

Evaluation of medial and lateral meniscus thicknesses in early osteoarthritis of the knee with magnetic resonance imaging

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ABSTRACT

Objective: To evaluate early changes occurring in both medial and lateral meniscus thickness from the knees of patients with osteoarthritis (OA).

Methods: We conducted this study in the Department of Anatomy and Division of Radiology, Faculty of Medicine, Kocaeli University, Kocaeli, Turkey during the period 2004 to 2005. In this study, we measured the thickness of the medial and lateral meniscus in a group of 36 (50 knees) consecutive patients with chronic knee pain, and clinical findings of early OA, and 10 (20 knees) control subjects using MRI.

Results: The thickness of the posterior horn of the medial meniscus and anterior horn of the lateral meniscus were significantly higher in the OA patients compared with the control subjects.

Conclusion: This study showed that meniscal degeneration in early stage OA is not evenly distributed in the knee. Thickening of the menisci in some areas may occur due to their own localization and biomechanics.

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Osteoarthritis (OA) has been recognized as the most common form of arthritis and a leading cause of disability.¹ Osteoarthritis of the knee joint is the most significant site, causing considerable pain and loss of function.² Early changes of OA include meniscus degeneration, cartilage erosions, and osteophyte formation.³ Meniscal degeneration is a feature of osteoarthritic knee joints frequently revealed on MRI, suggesting a strong relationship between this feature and the degenerative changes in these joints.⁴ The menisci are crescentic laminae deepening the articulation of the tibia, which receives the femur,⁵ they provide joint lubrication, and

improve load distribution.⁶ A degenerative meniscal lesion is often associated with early-stage knee OA.⁷ The arthrographic appearance of the menisci in the osteoarthritic knee joint of patients exhibited a loss of the normal smooth triangular shape with irregularities to the surface indicative of degeneration.⁸ Libichner et al³ evaluated early signs of OA by using in-vivo MRI with the Pond-Nuki animal model. They found the posterior part of the medial meniscus lost its characteristic triangular shape and homogenous hypointense signal. For understanding of the development of OA, knowledge about the special features of the menisci is important for diagnostic

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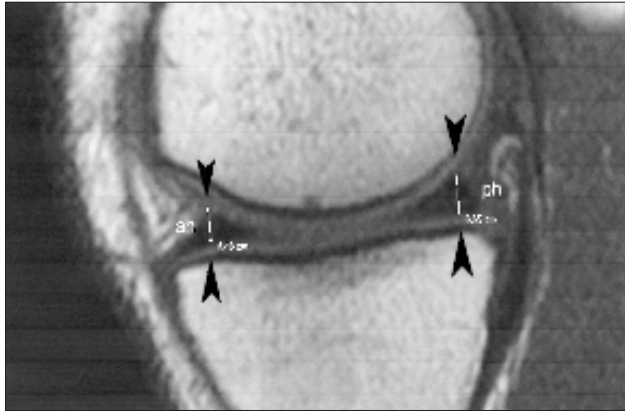


Figure 1 - On T1- weighted sagittal image the thickness of the anterior (ah) and posterior (ph) horns of the medial meniscus are seen.

reasons. The purpose of this study was to evaluate early changes occurring in both medial and lateral meniscus thickness from the knees of patients with OA.

Methods. Following Ethical Committee approval, 46 subjects (70 knees) were evaluated by MR imaging between November 2004 and March 2005 at the Faculty of Medicine, Kocaeli University, Kocaeli, Turkey. There were 36 patients (50 knees). They had a mean age of 41.9 years (range 20-67), and a mean weight of 75.3 kg (range 55-88). Twenty of them were female and 16 male. There were 32 right and 18 left knees. These knees were recorded as osteoarthritic based on MR imaging evaluation. They had chronic knee pain and clinical diagnosis of early OA of the knee. Exclusion criteria included a recent history of traumatic knee injury, evidence of other types of arthritis and previous surgery. As controls, we examined 10 healthy individuals (20 knees) without symptoms or signs of musculoskeletal disease, no history of pain, trauma, or operations of the knee. They had a mean age of 39.7 years (range 21-66), and a mean weight of 73.4 kg (range 54-84). Five were female and 5 male. There were 10 right and 10 left knees. None of these knees had any pathologic signal intensity. Symptomatic osteoarthritic knee pain was defined by a positive response to queries of pain, swelling, or morning stiffness in or around the knee most days for at least one month.⁹ All knee joints were evaluated for the presence of meniscal lesions. Degenerative meniscal lesions, with or without ruptures of the anterior cruciate ligament (ACL), osteophytes and degenerative articular cartilage lesions were found on MR imaging. Early OA was diagnosed when either 2 or 3 of these findings were present.⁹

Table 1 - Thickness of the medial/lateral meniscus measured in this study.

Location	Patient group (50 knees)	Control group (20 knees)
<i>Medial</i>		
Anterior horn	6.00 ± 0.98	5.54 ± 1.17
Mid body	6.65 ± 1.16	5.95 ± 1.13
Posterior horn	7.19 ± 1.09*	6.25 ± 1.19*
<i>Lateral</i>		
Anterior horn	5.45 ± 0.76*	4.89 ± 0.67*
Mid body	6.63 ± 1.17	6.06 ± 1.18
Posterior horn	6.45 ± 0.87	6.32 ± 1.29
*Values were significant		

Magnetic resonance imaging and analysis. The MRI is a highly sensitive technique for evaluation of the intra-articular structures of the knee, and provides exquisite anatomical detail of the meniscus size.¹⁰ The MRI studies of the patients were performed with a 1.5 T MRI scanner (Phillips Intera Master 1.5T, Netherlands) by using a knee dedicated coil system. The MR images were interpreted by radiology specialists in Kocaeli University, Department of Radiology. The knee MRI of the patients were performed by using knee dedicated coil system. Turbo spin echo (TSE) T1-weighted sagittal and dual TSE T2-weighted fat-saturated coronal images were obtained. The sequence parameters were as followed: T1-weighted TSE sagittal images: field of view (FOV) 180 mm, slice thickness 3.0 mm, interslice gap 1.0 mm, matrix 512 x 512, TSE factor 3, time to repetition (TR) 500 ms, time to echo (TE) 17 ms, rectangular field of view (RFOV) 100%, number of signal averages (NSA) 2. T2-weighted dual TSE fat-saturated coronal images: FOV 180 mm, slice thickness 3.2 mm, interslice gap 0.6 mm matrix 256 x 256, TSE factor 12, TR 3166 ms, TE 100 ms, RFOV 91%, TE 11 ms, NSA 2. In the control and study groups, the medial and the lateral menisci thickness were measured in 3 different (anterior, medial and posterior) regions. The thickness of the anterior and posterior horns were measured on the sagittal plane (**Figure 1**), the thickness of the mid-portion of the meniscal body was measured on the coronal plane. All measurements were performed using Philips Viewforum Workstation Software. The thickness of the medial and lateral menisci was measured in the same coronal image from the region where the thickness of the menisci were thickest. The measurements described above were obtained as millimeters, in the same slices for each patient.

The SPSS 11.0 package (SPSS Inc, Chicago, Illinois, USA) for PC was used for the statistical analysis. After tests for normality, statistical significance was calculated using an independent sample t test for normally distributed data, and the Mann-Whitney U test for data not normally distributed.

Results. The thicknesses of the anterior and posterior horn and mid body of the medial and lateral meniscus are summarized in **Table 1**. We found that the thickness of the posterior horn of the medial meniscus, and the anterior horn of the lateral meniscus in the OA patients was significantly higher compared with those of the control subjects. There were no differences between subjects in age or weight. There were 36 patients (50 knees) with an MRI diagnosis of OA. In 14 knees (28%), MRI revealed osteophytes and degenerative articular cartilage lesions of the tibial and femoral condyles. In 37 knees (76%), degenerative meniscal lesions were found. In this subgroup, 9 ruptures of the ACL were recorded. Twenty-nine medial menisci were damaged, and 2 of them had a tear. There were 8 knees with both medial and lateral meniscal damage, however, they had no tear.

Discussion. The results presented in this study demonstrate that posterior horn thickness of the medial meniscus, and anterior horn thickness of the lateral meniscus were significantly higher in OA patients compared with controls. In OA patients, all the measurements were higher than the control group. These findings were not however, of statistical significance. In several previous studies, the average thickness of the menisci was reported.¹¹⁻¹³ The average thickness of the anterior and posterior horn, and mid body of the medial and lateral meniscus was similar to those reported measurements in our control group. It is important to develop methods that can detect less severe changes to learn more about the early pathophysiological processes.¹⁴ Early changes of OA include meniscus degeneration.³ Le Graverand et al,¹⁵ examined the histologic changes that accompany the formation of cell clusters during the early stages of OA development in the meniscus. They found an alteration in the normal interconnected network of meniscal cells in the fibrocartilaginous region of the tissue. This led to isolation of islands of cells within the extracellular matrix of the meniscal tissue, and the size of these islands increased with time, apparently as the result of cell proliferation. On the other hand, Sandy et al¹⁶ determined the increase in the biosynthetic activity throughout the meniscal cartilage in the early stages of experimental osteoarthritis. This increase

was found to be due to general stimulation of existing chondrocytes. Changes to the articular contour of the menisci, in which the surfaces appeared convex and to bulge into the joint space, would suggest alterations in the tissue, similar to the swelling of articular cartilage in early OA associated with increased tissue hydration.^{17,18} In the study of Le Graverand et al,¹⁵ significant increase in water content was found in the medial meniscus following ACL transection in early stage of OA knees.

Only few investigations have determined the topological changes of the meniscus in the early stages of OA knee. Nagata et al¹⁹ investigated the degeneration of the medial meniscus in the OA knee by histological and immunohistochemical analysis. They observed heavier degenerated and rough structures in the middle and the posterior portion, while mild degenerated structures were found in the anterior portion. Medial meniscus abnormalities affecting the posterior horn have been shown to be more common than those of the lateral meniscus, in both symptomatic and asymptomatic populations.^{20,21} The most frequent site of spontaneous meniscal tears is in the posterior horn of the medial meniscus in OA patients.¹⁴ This is in keeping with our results that shows an increase in the thickness of the posterior horn of the medial meniscus in OA patients. These findings may be related to a combination of the shape, size, and relative immobility of the medial meniscus. It is known that the posterior horn of the medial meniscus is fixed to the posterior tibial intercondylar area,⁵ and is wider than the anterior horn.²² We suggest that the posterior horn of the medial meniscus was affected due to its own anatomical structure and localization. Our results show that the OA patients have a tendency to posterior horn damage before the anterior horn and mid zone of the medial meniscus. In this research, it was somewhat surprising that the anterior horn of the lateral meniscus was found to be higher in the OA patients compared with the controls. The anterior horn of the lateral meniscus is attached in front of the intercondylar eminence, posterolateral to the ACL, with which it partly blends.⁵ Anatomical localization and biomechanics of the ACL may account for our findings. The ACL is a primary restraint to anterior translation of the tibia on the femur, and a secondary restraint to internal rotation, varus, valgus and hyperextension. The ACL deficiency results in the disintegration of the normal rolling-gliding movement of the femur on the tibia. The abnormal movement is suggested as a cause of potential injury to the menisci.²² There exists a correlation of ACL and meniscal tears.²³ We know that the femoral notch narrowing at the ACL insertion site is associated with

OA severity.²⁴ Quasnichka et al²⁴ reported decreased intercondylar notch width in OA-prone Dunkin-Hartley guinea pigs, indicating that bone remodeling at the ACL insertion site is a response to elevated ACL laxity. In our cases, partial ACL tears were present. A possible explanation of the increased height of the anterior horn of the lateral meniscus is deterioration of the ACL at the insertion site while it blended with the meniscus.

In OA of the knee, comparing degeneration of the cartilage, and topological changes of the meniscus were not previously well-reported.¹⁹ This study demonstrated the increase in thickness of the posterior horn of the medial meniscus and the anterior horn of the lateral meniscus, a clear indication that meniscal degeneration in OA is not evenly distributed in the knee. It is quite possible that progression of OA in the knee joint will result in thickening of the meniscus in some areas. In conclusion, measurement of thickness may provide a valuable quantitative tool for studying in-vivo progression of OA patient conditions.

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