

Research Article

Morphometric analysis of lateral menisci in North Indian population: a cadaveric study

Jyoti Rohila^{1*}, Suresh Kanta Rathee¹, Swati Bansal²

¹Department of Anatomy, Pt. B.D. Sharma PGIMS Rohtak, Haryana, India

²Department of Anatomy, Haryana Institute of Medical Sciences, Kaithal, Haryana, India

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*Correspondence:

Dr. Jyoti Rohila,

E-mail: jyotirohilla41@yahoo.in

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ABSTRACT

Background: The menisci (formerly called semilunar cartilages) of the knee lie within the knee joint between the femur and tibia and somewhat adapt the tibial and femoral condyles to each other. The menisci are liable to injury resulting from twisting strains applied to flexed weight bearing knee. The mean annual incidence of meniscal tears is about 60-70 per 100,000 with a male to female ratio ranging from 2.5:1 to 4:1. The present study was conceived to provide valuable morphological data for preparing meniscal allograft for people of this region so that accurate matching can be done in meniscal transplantation.

Methods: The study was carried out in 100 lateral menisci of adult human male cadavers with age ranging from 20 to 50 years. Distance between anterior and posterior horns of lateral meniscus, outer and inner border length, width and thickness at three points, namely anterior, middle and posterior one third was taken with the help of non-elastic thread and Vernier caliper. Written informed consent was taken from the relatives of the deceased.

Results: Distance between the two horns of lateral meniscus, outer border and inner border length of right and left lateral meniscus were not significantly differently from each other. Width and thickness of lateral meniscus was highest in the middle part which was significantly different from other parts.

Conclusions: In conclusion, width and thickness was highest in the middle third part of lateral menisci. Also, shapes of lateral menisci were different from others studies. The current study presents a database of morphological values of lateral menisci for North Indian population for meniscal transplantation.

Keywords: Menisci, Knee joint, Morphometry, Width, Thickness

INTRODUCTION

The menisci (formerly called semilunar cartilages) of the knee lie within the knee joint between the femur and tibia and somewhat adapt the tibial and femoral condyles to each other. Each meniscus is a piece of fibro cartilage with a thickened outside edge and a thin inner edge so that it is wedge shaped in cross section.¹

The periphery of lateral meniscus is thicker and the width of the meniscus is greater and more uniform in the anterior and posterior halves.² The two horns of the lateral meniscus tend to be the same size and hence this

meniscus more nearly approaches the form of an incomplete '0'.³ Various functions of the menisci include low transmission, shock absorption, joint stabilization, cartilage nutrition and joint lubrication. They transmit approximately 50% of the weight bearing forces in extension and 85% in flexion.⁴

Menisci perform important functions and hence, are frequently exposed to injuries. The menisci are liable to injury resulting from twisting strains applied to flexed weight bearing knee.⁵ The mean annual incidence of meniscal tears is about 60-70 per 100,000 with a male to female ratio ranging from 2.5:1 to 4:1. Meniscal

pathology in younger patients is likely to be consequent to an acute traumatic event while degenerative changes are more frequent at an older age.

Removal of meniscus after trauma is the most commonly performed procedure in the knee and often leads to degenerative arthritis. Tears of menisci are common in the avascular zones and if treatment is needed, are best resected.²

Motta Filho et al reported an average thickness of 4-5 mm and average width of 12 mm for lateral meniscus.⁶ Similar width and thickness were reported by Hayashi et al.⁷ Testut and Latarjet described an average thickness of 8 mm and width of 10-12 mm for lateral meniscus.⁸ Murlimanju et al described three morphological variants of lateral menisci which were C shaped, Crescent and Discoid.⁹

Meniscal transplantation is being evaluated to restore normal contact mechanism to the joint. If normal contact mechanics are to be successfully restored by meniscal transplant then geometric match between transplant and original meniscus must be considered in transplant selection procedure.

Availability of data regarding lateral meniscus is scarce in North Indian population as less literature is available on this topic. Hence, the present study was conceived to provide valuable morphological data for preparing meniscal allograft for people of this region so that accurate matching can be done in meniscal transplantation.^{10,11}

METHODS

The study was carried out in 100 lateral menisci of adult human male cadavers with age ranging from 20 to 50 years. The study was conducted during medico-legal autopsies done in the Department of Forensic Medicine, PGIMS Rohtak, Haryana, India. Family members of the subjects were fully informed and written consent was taken before taking the specimen. This research work was approved by the Institutional Ethical Committee.

Method of dissection

After the dissection of skin and muscles, the menisci were approached anteriorly by a longitudinal incision on each side of the joint capsule, cutting the patellar ligament and the collateral ligaments transversely.

In order to expose the menisci clearly, the joint capsule and the intra articular ligaments were cut and the condyles were circumferentially detached from their soft tissue attachments, exposing the tibial plateau.⁹

Approximately 2-3 cm thick tibial plateau was taken out along with menisci with the help of electric saw. After that skin was stitched.

Inclusion and exclusion criteria

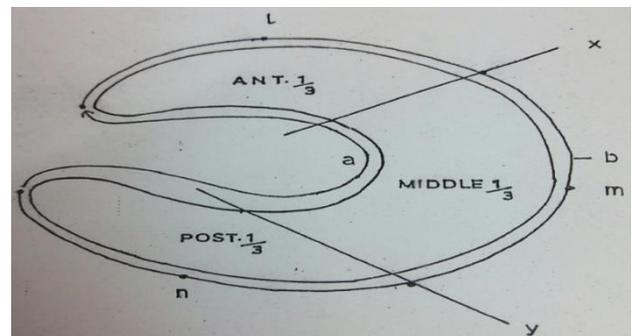
Specimens were analyzed for different measurements whose autopsies had been performed within 24 hours of death. Cases with any primary traumatic injury, any arthroscopic surgical interventions on knee joint and in which structures were seen to be distorted before or during autopsy were excluded.

The sample for this study was collected from April, 2012 to June, 2013. For this study, 100 lateral menisci of both knees of 50 adult human cadavers were taken for analysis. All dissections were performed in a systematic fashion.³

Measurements

Firstly the length of each meniscus was measured, for which non-elastic cotton thread was placed across the outer edge of the meniscus from the apex of the anterior horn to the apex of posterior horn. Next, the thread length was measured using a digital Vernier caliper (least count-0.02 mm).

Then, the distances between the anterior and posterior horns were measured using digital caliper, which was placed between the apex of the anterior horn and the apex of the posterior horn. The width was measured at three points - the anterior third, middle third, and posterior third (Figure 1).



a= Inner border length; b= Outer border length.

Figure 1: Meniscus of knee joint.

The meniscus is divided into three equal parts by two lines x and y along the outer border length. The mid points of these three parts were marked as l, m, and n. The thickness of the outer border and width of meniscus to be noted at these three points (l, m and n).

From each point, the caliper was positioned from the outer edge to the inner edge of each meniscus. The thickness of the meniscus was determined using the same width points, and then the caliper was placed between the top and bottom edge in the outer circumference only.

Measurements were repeated twice and the mean value was taken to avoid intra-observer bias. The data thus

obtained was recorded on a standardized collection sheet. Different shapes of lateral menisci were also noted as described by Murlimanju et al.⁹

Statistical analysis

Data collected was analyzed using SPSS 20.0 (IBM., USA). Descriptive statistics were presented as mean and standard deviation and parametric test were applied (student t-test and analysis of variance (ANOVA)) to see significant difference between mean values. The level of significance was considered when p value was less than 0.05.

RESULTS

As the data was analyzed, it was observed that outer border length and inner border length of lateral menisci of right knee was 10.21±0.74cm and 5.33±0.72cm respectively. Distance between anterior and posterior horn of right lateral meniscus was 1.71±0.42cm.

Outer border length and inner border length of left knee was 10.07±0.70cm and 5.33±0.79cm respectively and the distance between two horns was observed to be 1.69±0.37cm in left knee. When these variables were compared between right and left knee, no significant difference was observed (p-value>0.05).

Table 1: Width comparison in lateral menisci.

Group	Variable	Mean±SD (in mm)	Groups compared	p-value
A	Width in Anterior one-third	9.93±1.71	A-B	0.001
B	Width in Middle one-third	11.21±2.91	B-C	>0.05
C	Width in Posterior one-third	11.03±1.40	C-A	0.001

When width of lateral menisci was measured in its anterior, middle and posterior one-third, it was found to be 9.89±1.77mm, 11.42±2.38mm and 10.90±1.31mm respectively in right knee. Width in the anterior, middle and posterior one-third of left knee was observed as 9.98±1.66mm, 11.01±3.37mm and 11.17±1.49mm respectively. When these variables of width were compared between right and left knee, no significant difference was noted (p-value>0.05). Table 1 shows the width comparison in lateral menisci among anterior, middle and posterior one-third.

Thickness of the lateral menisci was also measured in its anterior, middle and posterior one third and results observed as 4.96±1.22mm, 7.03±1.09mm and 6.32±1.17mm respectively in the right knee while in the left knee it was found to be 4.49±0.97mm, 6.48±1.11mm and 6.03±0.75mm in its anterior, middle and posterior one third respectively. When comparison of thickness between right and left lateral menisci done, the difference between right and left lateral menisci in its anterior and

middle one third was found to be statistically significant (p-value<0.05) whereas thickness in its posterior third was not statistically significant (p-value>0.05). Table 2 shows the thickness comparison in lateral menisci among anterior, middle and posterior one-third.

Figure 2 shows the frequency of shapes of lateral menisci found in the present study.

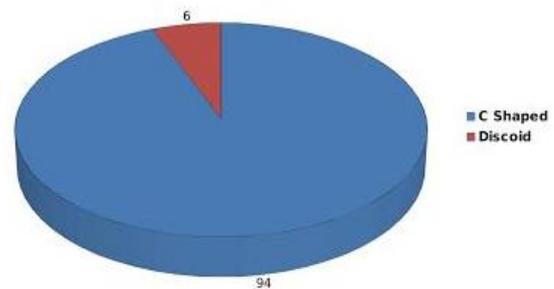


Figure 2: Frequency of different shapes in lateral menisci.

Table 2: Thickness comparison in lateral menisci.

Group	Variable	Mean±SD (in mm)	Groups compared	p-value
A	Thickness in Anterior one-third	6.40±1.37	A-B	0.007
B	Thickness in Middle one-third	6.93±1.15	B-C	0.662
C	Thickness in Posterior one-third	6.72±1.12	C-A	0.201

DISCUSSION

Braz PRP et al studied the lateral meniscus; found middle third was the thickest followed by posterior and anterior third. With regard to width there was no significant difference between anterior, middle and posterior third. Distance between anterior and posterior horn of lateral meniscus was found to be around 12.55 ± 1.98 mm.¹² Murlimanju et al reported percentages of different types of lateral menisci which were 61.1% C shaped, 38.9% crescent shaped. No discoid lateral meniscus was observed.⁹

With regard to the width of the lateral meniscus, we found that there was significant difference between the anterior (9.93 ± 1.71 mm), middle third (11.21 ± 2.91 mm), and posterior thirds (11.03 ± 1.40 mm). However, on individual analysis, no significant difference was found on comparing the width between middle third and posterior third. Ashwini et al reported for lateral meniscus that the posterior third part (9.36 ± 1.19 mm) was the widest compared to the anterior third (8.08 ± 1.14 mm) and the middle third parts (8.52 ± 2.12 mm).¹³

Braz PRP et al reported that for width of the lateral meniscus, there was no significant difference between the anterior (11.32 ± 1.46 mm), middle (11.16 ± 1.64 mm), and posterior thirds (11.67 ± 1.54 mm) while no statistically significant difference was reported by Almeida et al in the lateral meniscus between the three parts analyzed.^{12,14} The results for width of lateral meniscus of our study are not in agreement with other studies. According to our study, width of middle third of lateral meniscus was the widest part while other studies reported posterior third of lateral meniscus to be widest. Above findings suggest that there are differences in the shape of lateral menisci in present study as compared to other studies.

With regard to the thickness of the lateral meniscus of our study, the thickness of all the three points was significantly different from each other. The middle third was the thickest part (6.75 ± 1.13 mm), followed by posterior (6.18 ± 0.99 mm) and anterior thirds (4.73 ± 1.12 mm). Braz PRP et al, in the lateral meniscus, reported that the anterior third was the thinnest (4.40 mm) followed by the posterior (5.46 mm) and middle (6.52 mm) thirds, and their average value was 5.46 mm.¹²

Almeida et al reported that the lateral meniscus showed a significant difference among the anterior (3.57 mm), middle third (6.10 mm) and posterior (5.92 mm) thirds, with the middle as the thickest point of the meniscus.¹⁴ In contrast to above studies, study done by Ashwini et al. reported that the posterior third (2.06 ± 9.3 mm) of the lateral meniscus was the thickest part ($p < 0.05$) followed by middle third (1.76 ± 0.81 mm) and anterior third (1.41 ± 0.51 mm) was the least. A statistically significant difference was observed ($p < 0.05$) among the anterior, middle and posterior thirds of lateral meniscus.¹³ Our study is in consistent with Braz PRP et al and Almeida et

al in its measurement of thickness of lateral menisci. Results of our study are not in agreement with the results of Ashwini et al.

According to Smillie, the morphological differences of menisci, in particular, in the thickness and width can determine not only the possibility of an injury, but also the location and the kind of injury.² This author also suggests that the narrow meniscus is less prone to ruptures than the wide. This supposition is justified because the narrow meniscus is liable to a less action of femoral condyle. This point is of clinical significance and study can be done on the status of injury in the future as data is very scarce in North-Indian population.

With regards to shape of lateral menisci, the present study results do not corroborate with findings of Murlimanju et al. which shows different shapes of menisci for North Indian population. In the present study, right and left knee lateral menisci were compared which shows no statistical difference between the two.

However, Braz PRP et al and Ashwini et al. conducted study among mixed specimens (both right and left knee) and reported results for lateral menisci which shows almost congruent shapes and parameters of lateral menisci.

CONCLUSION

In conclusion, width and thickness was highest in the middle third part of lateral menisci. Also, shapes of lateral menisci were different from others studies. The current study presents a database of morphological values of lateral menisci for North Indian population for meniscal transplantation.

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