Table 4. Relationship of BMI with other parameters

	Total (n=300)		MML + (n=200)		MML - (n=100)	
	r	P	r	P	r	P
Age	0.273	**<0.001**	0.247	**<0.001**	0.249	**<0.001**
DMY (mm)	0.393	**<0.001**	0.377	**<0.001**	0.371	**<0.001**
MTP (mm)	0.001	0.971	0.021	0.660	0.037	0.588
DMY/MTP	0.321	**<0.001**	0.303	**<0.001**	0.307	**<0.001**

Kendall's tau b Test, r: Correlation Coefficient

DISCUSSION

With increasing age, degeneration occurs in the knee meniscus. Although repairs are not always possible in degenerative meniscus lesions, there are publications in the literature showing that partial menisectomy provides clinical improvement (9). This study determined that the parameter most strongly associated with the presence of an MMDL was age, in agreement with the literature (10). In our series, MMDL was also more common in females, also in accordance with the literature, while no relation was found between side and the presence of a lesion (10,11).

We found no significant relationship between weight and MMDL (p=0.189), but an inverse relationship between height and MMDL was observed, which has not been reported previously. Our data imply that it is inappropriate to invoke weight and height when seeking to explain the formation of lesions; BMI is a more reliable parameter.

Many studies have reported a relationship between obesity and meniscus degeneration (12-16). The mean BMI of our patients with an MMDL was 27.7 (18.8–48.8) versus 26.2 (18.3–40.4) in those without a lesion; the difference was significant, in agreement with the literature. Obesity was associated with an MMDL in the enrolled patients.

We also examined the relationship between medial fat tissue thickness (MFT) and the width of the MTP and MMDL. Patients with an MMDL had a significantly higher mean MFT than the non-lesion group, while the opposite was true for the MTP. Degenerative lesions were less common in the menisci of individuals with a wide MTP.

In addition, we used the MFT/MTP ratio to evaluate the relationship between bone structure and MFT. The MFT/MTP ratio was 0.61 (range 0.33–1.84) in the MMDL group and 0.48 (0.23–0.77) in the no MMDL group; the difference was significant (p<0.001). Although there are reports of a relationship between meniscus lesions and obesity, no study has investigated the relationship between the amount of fatty tissue around the knee and meniscus lesions. Further studies of the associations of MFT thickness, MTP width, and the MFT/MTP ratio on MMDL should include more patients and also evaluate parameters such as occupation, physical activity level, and daily activities.

While there was no significant relationship between BMI and MTP, there were significant relationships between BMI and age, MFT, and the MFT/MTP ratio, although the correlation coefficients were small (Table 4). Therefore, the reliability of the relationships between the anatomical measures and BMI must be confirmed.

Strength of the current study is that it was the first show associations of MFT, MTP, and the MFT/MTP ratio with MMDL. A limitation is that we were unable to examine the associations of daily activities and occupation with MMDL formation. Also, the inclusion of the wide age group in the study caused heterogeneity in the sample. Comparative prospective randomized studies to be carried out will provide clearer information. Meniscus degeneration is a multifactorial condition. Therefore future evaluations should examine the effects of daily and sporting activities on these patients.

CONCLUSION

As a result, the degenerative meniscus lesion was more common in the knees of the individuals included in the study with higher fat tissue thickness in the medial of the knee. To establish the degenerative mechanism in meniscus lesions, it can be helpful to evaluate the relationship between medial fat tissue thickness of the knee (MFT) and MMDL and to objectify and quantify the features of the anatomical and physiological features of the patient for the treatment plan.

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REFERENCES

1. Seedhom BB, Dowson D, Wright V. Proceedings: Functions of the menisci. A preliminary study. Ann Rheum Dis 1974;33:111.
2. Kawamura S, Lotito K, Rodeo SA. Biomechanics and healing response of the meniscus. Oper Techn Sport Med. 2003;11:68-76.
3. McDermott I. Meniscal tears, repairs and replacement: their relevance to osteoarthritis of the knee. Br J Sports Med 2011;45:292-7.
4. Makris EA, Hadidi P, Athanasiou KA. The knee meniscus: Structure-function, pathophysiology, current repair techniques, and prospects for regeneration. Biomaterials 2011;32:7411-31.
5. Englund M, Guermazi A, Lohmander S. The Meniscus in Knee Osteoarthritis. Rheum Dis Clin North Am 2009;35:579-90.
6. Arnoczky SP, Warren RF. The microvasculature of the meniscus and its response to injury. An experimental study in the dog. Am J Sports Med 1983;11:131-41.
7. Hauger O, Frank LR, Boutin RD, et al. Characterization of the "red zone" of knee meniscus: MR imaging and histologic correlation. Radiology 2000;217:193-200.
8. Hohmann E, Angelo R, Arciero R, et al. Degenerative Meniscus Lesions: An Expert Consensus Statement Using the Modified Delphi Technique. Arthroscopy 2020;36:501-12.
9. Canbay A, Sevimli R, Gormeli G et al. Evaluation of clinical results after arthroscopic meniscus repair and partial meniscectomy. Ann Med Res 2020;27:1374-9.

10. Lange AK, Singh MAF, Smith RM, et al. Degenerative Meniscus Tears and Mobility Impairment in Women with Knee Osteoarthritis. Osteoarthritis Cartilage 2007;15:701-8.
11. Fukuta S, Masaki K, Korai F. Prevalence of Abnormal Findings in Magnetic Resonance Images of Asymptomatic Knees. J Orthop Sci 2002;7:287-91.
12. Dequeker J, Goris P, Uytterhoeven R. Osteoporosis and osteoarthritis (osteoarthrosis). Anthropometric distinctions. Jama 1983;18;249:1448-51.
13. Felson DT, Anderson JJ, Naimark A, et al. Obesity and knee osteoarthritis. The Framingham Study. Ann Intern Med 1988;01;109:18-24.
14. Ford GM, Hegmann KT, White GL, et al. Associations of body mass index with meniscal tears. Am J Prev Med 2005;28:364-8.
15. Haviv B, Bronak S, Thein R. Correlation between body mass index and chondral lesions in isolated medial meniscus tears. Indian J Orthop 2015;49:176-80.
16. Covall DJ, Wasilewski SA. Roentgenographic Changes After Arthroscopic Meniscectomy: Five-Year Follow-Up in Patients More Than 45 Years Old. Arthroscopy 1992;8:242-6.