

## Morphometric Study of Menisci of Knee Joint in Human Cadavers

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### Abstract

**Introduction:** The Menisci of knee joint are crescentic laminae of fibrocartilage on the articular surface of the tibia that deepen the articulation of tibial surface of femur. The Medial Meniscus is broad and semicircular in shape. The Lateral Meniscus is nearly circular and more freely movable than the Medial Meniscus. The Medial and Lateral Menisci serve very important roles in knee stability, function and dynamic loading and are thus important in maintaining proper joint health. The function of stabilization, mainly the rotational, is one of the most important and is directly related to the meniscal injuries. Variations of shape and in particular of thickness and width of Menisci can determine the possibility and the kind of injury. The anatomical variations of the structures of the knee joint have recently become significant because of recent imaging techniques such as arthroscopy, computed tomography and magnetic resonance imaging. The emergence of Meniscal transplantation in meniscal injuries has revolutionized the treatment modalities, the size and shape of the meniscus being very important. **Methods:** 100 menisci from 50 adult cadaveric knee joints which were preserved in formaldehyde solution were included in this study. The morphological variants of the shapes of Medial menisci were noted and classified. The width and the thickness of the Medial Menisci were measured using a Vernier's Calipers. **Results:** The mean width of the Medial Menisci was 7.96mm in anterior third, 8.10mm in middle third and 13.46mm in the posterior third. The mean thickness of the Medial Menisci was 4mm in anterior third, 3.84mm in the middle third and 4.02mm in the posterior third. The mean width of the Lateral Menisci was 9.14mm in the anterior third, 9.32mm in the middle third and 9.10mm in the posterior third. The mean thickness of the Lateral Menisci was 3.4mm in anterior third, 4.18mm in the middle third and 3.64mm in the posterior third. **Conclusions:** The mean width of the Medial Meniscus was maximum at the post third of the Medial Meniscus. The mean thickness of the Medial Meniscus was least in the middle third. Lateral Meniscus was thickest in the middle third. A single specimen of partial Discoid Lateral Meniscus was observed. The medial meniscus is more prone to injuries in the middle third as it is thinner and becomes impacted during movements of the knee joint. Lateral Menisci are less prone to ruptures. Narrow meniscus is less liable to pressure from femoral condyle. The exact size and also shape is essential for meniscal transplantation in injuries to the Menisci.

**Keywords:** Medial Meniscus, Lateral Meniscus, crescentic, knee joint.

## **Introduction**

The Menisci of knee joint are crescentic laminae of fibrocartilage on the articular surface of the tibia that deepen the articulation of tibial surface of femur. The Menisci are thicker and convex at their outer margins while the inner free margins are thin and concave. The Medial Meniscus is broad and semicircular in shape. The Lateral Meniscus is nearly circular and more freely movable than the Medial Meniscus<sup>1</sup>. The Medial and Lateral Menisci serve very important roles in knee stability, function and dynamic loading and are thus important in maintaining proper joint health<sup>2</sup>. The Medial and Lateral Menisci although similar in function have minor differences in their shape and thus their biomechanical role in the knee<sup>3</sup>. The function of stabilization, mainly the rotational, is one of the most important and is directly related to the meniscal injuries. There are marked differences in the contour and insertion between the Lateral and the Medial Menisci which are important in relation to the injury mechanisms. Variations of shape and in particular of thickness and width of Menisci can determine the possibility and the kind of injury<sup>4</sup>. The occurrence of a discoid type of Lateral Meniscus is an important observation for reporting.

The anatomical variations of the structures of the knee joint have recently become significant because of recent imaging techniques such as arthroscopy, computed tomography and magnetic resonance imaging<sup>5</sup>. The emergence of Meniscal transplantation in meniscal injuries has revolutionized the treatment modalities, the size and shape of the meniscus being very important. There are tissue banks available for selecting donor Menisci for transplantation<sup>6</sup>.

In the present study, the various shapes of Medial and Lateral Menisci were estimated and also the incidence of Discoid Lateral Meniscus was looked for. The thickness and width of the Medial and Lateral Menisci were determined. The distance between anterior and posterior horns of each of the Medial and Lateral Menisci were documented.

## **Methods**

The study included 100 menisci from 50 knee joints procured from the Department of Anatomy, Sri Devaraj Urs Medical College, Tamaka, Kolar, Karnataka. All specimens were preserved in 10% formaldehyde solution. The knee joint was opened by turning the patella downwards. The ligaments of the knee joint were identified and the fibrous capsule was opened. The synovial membrane and surrounding connective tissue were removed. The Cruciate ligaments (anterior and posterior) were then identified and divided. The proximal surfaces of the tibia and menisci were visualized by cutting the remains of the fibrous capsule and the surrounding connective tissues. The anterior and posterior horns of the Medial and Lateral Menisci were identified and their attachments

to the tibia were defined. The Medial and Lateral Menisci were dissected intact by dividing their attachments to the tibia.

The width and thickness of the Medial and Lateral Menisci were recorded after dissecting the intact menisci using Vernier Calipers. Menisci showing structural changes similar to those in injuries or degenerated specimens were excluded from the study.

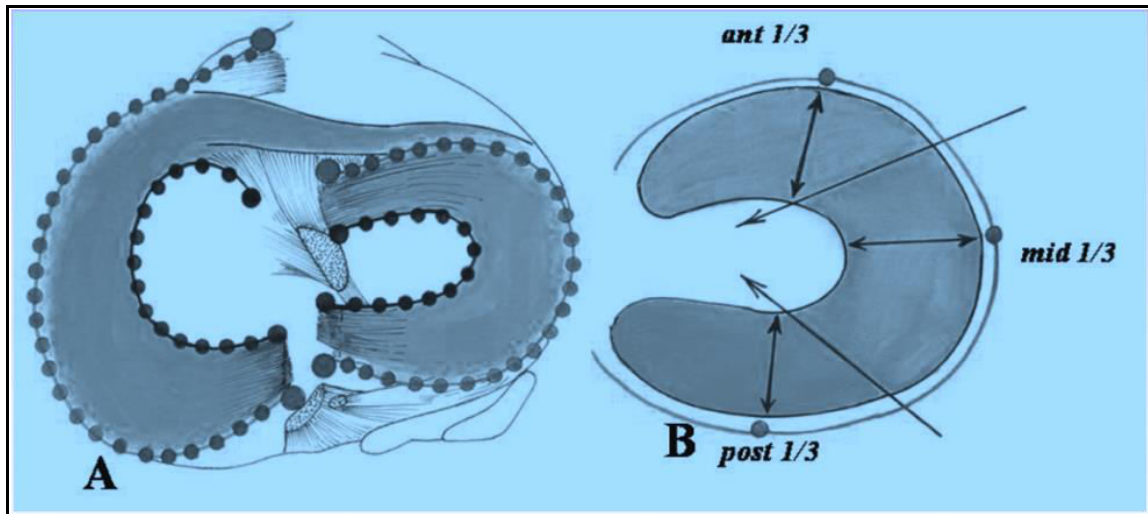
First, the lengths of the menisci were determined. The length was calculated as follows: the distance between the anterior and posterior horns was also measured. This was divided into four equal parts using three markings, designated as one anterior, one middle, and one posterior. The length was measured using each of these markings as projections on the entire circumference of the menisci. The width of each meniscus was measured by drawing a line from the peripheral margin to the inner free margin of the menisci at the above-mentioned three points. A Vernier Caliper was used to obtain measurements. (Figures 1,2 & 3). The thickness was also determined at the same three points using a Vernier Calipers (Figure 3)



**Figure 1:** Identification of Menisci of knee joint



**Figure 2:** Discoid lateral menisci



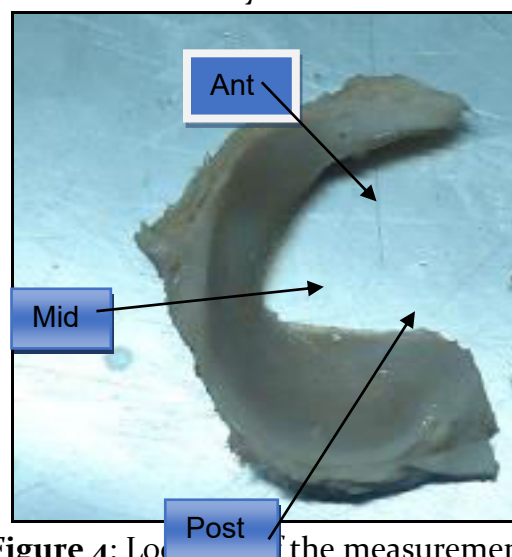
**Figure 3:** Measurement of thickness of menisci of knee joint

### Statistical Analysis

The data on morphometrics of Menisci of knee joint were analyzed using descriptive statistics, including mean and standard deviation.

### Results

The mean width of the Lateral Menisci was 9.14 mm in the anterior third, 9.32 mm in the middle third and 9.10 mm in the posterior third. The mean thickness of the lateral Menisci was 3.52 mm in the anterior third, 4.48 mm in the middle third and 3.64 mm in the posterior third (Table 1). The lateral meniscus was the widest in the middle third and thickest in the middle third. Lateral Menisci are less prone to ruptures. A narrow meniscus is less prone to pressure from the femoral condyle. A discoid lateral meniscus was identified and documented in this study.



**Figure 4:** Location of the measurements

The medial meniscal measurements were performed in the same parts of the meniscus. The mean width of the Medial Menisci was 7.96 mm in anterior third, 8.10 mm in middle third and 13.46 mm in the posterior third as shown in table 1. The mean thickness of the medial meniscus was 4, third, 3.84 mm in the anterior, middle third and 4.02 mm in the posterior third, respectively.

**Table 1:** Width and thickness of the Lateral and Medial Menisci

Location	Lateral Menisci		Medial Menisci	
	Mean width (mm)	Mean thickness (mm)	Mean width (mm)	Mean thickness (mm)
Anterior third	9.14	3.52	7.96	4
Middle third	9.32	4.48	8.1	3.84
Posterior third	9.28	3.64	13.46	4.02

## Discussion

According to Almeida et al<sup>4</sup>, the width of the medial meniscus was recorded as follows: anterior third – 9.02 mm, middle third – 12.16 mm and posterior third – 17.37 mm. In a study by Almeida et al., the widths of the Lateral Menisci were more uniform: the anterior third was 11.86, the middle third was 11.97, and the posterior third was 11.44. Jonathan Noble reported the widths as ant. – 9.25 mm, middle – 13.25 mm and post. Third – 18 mm<sup>7</sup> for lateral meniscus and Anterior third – 11.25 mm, middle third – 12 mm and posterior third – 11.5 mm for medial meniscus.

The present study also highlighted that the middle third of the lateral meniscus is the thickest. The present study also mentioned that the middle third of the Medial Meniscus may be more frequently prone to injuries, being the thinnest region of the Medial Meniscus. The Medial Meniscus was widest in the posterior third (13.46 mm in the present study. In 1889, Young first described the Discoid Lateral Meniscus<sup>8</sup>. Kaplan EB in 1957 studied 6 cadaveric knee joints and found that only one cadaver had bilateral Discoid Menisci<sup>9</sup>. Dickhaut et al. (1982) described Discoid Lateral Meniscus as a morphologically variable anomaly. They concluded that Discoid type of Lateral Meniscus had a role in causation of abnormal mobility and caused symptoms in patients<sup>10</sup>

Albertsson M and Gillquist J in 1988 studied Discoid Menisci in 7,056 knee arthroscopies performed, 30 of which had discoid menisci, 29 Discoid Lateral Menisci and one Discoid Medial Meniscus<sup>11</sup> Ashwini et al in 2012 studied a case of unilateral Discoid Lateral Meniscus in an adult cadaver and suggested that Discoid Lateral Meniscus is a

rare anomaly which is clinically important because of its higher incidence of tear<sup>12</sup>. The present study identified a discoid lateral meniscus in one specimen of 50 dissected cadaveric knee joints.

## **Conclusions**

The medial and lateral menisci are important structures in the knee joint that transmit weight-bearing forces and increase knee joint stability. The menisci also facilitate nutrition, provide lubrication and shock absorption for the articular cartilage, and promote knee proprioception.

The characteristic finding was an incomplete discoid Lateral Meniscus in one specimen of the left-sided lateral meniscus.

The widths of the Medial Menisci at the three locations on the surface of the menisci showed that the Medial Meniscus was widest at the posterior third, measuring a mean of 13.46 mm. This suggests that the Medial Meniscus, being significantly wider in the posterior third, is more prone to injuries than the Lateral Meniscus, as more pressure is transmitted over the Medial Meniscus from the femoral condyles. The thicknesses of the Medial and Lateral Menisci were recorded in the anterior, middle, and posterior thirds. The thickness of Medial Menisci in the middle third

was seen to be thinnest with 3.84 mm suggesting that middle third of the Medial Meniscus is more frequently prone to injuries. The exact size and shape are essential for meniscal transplantation for injuries to the menisci, which are very common in sports.

Meniscal transplantation is emerging as an important modality in the management of meniscal tears, which is managed by removal of the meniscus leading to knee joint arthritis. Further, this study can be helpful for orthopedicians in the understanding of degenerative diseases affecting knee joint menisci, as these diseases affect anatomical parameters such as width, thickness, and shape of the meniscus. The exact size and shape are essential for meniscal transplantation in meniscal injuries.

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