

Morphometry of Menisci of Human Knee Joint, A Cadaveric Study

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Abstract

Context: The menisci are cartilaginous tissue which provide structural integrity to the knee during tension and torsion. Variations of form, thickness and width determine possibility and kind of injury. Now a days, Menisci are considered having integral role in normal knee joint mechanics. The detail knowledge of meniscal morphometry is important to understand its pathology and treatment.

Aims: To measure width, thickness, outer and inner circumference, distance between anterior and posterior horn of medial and lateral menisci.

Methods and Material: Study was done on 80 menisci of both sides. Distance between anterior and posterior end, outer and inner circumference, width and thickness of menisci measured by using Vernier caliper.

Statistical analysis used: P value calculated by t test to assess statistical significance.

Results: Width of posterior 1/3rd shows statistically significant variation, along with thickness of posterior 1/3rd.

Conclusions: The difference between anterior and posterior horn of the medial meniscus was quite higher than that of lateral meniscus. In the medial meniscus, the posterior third was widest and thickest part which was statistically significant, whereas there was no statistically significant difference in anterior and middle third thickness and width of both menisci. These findings are in accordance with certain injuries being common in medial menisci. However more sophisticated instruments needed for better measurement.

Keywords: Knee; Meniscus; Morphometry; Injury; Horn.

Keymessages: Detailed morphometry of menisci helps to understand meniscal injuries and their management.

Introduction

The menisci are cartilaginous tissue which provide structural integrity to the knee during tension and torsion.⁵ Variations of form, thickness and width determine possibility and kind of injury.^{2,6} There are many differences in anatomical features and insertion between lateral and medial meniscus. The contour of meniscus changes from semicircular to circular. So detailed morphometric study is needed to measure its width, thickness, distance between anterior and posterior horn. Meniscal injury is very common clinical condition. Now a days, Menisci are not optional or expandable structures,¹ they have integral role in normal knee joint mechanics. The detail knowledge of meniscal morphometry is important to understand its pathology and treatment.⁵

Subjects and Methods

The study was done on 40 cadavers. Total no of sample were 80 menisci including both right and left (Fig. 1,2). After removing skin over knee joint, Ligamentum patellae and patella turned superiorly. Knee was flexed to see menisci. Menisci showing structural changes due to injury, degenerative changes were excluded.

The measurements include outer and inner circumference of menisci, width and thickness by using Vernier caliper. Distance between anterior and posterior end is also measured (Fig. 3,4,5,6,7).

Results

In present study, mean distance between two ends of medial meniscus found is 22.6±6.1mm for medial meniscus (Table 3) and 11.7±5.6mm for lateral meniscus (Table 4) (Graph 3). There being no statistical difference among them (Table 1).

Mean width of medial meniscus in anterior 1/3rd 8.60±2.3mm, middle 1/3rd 8.70±2.4mm, posterior 1/3rd 11.70±3.5mm (Table 3). So it is observed that posterior most part is the thickest (p=0.00) (Table 1), while width for lateral meniscus is anterior 1/3rd 9.30±1.7mm, middle 1/3rd.

9.10±1.9mm, posterior 1/3rd 10.00±2.0mm (Table 4) (Graph 2). There is no statistical difference observed among the parameters (Table 1).

Mean thickness of medial meniscus in anterior 1/3rd 4.40±1.1mm, middle 1/3rd 4.80±1.5mm, posterior 1/3rd 4.70±1.3mm (Table 3), the posterior most part is the thickest (p=0.00)

(Table 1), while width for lateral meniscus is anterior 1/3rd 4.10±1.4mm, middle 1/3rd 4.90±1.7mm, posterior 1/3rd 5.10±1.7mm (Table 4) (Graph 1).

Mean outer circumference for medial meniscus is 84.50±11.1mm, inner circumference is 49.30±7.2mm (Table 3), while lateral meniscus has mean outer circumference of 77.70±13.3 mm, inner circumference of 41.90±10.6mm (Table 4) (Graph 4).

Width of posterior 1/3rd shows statistically significant variation, along with thickness of posterior 1/3rd as well (Table 1).

For distance between two ends of meniscus, mean difference between right and left knee of medial meniscus is 3.25 and for lateral meniscus it is -3.4 mm. Mean difference in width from anterior, middle, posterior third it is 0.55, 3, 0.4 mm respectively for medial meniscus. For lateral meniscus these parameters are - 0.3, 0.1, - 0.05 mm. Mean difference in thickness from anterior, middle, posterior third it is 0.2, 0.2, - 0.75 mm respectively for medial meniscus, for lateral meniscus these parameters are - 0.8, 0.6, 0.25 mm. Mean difference in circumference is 6.4 (outer), 1.4 (inner) mm for medial meniscus and 2.05 (outer), - 2.4 (inner)mm for lateral meniscus (Table 2).

Table 1: Comparison of different parameters between medial and lateral meniscus (T- Test).

		Independent Samples Test			
		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
Distance between two ends of meniscus	Equal variances assumed	.195	.660	8.276	78
	Equal variances not assumed			8.276	77.532
width anterior third	Equal variances assumed	3.190	.078	- 1.464	78
	Equal variances not assumed			- 1.464	71.146
width middle third	Equal variances assumed	.783	.379	- .814	78
	Equal variances not assumed			- .814	75.070
width posterior third	Equal variances assumed	12.388	.001	12.617	78
	Equal variances not assumed			12.617	52.123
Thickness anterior third	Equal variances assumed	.329	.568	- 1.489	78
	Equal variances not assumed			- 1.489	68.872
thickness middle third	Equal variances assumed	.007	.936	- .872	78
	Equal variances not assumed			- .872	77.057
thickness posterior third	Equal variances assumed	48.149	.000	- 34.418	78
	Equal variances not assumed			- 34.418	39.740
circumference outer	Equal variances assumed	.881	.351	17.493	78
	Equal variances not assumed			17.493	77.884
circumference inner	Equal variances assumed	.941	.335	3.655	78
	Equal variances not assumed			3.655	68.373

p value <0.05* statistically significant - marked in yellow.

Table 2: Mean difference of the parameters between right knee and left knee of medial meniscus and lateral meniscus.

Parameters / Side of the Knee	Distance between two ends of meniscus (in mm)	Width (in mm)			Thickness (in mm)			Circumference (in mm)	
		Anterior third	Middle Third	Posterior Third	Anterior Third	Middle Third	Posterior Third	Outer	Inner
Medial Right- knee vs Left knee	3.25	0.55	3	0.4	0.2	0.2	-0.75	6.4	1.4
Lateral Right- knee vs Left knee	-3.4	-0.3	0.1	-0.05	-0.8	0.6	0.25	2.05	-2.4

Table 3: Descriptive statistics of different parameters of medial meniscus.

Parameters		Minimum	Maximum	Mean	Std. Deviation	Median
Distance between two ends of meniscus (in mm)		10.0	38.0	22.6	6.1	23.0
Width (in mm)	Anterior third	5.0	15.0	8.6	2.3	8.0
	Middle third	4.0	15.0	8.7	2.4	9.0
	Posterior third	4.0	20.0	11.7	3.5	11.5
Thickness (in mm)	Anterior third	2.0	7.0	4.4	1.1	4.0
	Middle third	3.0	10.0	4.8	1.5	4.0
	Posterior third	2.0	10.0	4.7	1.3	5.0
Circumference (in mm)	Outer	65.0	117.0	84.5	11.1	83.0
	Inner	30.0	65.0	49.3	7.2	50.0

Table 4: Descriptive statistics of different parameters of lateral meniscus.

Parameters		Minimum	Maximum	Mean	Std. Deviation	Median
Distance between two ends of meniscus (in mm)		4.0	26.0	11.7	5.6	10.0
Width (in mm)	Anterior third	06.0	12.0	9.3	1.7	9.0
	Middle third	6.0	14.0	9.1	1.9	9.0
	Posterior third	7.0	15.0	10.0	2.0	10.0
Thickness (in mm)	Anterior third	2.0	10.0	4.1	1.4	4.0
	Middle third	3.0	11.0	4.9	1.7	5.0
	Posterior third	3.0	12.0	5.1	1.7	5.0
Circumference (in mm)	Outer	50.0	104.0	77.7	13.3	78.0
	Inner	5.0	59.0	41.9	10.6	44.0
	Inner	5.0	59.0	41.9	10.6	44.0

Table 5: Comparison of thickness of medial meniscus with previous studies.

Medial menisci Thickness in mm	Almeida et al (2004)	Braz and Silva (2010)	Ashwini C et al(2013)	Present study
Anterior 1/3rd	5.92±1.37	6.17	1.54±0.78	4.40±1.1
Middle 1/3rd	5.31±1.06	6.31	1.77±0.56	4.80±1.5
Posterior 1/3rd	5.91±1.13	5.18	1.8±0.78	4.7±1.3

Table 6: Comparison of thickness of lateral meniscus previous studies.

Lateral menisci Thickness in mm	Almeida et al (2004)	Braz and Silva (2010)	Ashwini C et al (2013)	Present study
Anterior 1/3rd	3.71±1.15	4.40	1.41±0.57	4.10±1.4
Middle 1/3rd	6.10±1.04	6.52	1.76±0.1	4.9±1.7
Posterior 1/3rd	5.91±0.78	5.46	2.06±0.93	5.10±1.7

Table 7: Comparison of width of medial meniscus previous studies.

Medial menisci Thickness in mm	Almeida et al (2004)	Ashwini C et al (2013)	Muralimanju et al (2008)	Present study
Anterior 1/3rd	9.02±1.59	6.52±1.29	8.38±1.64	8.60±2.3
Middle 1/3rd	12.16±2.58	6.66±1.11	7.68±1.92	8.70±2.4
Posterior 1/3rd	17.37±2.22	11.28±2.09	13.93±2.69	11.70±3.5

Table 8: Comparison of width lateral meniscus previous studies.

Medial menisci Thickness in mm	Almeida et al (2004)	Ashwini C et al (2013)	Muralimanju et al (2008)	Present study
Anterior 1/3rd	11.86±1.81	8.08±1.14	9.84±1.78	9.30±1.7
Middle 1/3rd	11.97±2.56	8.52±2.12	8.82±2.01	9.10±1.9
Posterior 1/3rd	11.44±1.07	9.36±1.19	9.70±1.69	10.00±2.0

Table 9: Comparison of outer and inner circumference of medial meniscus previous studies.

Medial menisci	Braz and Silva	Ashwini C et al (2010)	Muralimanju et al (2008)	Present study
outer circumference	91.85±5.66	90.12±8.00	99.06±11.21	84.50±11.1
inner circumference		59.96±85.51	55.44±8.37	49.30±7.2

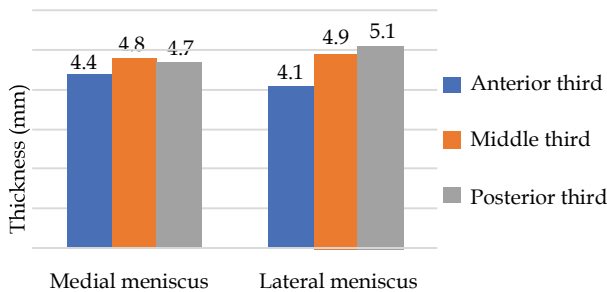
Table 10: Comparison of outer and inner circumference lateral meniscus previous studies.

Lateral menisci	Braz and Silva (2010)	Ashwini C et al (2013)	Muralimanju et al (2008)	Present study
outer circumference	92.80±7.52	83.28±7.46	90.25±9.36	77.70±13.3
inner circumference		49±5.49	50.63±5.33	41.90±10.6

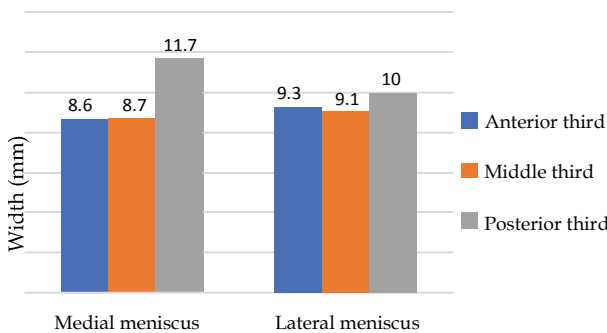
Table 11: Comparison of distance between anterior and posterior horn of medial and lateral meniscus with previous studies.

menisci	Braz and Silva (2010)	Ashwini C et al (2013)	Muralimanju et al (2008)	Almeida et al	Present study
distance between horns of medial meniscus	25.80±3.7	21.32±7.46	24.13±4.19	29.70±4.12	22.6±6.10
distance between horns of lateral meniscus	6.8±1.99	49±5.49	11.31±3.86	12.71±1.84	11.7±5.60

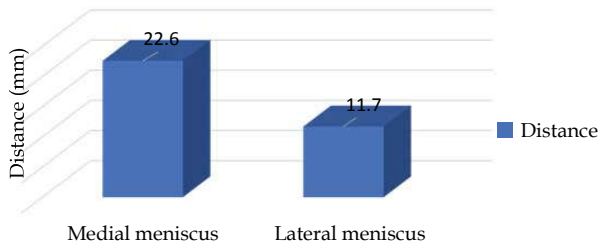
Graph 1: Mean thickness (mm) at different sites of medial and lateral meniscus.



Graph 2: Mean width (mm) at different sites of medial and lateral meniscus.



Graph 3: Mean distance (mm) between two ends of meniscus.



Graph 4: Mean circumference (mm) at different sites of medial and lateral meniscus.

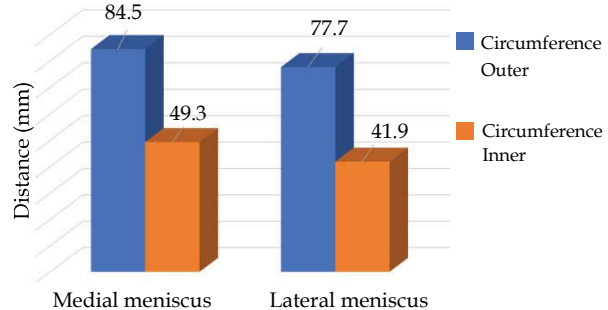


Fig. 1: Medial and lateral menisci.



Fig. 2: Dissected out menisci



Fig. 3: Measurement of width.



Fig. 4: measurement of thickness.



Fig. 5: Measurement of distance between anterior and posterior horn.



Fig. 6: Measurement of outer circumference.

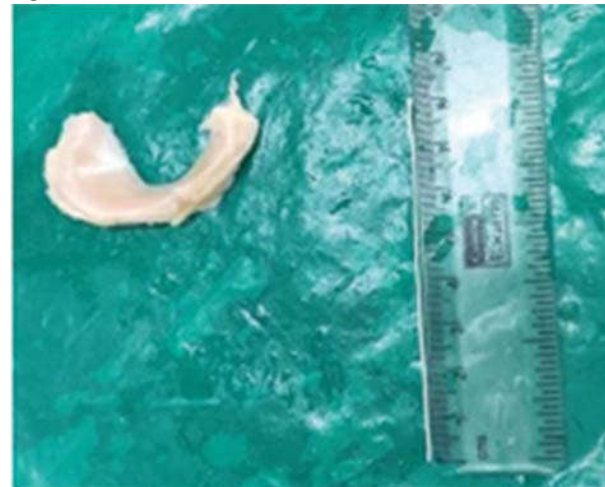


Fig. 7: Measurement of outer circumference.

Discussion

Braz and Silva (2010)³ mentioned the average thickness of outer circumference of medial and lateral menisci as 5.88 mm and 5.46. Ashwini C.¹ et al found posterior third of medial meniscus as thickest (1.8+ - 0.78), then middle third (1.77+ - 0.56), anterior third (1.54 = - 0.78mm). The difference in thickness of anterior, middle and posterior thirds of medial meniscus was of no statistical significance.($p>0.05$). They also found that posterior third (2.06+-9.3mm) of lateral meniscus was thickest ($p<0.05$), then middle third (0.81mm) and anterior third (1.41+-0.51) was the least. They also observed that thickness of middle third of medial meniscus was more than middle third of lateral meniscus (Table 5, 6). This explains higher incidence of injuries in medial meniscus. There was no statistically significant difference in thickness of anterior and posterior third of both the menisci. Regarding width of posterior third of both menisci, it was widest part similar to findings of Muralimanju et al⁶ and Almeida et al.² While

anterior third of medial meniscus was having the smallest width compared with other two points (Table 7,8).

This explains lower incidence of injury in anterior third i.e. wider the meniscus, it is more exposed for injury.

There was no statistically significant difference between peripheral length of medial and lateral meniscus which was found by Braz and Silva.³

Inner length of medial meniscus was significantly higher than of lateral meniscus. ($p < 0.05$) which was not seen by Muralimanju et al (Table 9,10).

The distance between two horns was less in lateral menisci, this finding was similar in most of the studies (Table 11).

Almeida et al² observed that medial meniscus was thinnest at posterior third followed by anterior and middle third.

M. Panigrahi et al⁴, in a cadaveric study of Morphometric analysis of adult menisci found that length of medial menisci of both right and left was more than of lateral menisci. Width of medial meniscus was less on right side.

Conclusion

Menisci are considered as having important role in knee joint biomechanics. Meniscal injuries are commonly seen, though now a days the emphasis is in preserving the meniscus. In such cases meniscal replacement and regenerative techniques are followed, for which accurate knowledge of anatomy in terms of morphometry of menisci plays a vital role. We have observed that there was no statistically significant difference between the outer length or circumference of medial and lateral meniscus. The difference between anterior and posterior horn of the medial meniscus was quite higher than that of lateral meniscus. In the medial meniscus, the posterior third was widest and thickest part which was statistically significant, whereas there was no statistically significant

difference in anterior and middle third thickness and width of both menisci. These findings are in accordance with certain injuries being common in medial menisci. However more sophisticated instruments needed for better measurement and study can be correlated with radiological study done to measure the parameters in living.

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