ORIGINAL ARTICLE RADIOLOGICAL

NORTH CLIN ISTANB 2017;4(3):242-246
doi: 10.14744/nci.2017.79847

Evaluation of the relationship between the femoro-tibial angle and meniscal injury

Mehmet Sirik

Department of Radiology, Adıyaman University Faculty of Medicine, Adıyaman, Turkey

ABSTRACT

OBJECTIVE: The purpose of this study was to assess the relationship between the presence of meniscal injury and the femorotibial angle in the knee joint.

METHODS: Patients who underwent knee magnetic resonance imaging (MRI) at our department between January 2015 and March 2015 were included in this study. Knee MR images of these patients were retrospectively re-evaluated for meniscal injury. The anatomic femorotibial angle measurements of the patients were calculated using AP knee radiograms. The relationship between femorotibial angle values and the presence of meniscal injury was analyzed.

RESULTS: One hundred and fourteen knee joints of 101 patients were included. The mean age of the patients was 40.6±13.4 years. The number of injured medial menisci was 92 and the average femorotibial angle in these knees was 5.6±1.88; the number of non-injured medial menisci was 22 and the average femorotibial angle value in these knees was 5.8±1.92 (p=0.82); The number of lateral meniscus with injury was 22 and the mean femorotibial angle value in these knees was 6.1±1.50; the number of lateral meniscus without injury was 92 and the average femorotibial angle value in these knees was 5.6±1.96 (p=0.20).

CONCLUSION: In our study, there was no statistically significant correlation between femorotibial angle values and the presence of injury in medial and lateral meniscuses. We believe that frontal plane bone alignment disorder of the knee does not have a predisposition to meniscal injury.

Keywords: Femorotibial angle; malalignment; meniscal injury.

The meniscus is an integral part of the complex biomechanical system of the knee and provides a uniform distribution of weight along the joint surface as it increases the contact surface area. Damage to the meniscus causes this function to change and contributes to the imbalance of the knee joint compartment by changing the shape of load distribution [1]. Meniscal lesions are among the most common knee problems faced by orthopedists [2]. The accurate and timely diagnosis of meniscal tears is crucial for reducing morbidity and for planning treatment. It is well known that damage to the

Received: April 24, 2017 *Accepted:* August 08, 2017 *Online:* October 19, 2017

Correspondence: Dr. Mehmet Sirik. Adıyaman Universitesi Tıp Fakultesi Egitim Ve Arastırma Hastyanesi, Radyoloji Anabilim Dalı Adıyaman, Turkey
Tel: +90 416 216 10 15-22 30 e-mail: dr.mmtsrk@gmail.com

meniscus is caused by degenerative osteoarthritis (OA) because it increases axial and vertical stress to the adjacent articular cartilage [3]. Normally, the load on the knee during walking is disproportionately transferred to the medial compartment. During walking with a knee varus deformity, the load is transferred further medially [4]. It is known that knee alignment disorders (malalignment) are important biomechanical factors in the progression of knee osteoarthritis [5, 6]. The femorotibial angle in the frontal plane is the angle formed by the intersection of anatomical axes of the femur and tibia [7]. In normal knee alignment, there is an approximately 5°–7° valgus femorotibial angle [8]. The decrease in this angle increases the load on the medial compartment of the knee, and thus, the load distribution on the lateral and medial menisci changes.

In this study, we aimed to investigate the possible relationship between meniscal injuries and femorotibial angle values.

MATERIALS AND METHODS

Our retrospective study was approved by the local ethics committee. MR images of patients aged >18 years who underwent knee magnetic resonance imaging (MRI) at our department between January 2015 and April 2015 were retrospectively re-evaluated for meniscal injury. All MR examinations were performed on a 1.5-T Achieva scanner (Philips, Best, The Netherlands) with a standard knee protocol consisting of four sequences. Three of them were proton density, spectral attenuated inversion recovery (PD SPAIR) and one was a T1-W turbo spin-echo (TSE) image. The SPAIR sequences were as follows: 1) sagittal plane: repetition time (TR), 3034 ms; echo time (TE), 30 ms; slice thickness, 3.5 mm; and gap, 0.3 mm; 2) coronal plane: TR, 3034 ms; TE, 30 ms; slice thickness, 3.5 mm; and gap 0.3 mm; and 3) axial plane: TR, 3034 ms; TE, 30 ms; slice thickness, 3.5 mm; and gap, 0.3 mm, and the T1-W TSE sequence was as follows: coronal plane: TR, 560 ms; TE, 17 ms; slice thickness, 3.5 mm; and gap, 0.6 mm.

When assessing meniscal injury, small focal hyperintense area not reaching the meniscus joint surface was interpreted as a grade 1 degeneration, linear hyperintense area not reaching the joint surface was interpreted as a grade 2 degeneration, and abnormal meniscal hyperintensities extending to at least one joint surface were interpreted as grade 3 degeneration (meniscal tear) [9]. Patients with acute trauma, ligamentous knee joint injury, knee operation, and benign or malignant mass lesion were excluded from the study. Femorotibial angles of the knees with and without medial and lateral meniscal injuries were separately assessed. The anatomic femorotibial angle was calculated using anatomical axes of the femur and tibia on the AP knee radiograms performed at the same time as knee MRI. To standardize the measurements, two transverse lines were drawn perpendicular to the shaft of the femur and tibia. A line connecting the midpoints of this line was drawn. Femorotibial angle values were obtained at the intersection of these lines (Fig. 1A,B). Femorotibial angles were statistically compared between knees with and without meniscal injury. SPSS 21.0 program was used for statistical analysis. Student t-test (independent sample t-test) was used for descriptive statistics and normal scatter data.

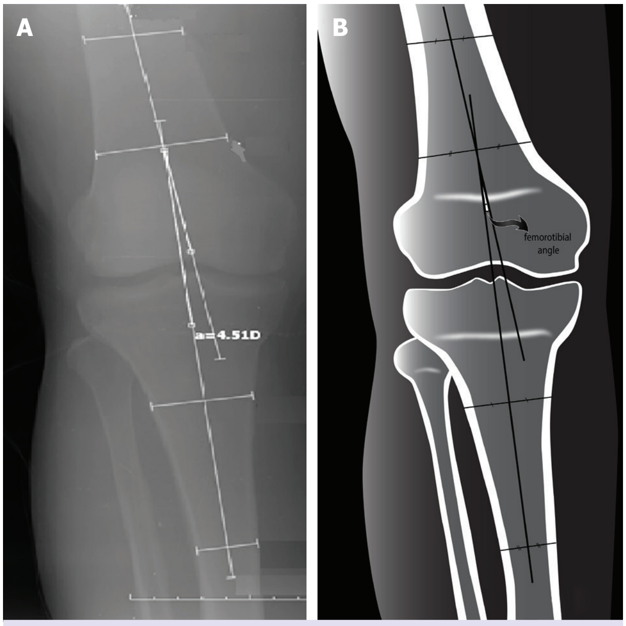

FIGURE 1. Femorotibial angle using AP knee radiograms (A) and schematic measurement (B).

RESULTS

In total, 114 knee joints (57 right; 57 left) belonging to 101 patients (male/female=53/48) were included in the study. The mean age of the patients was 40.6±13.4 years (Table 1). There were medial meniscal injuries in 92 knees. Of these, 29 were meniscal tears, 44 were grade 2 degeneration, and 19 were grade 1 degeneration. The mean femorotibial angle value in these knees was 5.6±1.88. Medial menisci es were normal in 22 knees. The mean femorotibial angle value in these knees was calculated as 5.8±1.92 (p=0.82), (Table 2); There were lateral meniscal injuries in 22 knees. Six of these were meniscal tears, 13 were grade 2 degenerations, and 3 were grade 1 degenerations. The mean femorotibial angle in these knees was 6.1±1.50. In 92 knees, the lateral meniscus was normal. The mean femorotibial angle value in these knees was 5.6±1.96 (p=0.20), (Table 3). There was no statistically significant relationship between the presence of injury (degeneration or tear) in the medial and lateral meniscus and femorotibial angle values.

Table 1. General characteristics of patients

Number of patients included	101
Average age of the patients	40.6±13.4
Gender (Male/Female)	53/48
Right knee/left knee (total number)	57/57 (114 knees)
Number of patients of whom studied both knees	13

DISCUSSION

Important functions of the meniscus in the knee joint include load distribution, force absorption, slipperiness, and stabilization. The meniscus is responsible for supporting 40%–70% of the load in the knee; the rest is distributed with direct contact with the articular cartilage. The meniscus follows the movement of the tibia and femur during the movement of the knee, increases the contact area, provides effective distribution of forces along the joint surfaces, and is important for protecting joint integrity [1]. The medial meniscus is less mobile than the lateral meniscus because of its tight association with the medial collateral ligament and it exerts more force during movement. Therefore, the medial meniscus is more susceptible to injury. Similarly, the rate of medial meniscal injury was higher in our study. The incidence of meniscal tears increases with age. Meniscus tears are usually associated with degenerative joint disease and con-

Table 2. Comparison of femorotibial angles in knees with and without medial meniscal injury

	Medial meniscus with injury	Medial meniscus without injury	P
	n=92	n=22	
Femoro-tibial angle	5.6±1.88	5.8±1.92	0.82

Table 3. Comparison of femorotibial angles in knees with and without lateral meniscal injury

	Lateral meniscus with injury	Lateral meniscus without injury	P
	n=22	n=92	
Femoro-tibial angle	6.1±1.50	5.6±1.96	0.20

tribute to it . Tears are more common in the posterior horn of meniscus and preferring the narrower medial meniscus. However, lateral meniscus tears are more common in young patients with acute injuries. Isolated tears in the anterior horn are rare and constitute 2% and 16% of the medial and lateral meniscus tears, respectively [3]. MRI is a rapid and noninvasive imaging tool that complements physical examination for assessing knee injuries. Although conventional radiography and computed tomography are frequently used for detecting bone injuries in the knee, MRI is a great imaging technique for better identification of soft tissue contrast, articular cartilage, injury to tendons, ligaments, and menisci [10]. Sensitivity and specificity of MRI in detecting meniscal tears were 68.4%–92.7% and 76.1%–95.2%, respectively [11]. In another study, the sensitivity and specificity of MRI were 100% and 88.4% in detecting meniscal and ligament injuries, respectively [10]. As reported by Mackenzie et al., [12] compared with arthroscopic evaluation of meniscal and cross ligament injuries, the sensitivity and specificity of MRI were 94% and 88%, respectively.

Various techniques have been developed for determining the femorotibial angle. Gold standard for femorotibial angle , the angle formed by the intersection of lines representing mechanical axes of the femur and tibia. These measurements are made along the hip-knee-ankle axis on total lower extremity radiograms. It is difficult to accurately measure this angle because measurement points are not precisely defined due to wide variability between observers from different viewpoints [13].

In clinical practice, obtaining anteroposterior knee radiograms is the most common method for evaluating the knee OA radiographically because of the high cost of complete extremity radiograms. The femorotibial angle, which describes the anatomical axis of the knee, can be measured using AP knee radiograms [7]. This method moderately correlates with the angle obtained from complete extremity radiograms [14]. Similarly, in our study, femorotibial angle values were calculated using AP knee radiograms.

Brouwer et al. [7] have shown that malalignment in the knee is an important risk factor in the development of knee OA. In addition, this study further reinforced the idea that alignment disorder is positively associated with knee OA progression. Yang et al. [8] also stated that malalignment in the knee increased sensitivity to the development of OA in the medial and lateral compartment of the knee. In another study conducted by Akalın et al., [15] no relationship was observed between knee OA and rotational alignment of the lower limb. Although it is known that malalignment of the bone structure forming the knee joint is one of the important biomechanical factors associated with knee OA, there is not enough information about whether this imbalance causes meniscal injury.

In conclusion, although there are numerous studies on the malalignment in the knee in the medical literature, we have not come across a study investigating the relationship between malalignment and meniscal injury. In our study, statistically significant correlation was not found between the femorotibial angle values and meniscal injury.

A limitation of our study was that the femorotibial angle was not calculated using complete lower extremity radiograms. Complete lower extremity radiograms are taken while the patient is standing and the femorotibial angle calculated using the lower extremity mechanical axis instead of the anatomical axis is more reliable. Another limitation is that the study population was small. More reliable information can be obtained in larger series.

Acknowledgment: I thank Dr. Ibrahim Inan for the schematic illustration.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study has received no financial support.

Authorship contributions: Concept – M.S.; Design – M.S.; Supervision – H.B.S., F.G.; Materials – M.S.; Data collection &/or processing – M.S.; Analysis and/or interpretation – M.S.; Literature search – M.S.; Writing – M.S.; Critical review – M.S.

REFERENCES

1. Costa CR, Morrison WB, Carrino JA. Medial meniscus extrusion on knee MRI: is extent associated with severity of degeneration or type of tear? AJR Am J Roentgenol 2004;183:17–23.

2. Fan RS, Ryu RK. Meniscal lesions: diagnosis and treatment. Med Gen Med 2000;2.
3. Nguyen JC, De Smet AA, Graf BK, Rosas HG. MR imaging–based diagnosis and classification of meniscal tears. Radiographics 2014;34:981–99.
4. Elmalı N, Baysal Ö, Germen B. The Influence Of Bone And Muscle Mass On Varus Osteoarthritis Of The Knee. Turgut Özal Tıp Merkezi Dergisi 2002;9:89–93.
5. Felson DT, Zhang Y. An update on the epidemiology of knee and hip osteoarthritis with a view to prevention. Arthritis Rheum 1998;41:1343–55.
6. Sharma L, Song J, Felson DT, Shamiyeh E, Dunlop DD. The role of knee alignment in disease progression and functional decline in knee osteoarthritis. JAMA 2001;286:188–95.
7. Brouwer GM, Van Tol AW, Bergink AP, Belo JN, Bernsen RMD, Reijman, M, et al. Association between valgus and varus alignment and the development and progression of radiographic osteoarthritis of the knee. Arthritis Rheum 2007;56:1204–11.
8. Yang NH, Nayeb Hashemi H, Canavan PK, Vaziri A. Effect of frontal plane tibiofemoral angle on the stress and strain at the knee cartilage during the stance phase of gait. J Orthop Res 2010;28:1539–47.
9. Li CA, Kim MK, Kim IH, Lee JH, Jang KY, Lee SY. Correlation of histological examination of meniscus with MR images: Focused on high signal intensity of the meniscus not caused by definite meniscal tear and impact on MR diagnosis of tears. Korean J Radiol 2013;14:935–45.
10. Yaqoob J, Alam MS, Khalid N. Diagnostic accuracy of magnetic resonance imaging in assessment of meniscal and ACL tear: correlation with arthroscopy. Pak J Med Sci 2015;31:263.
11. Grossman JW, De Smet AA, Shinki K. Comparison of the accuracy rates of 3-T and 1.5-T MRI of the knee in the diagnosis of meniscal tear. AJR Am J Roentgenol 2009;193:509–14.
12. Mackenzie R, Dixon AK, Keene GS, Hollingworth W, Lomas DJ, Villar RN. Magnetic resonance imaging of the knee: assessment of effectiveness. Clinical Radiology 1996;51:245–50.
13. Goker B, Block JA. Improved precision in quantifying knee alignment angle. Clin Orthop Relat Res 2007;458:145–9.
14. Kraus VB, Vail TP, Worrell T, McDaniel G. A comparative assessment of alignment angle of the knee by radiographic and physical examination methods. Arthritis Rheum 2005;52:1730–5.
15. Akalın Y, Ozcelik A, Köse N, Seber S. Rotational alignment of the lower extremity in adults: no relationship with osteoarthritis of the knee was proved. Eklem Hastalik Cerrahisi 2011;22:75–80.