

Meniscal Dimensions and its Clinical Implications- A Foetal Cadaveric Study

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ABSTRACT

Introduction: The menisci are made up of fibrocartilage. The menisci are prone for injuries and treated by meniscal repair, meniscectomy and the meniscal allograft transplantation. The knowledge about the morphometry is necessary for orthopaedician, embryologist and morphologist.

Aim: To analyse the morphometric parameters of medial and lateral menisci in the knee joint of fetuses.

Materials and Methods: A cross-sectional observational study was conducted in the Department of Anatomy, PSG Institute of Medical Sciences and Research, Coimbatore, Tamil Nadu, India, during the year May 2015 to May 2017 in seven males and eight female fetuses with gestational age ranging from 20-37 weeks. After dissection, the morphometric parameters like peripheral and inner length, width and thickness of anterior 1/3rd, middle

1/3rd and posterior 1/3rd of the menisci was measured using digital vernier callipers. ANOVA and paired t-test was used to compare the parameters between gender and sides.

Results: The morphometry was studied in 14 male and 16 female knee joints (30 medial and 30 lateral menisci). In the medial menisci width of anterior 1/3rd was significantly narrower than the middle and posterior 1/3rd. In lateral menisci, width of middle 1/3rd was greater than anterior and posterior 1/3rd which was statistically insignificant. There were no statistically significant morphometric differences between gender and sides.

Conclusion: The part of the menisci which were narrower was less prone for injuries. The knowledge of the morphometric parameters in particular the width and thickness of the menisci determines the commonest area of injury. This study provides morphometric data of menisci in fetuses as it is scarce.

Keywords: Foetus, Lateral menisci, Medial menisci, Meniscectomy

INTRODUCTION

The menisci were once described as functionless remain of a leg muscle [1]. The functions of the menisci are shock absorption, joint stability and load resistance. These functions are studied extensively in recent decades [2-4]. The morphology of the menisci is varied. The most common shape of the menisci was crescentic. The other morphology of the menisci was C shaped, V shaped, U shaped and Sickle shaped [5]. The other variants were discoid shape and ring-shaped menisci [5,6].

Tardieu C studied the hominid fossils. Three functional characters like femoro bicondylar angle, shape of femoral distal epiphysis and the tibial insertion of lateral meniscus was studied. There was no posterior insertion of the lateral meniscus in earlier part of evolution. As the bipedalism developed, the posterior insertion of the lateral meniscus also developed. In animals like chimpanzees there was only single insertion of lateral meniscus. But in humans because of bipedalism, the double insertion developed, and prevented the movement of lateral meniscus during extension and final locking mechanism of knee joint [7].

The menisci are prone for injuries in sports, trauma and day-to-day activities [8]. The incidence of meniscal tear is on the rise because of the Magnetic Resonance Imaging (MRI) imaging techniques and recent advances [9]. The incidence of meniscal tear was about 60-70 per lac with male to female ratio which ranges from 2.5:1 to 4:1. The lateral meniscus moves about 9 to 11 mm over the tibia during flexion and tear in the lateral meniscus was low [10]. The treatment for meniscal tear includes meniscal repair, partial or total meniscectomy. The meniscal allograft transplantation was done for young patients after meniscectomy, with stable and well aligned knee joint, pain and tenderness over the joint line after meniscectomy, without diffuse grade III outerbridge and no grade IV cartilage damages [11].

Meniscal allograft transplantation has been done for the past 20 decades. The allograft menisci can be fresh frozen or cryopreserved.

The menisci used for transplantation undergoes checking process like position, sizing, and viability. The position and sizing were done by using X-rays. The meniscal graft should be within the 10% of the size of the recipient's menisci [12].

The sizing of the menisci and its vascular supply is important for transplantation of the menisci. The menisci are supplied by blood vessels from the periphery. Both the horns get good blood supply [13]. The length of the menisci and the ligaments insertion should be known for bony fixation of the meniscal substitute [14]. Smillie IS, suggested that wider menisci were more prone for rupture than the narrowest. He postulated the fact that narrow menisci were subjected to less action of femoral condyle. The anterior 1/3rd of the menisci was less prone for injury which strongly justifies the above hypothesis, since the anterior 1/3rd was the narrowest part among the middle and posterior 1/3rd [15]. The medial menisci were the commonest menisci to undergo injury. The posterior horn was the commonest site of tear [16].

Total meniscectomy leads to accelerated osteoarthritis. Now-a-days meniscal preservation technique like meniscal repair was done. The meniscal repair facilitates meniscal regrowth. The failure rate of meniscal repair accounts for about 30% in a five year follow-up [17]. Even though various surgical techniques like inside out technique, meniscal fixators, outside in technique and all inside technique has been developed for meniscal repair, still the failure rate stands high [16,17]. The meniscal allografting was the treatment of choice and it is a complex procedure. It has a success rate of 89.2% over a 10 year follow-up [17]. The knowledge of morphometric parameters is necessary for the orthopaedic surgeons. The aim of the study was to analyse the morphometric parameters of the medial and lateral menisci in fetuses and to compare the morphometric differences between the genders and sides. This study will provide morphometric data in foetal menisci as it was scarce, and it can be compared to the morphometry of adult menisci from previous studies [18-22].

MATERIALS AND METHODS

This cross-sectional observational study was conducted in the Department of Anatomy, PSG Institute of Medical Sciences and Research, Coimbatore, Tamil Nadu, India, from May 2015 to May 2017 after obtaining Institutional Ethical Committee clearance (Project no 15/127). The study was conducted in 15 fetuses (7 males and 8 females) of age between 20-37 weeks of gestation which was already present in the Department of Anatomy. The total number of knee joints was 30 knee joints (30 medial menisci and 30 lateral menisci).

Inclusion criteria: All the fetuses with gestational age between 20 to 37 were included in the study.

Exclusion criteria: The fetuses with musculoskeletal disorder, injuries to menisci, degenerated menisci were excluded from this study.

Study Procedure

After fixation, dissection of the knee joint was done. The skin was incised, and the semimembranosus, semitendinosus, gracilis and biceps femoris muscles were cut. The patellar ligament was cut, and longitudinal incision was made on each side of the joint capsule. The capsule, coronary ligaments, the cruciate ligaments were cut to expose the menisci. The exposed menisci were kept intact on the tibial condyles. Different morphometric parameters were measured on the foetal menisci as follows [23-25].

1. Length of menisci:

a. Peripheral length: A thread was placed along the outer circumference from the apex of the anterior horn to the apex of posterior horn. The thread was taken out and measured with digital vernier calliper [Table/Fig-1].

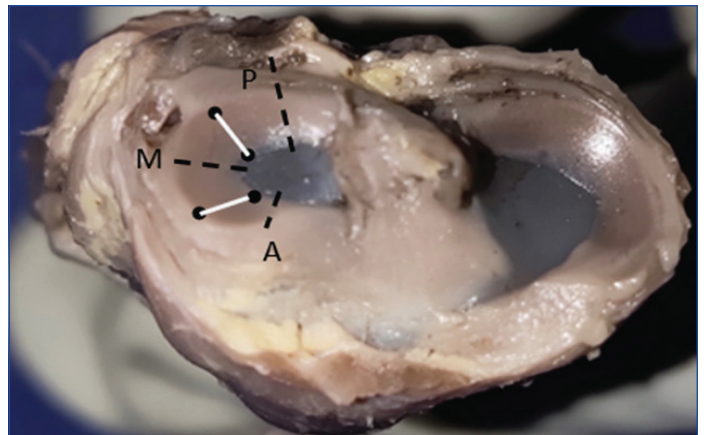
b. Inner length: A thread was placed along the inner circumference from the apex of the anterior horn to apex of posterior horn. The thread was taken out and measured with digital vernier calliper [Table/Fig-1].



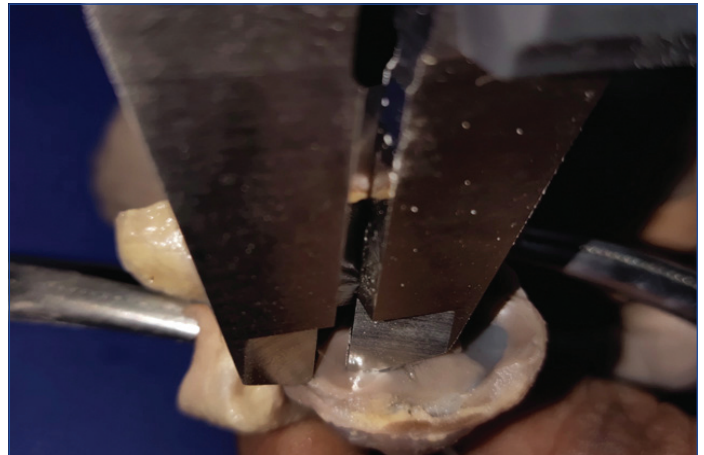
[Table/Fig-1]: Showing the method of measuring the peripheral and inner length using non elastic cotton thread.

2. Width of menisci: One thread was placed along the outer circumference from the apex of the anterior horn to the apex of the posterior horn. Another thread was placed along the inner circumference in a similar way. Now, both the threads were taken out and measured with digital vernier calliper. The length of each thread was taken and divided by three. Using this length, two points were marked on each circumference. The menisci were divided into three equal parts by joining the corresponding points on both the threads. The menisci were now divided into anterior 1/3rd, middle 1/3rd and posterior 1/3rd part [Table/Fig-2]. The width of the menisci was measured using vernier calliper at the midpoint of each part of the menisci [Table/Fig-3].

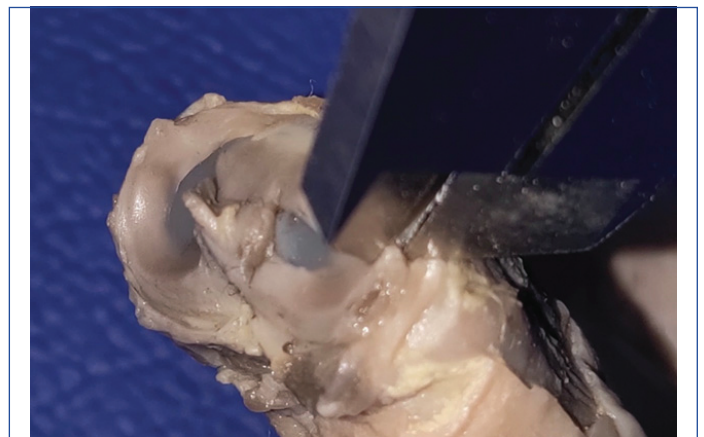
3. Thickness of the menisci along the outer circumference: The thickness was measured using vernier calliper along the peripheral length at the midpoint of anterior 1/3rd, middle 1/3rd and posterior 1/3rd part of the menisci [Table/Fig-4].



[Table/Fig-2]: Showing the three parts of the meniscus (anterior, middle and posterior thirds) for measurements of width and thickness of outer circumference.



[Table/Fig-3]: Showing the method of measurement of width of the menisci.



[Table/Fig-4]: Showing the method of measurement of thickness of the menisci.

STATISTICAL ANALYSIS

The data was noted in a data sheet for statistical analysis. Statistical Package of the Social Sciences (SPSS) software (version 26) was used for calculating the algorithmic mean and standard deviation. Paired t-test and ANOVA was used to compare the parameters between the genders and sides. The level of significance was considered at $p < 0.005$.

RESULTS

Amongst the 30 knee joints dissected for the present study, 14 knee joints were male and 16 knee joints were females. The mean age of the fetuses was 27.53 weeks with a standard deviation of 3.482. The maximum age was recorded to be 31 weeks and minimum age was 24 weeks. Out of 30 knee joints, there were 33 crescentic shape (55%), 7 sickle shape (11.7%), 6 C shape (10%), 5 U shape (8.4%), 1 V shape (1.7%), and 1 ring shaped menisci (1.7%). In this study, the discoid shape was observed mostly in the lateral menisci. There were 4 incomplete discoid shaped (6.6%) and 3 complete discoid shaped

(5%) menisci. A rare variant ring-shaped meniscus was present in one medial meniscus (1.7%). The mean and SD of peripheral and inner length of medial menisci was 15.99 ± 3.45 , 10.1 ± 2.3 mm and lateral menisci was 14.13 ± 3.1 , 8.34 ± 2.3 mm, respectively [Table/Fig-5]. The average mean width of anterior 1/3rd, middle 1/3rd and posterior 1/3rd of medial menisci was 1.52 ± 0.58 , 1.85 ± 0.65 , 2.16 ± 0.81 mm and lateral menisci 2.01 ± 0.71 , 2.28 ± 0.77 , 2.04 ± 0.61 mm, respectively. The mean and SD of thickness at the outer circumference of anterior 1/3rd, middle 1/3rd and posterior 1/3rd of medial menisci was 0.71 ± 0.36 , 0.83 ± 0.43 , 0.9 ± 0.38 mm and lateral menisci was 0.69 ± 0.28 , 0.74 ± 0.27 , 0.79 ± 0.35 mm, respectively [Table/Fig-5].

Parameters in mm	Menisci	Mean	Standard deviation	Mean difference	t-value	2 tailed significance
Peripheral length*	Medial	15.99	3.45	1.87	2.205	0.031*
	Lateral	14.13	3.10			
Inner length*	Medial	10.10	2.30	1.76	2.964	0.004*
	Lateral	8.34	2.30			
Width anterior 1/3 rd **	Medial	1.52	0.58	0.49	-2.921	0.005*
	Lateral	2.01	0.71			
Width middle 1/3 rd **	Medial	1.85	0.65	0.42	-2.326	0.024*
	Lateral	2.28	0.77			
Width posterior 1/3 rd	Medial	2.16	0.81	0.12	0.652	0.517
	Lateral	2.04	0.61			
Thickness anterior 1/3 rd	Medial	0.71	0.36	0.02	0.209	0.835
	Lateral	0.69	0.28			
Thickness middle 1/3 rd	Medial	0.83	0.43	0.09	0.959	0.342
	Lateral	0.74	0.27			
Thickness posterior 1/3 rd	Medial	0.90	0.38	0.11	1.126	0.265
	Lateral	0.79	0.35			

[Table/Fig-5]: Comparison of parameters between medial and lateral menisci by t-test. *statistically significant; p<0.005

The peripheral length was greater than inner length in both the menisci. The peripheral length and inner length of medial menisci was greater than lateral menisci which were statistically significant (t-test p=0.031 and p=0.004, respectively) [Table/Fig-5]. The width of posterior part of the medial menisci was greater than middle part followed by anterior part. By using ANOVA test the anterior part of the medial menisci was significantly (ANOVA p=0.002) smaller than the middle and posterior part [Table/Fig-6]. The widest part of the lateral menisci was middle part followed by posterior and anterior part [Table/Fig-5]. There was no statistically significant difference among the width of the three parts in lateral menisci (ANOVA p=0.266) [Table/Fig-6]. In lateral and medial menisci the thickest part was the posterior part. The difference in the thickness of three parts in both menisci was not statistically significant (ANOVA p=0.171). In medial menisci the width of anterior 1/3rd and posterior 1/3rd, thickness of anterior 1/3rd and posterior 1/3rd was greater than left side which was statistically insignificant [Table/Fig-7]. All the parameters in lateral menisci were subjected to paired t-test and found that there was no statistically significant difference between right and left side [Table/Fig-8]. In medial menisci the width and thickness of posterior 1/3rd was greater in females than males, but it is not statistically

Parameters in mm	Medial meniscus		Lateral meniscus	
	Mean	Standard deviation	Mean	Standard deviation
Width of anterior 1/3 rd	1.52	0.58	2.01	0.71
Width of middle 1/3 rd	1.85	0.65	2.28	0.77
Width of posterior 1/3 rd	2.16	0.81	2.04	0.61
F	6.647	1.346		
Significance	0.002*	0.266		

[Table/Fig-6]: Comparison of width of anterior, middle and posterior 1/3rd in medial and lateral menisci by ANOVA.

* Statistically significant p<0.005

significant [Table/Fig-9]. The paired t-test between male and female in lateral menisci showed no significant difference [Table/Fig-10].

Parameters in mm (Medial meniscus)	Side	Mean	Standard deviation	Mean difference	t-value	2 tailed significance
Peripheral length	Right	15.65	3.30	-0.696	-0.546	0.589
	Left	16.35	3.68			
Inner length	Right	10.35	2.06	0.492	0.579	0.567
	Left	9.85	2.57			
Width anterior 1/3 rd	Right	1.54	0.62	0.043	0.197	0.845
	Left	1.49	0.56			
Width middle 1/3 rd	Right	1.83	0.73	-0.033	-0.136	0.893
	Left	1.87	0.58			
Width posterior 1/3 rd	Right	2.19	0.76	0.058	0.192	0.849
	Left	2.13	0.89			
Thickness anterior 1/3 rd	Right	0.72	0.42	0.026	0.194	0.847
	Left	0.70	0.30			
Thickness middle 1/3 rd	Right	0.78	0.41	-0.103	-0.649	0.521
	Left	0.88	0.45			
Thickness posterior 1/3 rd	Right	0.92	0.45	0.045	0.317	0.754
	Left	0.88	0.31			

[Table/Fig-7]: Comparison of parameters in medial menisci between right and left knee joint.

Parameters in mm (Lateral meniscus)	Side	Mean	Standard deviation	Mean difference	t-value	2 tailed significance
Peripheral length	Right	14.45	3.15	0.646	0.563	0.578
	Left	13.81	3.12			
Inner length	Right	8.39	2.15	0.102	0.119	0.906
	Left	8.29	2.52			
Width anterior 1/3 rd	Right	2.00	0.71	-0.01	-0.045	0.964
	Left	2.01	0.74			
Width middle 1/3 rd	Right	2.34	0.77	0.129	0.449	0.657
	Left	2.21	0.80			
Width posterior 1/3 rd	Right	2.14	0.62	0.194	0.873	0.390
	Left	1.94	0.60			
Thickness anterior 1/3 rd	Right	0.64	0.24	-0.095	-0.947	0.352
	Left	0.74	0.30			
Thickness middle 1/3 rd	Right	0.80	0.23	0.124	1.277	0.213
	Left	0.68	0.29			
Thickness posterior 1/3 rd	Right	0.76	0.36	-0.065	-0.510	0.614
	Left	0.83	0.34			

[Table/Fig-8]: Comparison of parameters in lateral menisci between right and left knee joint.

DISCUSSION

The most common injury in menisci was tearing. This occurs most commonly due to sports activities. The type of injury and its possibility can be determined by its thickness and width of the menisci [17]. The data of the morphometric parameters of menisci in human foetuses was scarce in the literature. In the present study, the width of the anterior 1/3rd of the medial menisci was significantly narrower than the other parts which usually escape from injury.

Da Silva Almeida K et al., 2004, conducted study in 22 knee joints of adult human cadaver. The width of the medial menisci was greater than lateral menisci, but it was statistically insignificant. The medial menisci were thickest in the anterior part whereas in lateral menisci the middle part was thickest. The medial menisci were significantly thicker in the anterior and posterior third than the lateral menisci. The medial menisci were broader than lateral menisci which justifies the higher incidence of injuries [18]. In the present study, the thickness of the medial menisci in all the three thirds was greater than the

Parameters in mm (Medial meniscus)	Gender	Mean	Standard deviation	Mean difference	t-value	2 tailed significance
Peripheral length	Male	15.84	2.93	-0.306	-0.238	0.813
	Female	16.14	3.94			
Inner length	Male	10.30	2.04	0.365	0.427	0.673
	Female	9.93	2.57			
Width anterior 1/3 rd	Male	1.69	0.50	0.328	1.575	0.126
	Female	1.36	0.62			
Width middle 1/3 rd	Male	1.89	0.56	0.080	0.332	0.742
	Female	1.81	0.73			
Width posterior 1/3 rd	Male	2.12	0.58	-0.073	-0.240	0.812
	Female	2.20	0.99			
Thickness anterior 1/3 rd	Male	0.79	0.40	0.156	1.191	0.244
	Female	0.64	0.32			
Thickness middle 1/3 rd	Male	0.88	0.39	0.090	0.565	0.577
	Female	0.79	0.47			
Thickness posterior 1/3 rd	Male	0.10	0.41	0.181	1.322	0.197
	Female	0.81	0.34			

[Table/Fig-9]: Comparison of parameters in medial menisci between male and female knee joint.

Parameters in mm (Lateral meniscus)	Gender	Mean	Standard deviation	Mean difference	t-value	2 tailed significance
Peripheral length	Male	13.87	3.28	-0.501	-0.436	0.666
	Female	14.37	3.01			
Inner length	Male	8.88	2.51	1.020	1.220	0.233
	Female	7.86	2.07			
Width anterior 1/3 rd	Male	1.97	0.68	-0.068	-0.255	0.801
	Female	2.04	0.76			
Width middle 1/3 rd	Male	2.40	0.70	0.222	0.782	0.441
	Female	2.18	0.84			
Width posterior 1/3 rd	Male	2.04	0.57	-0.010	-0.044	0.966
	Female	2.05	0.66			
Thickness anterior 1/3 rd	Male	0.70	0.34	0.026	0.258	0.798
	Female	0.68	0.22			
Thickness middle 1/3 rd	Male	0.74	0.25	-0.008	-0.083	0.934
	Female	0.74	0.28			
Thickness posterior 1/3 rd	Male	0.84	0.46	0.085	0.663	0.513
	Female	0.75	0.21			

[Table/Fig-10]: Comparison of parameters in lateral menisci between male and female knee joint.

lateral but the difference was not statistically significant. The width of anterior 1/3rd and middle 1/3rd was wider in lateral menisci than medial menisci which was statistically significant.

Murlimanju BV et al., studied knee joints of 106 human fetuses (26 male and 27 female fetuses). There were significant differences in peripheral length, inner length, width, and thickness between the genders and sides. The peripheral and inner border length was significantly higher in medial menisci which were in par with the present study [24]. The thickness was more in the anterior part of medial menisci and lateral menisci [24]. In the present study, the thickness was more in the posterior third of both the menisci. The widest part in medial menisci was posterior part and middle part in lateral menisci and there was no statistical difference. In medial menisci the width of anterior 1/3rd was statistically lesser than the middle and posterior third [Table/Fig-11] [24,25].

Gohiya V and Pandey R., studied the morphometry of menisci in 54 fetuses. The peripheral and inner length of medial menisci was greater than lateral menisci which was statistically significant [25]. This finding was same as that of the present study. The thickness of all three parts of the medial menisci was significantly greater than the lateral menisci [25].

Whereas in the present study thickness was greater in medial menisci than lateral menisci but it was not statistically significant. The width of the three parts in lateral menisci was greater than medial menisci which was statistically significant [25]. In the present study, the findings are same except for the statistical difference [Table/Fig-11] [24,25].

Parameters in mm	Menisci	Murlimanju BV et al., 2010 [24] (Mangalore)	Gohiya V and Pandey R, 2014 [25] (Indore)	Present study
Peripheral length	Medial	26.66±4.69	26.92±4.7	15.99±3.45
	Lateral	25.14±4.05	23.59±3.57	14.13±3.10
Inner length	Medial	14.72±2.63	16.36±3.31	10.10±2.30
	Lateral	12.59±3.22	12.90±1.9	8.34±2.30
Width anterior 1/3 rd	Medial	2.94±0.61	3.06±0.61	1.52±0.58
	Lateral	3.26±0.60	3.22±0.50	2.01±0.71
Width middle 1/3 rd	Medial	2.88±0.61	2.94±0.53	1.85±0.65
	Lateral	3.54±0.75	3.49±0.70	2.28±0.77
Width posterior 1/3 rd	Medial	3.28±0.62	3.51±0.74	2.16±0.81
	Lateral	3.44±0.63	3.63±0.63	2.04±0.61
Thickness anterior 1/3 rd	Medial	1.61±0.39	2.04±0.47	0.71±0.31
	Lateral	1.57±0.41	1.80±0.42	0.69±0.28
Thickness middle 1/3 rd	Medial	1.47±0.35	2.19±0.49	0.83±0.43
	Lateral	1.52±0.39	2±0.45	0.74±0.27
Thickness posterior 1/3 rd	Medial	1.48±0.36	2.05±0.56	0.90±0.38
	Lateral	1.49±0.34	1.76±0.41	0.79±0.79

[Table/Fig-11]: Comparison of parameters between the previous and present studies [24,25].

Kaur A et al., studied the morphometry in 60 adult medial menisci and revealed that the width of medial menisci was statistically not significant between the right and left side [19]. In the present study, there was no statistically significant difference between right and left side of medial menisci. The anterior third was significantly smaller than the middle and posterior part in the present study.

Rao N et al., studied the morphometry in 50 adult cadavers. The peripheral and inner length does not have statistical difference between the medial and lateral menisci but in the present study, there was statistically significant difference [20]. Posterior part of the medial menisci was the widest part which is in accordance with the present study. There was statistically significant difference between the width of the three parts between medial and lateral menisci [20]. In the present study the significant difference was present in anterior and middle 1/3rd. The middle part was the thickest in both the menisci whereas in the present study the posterior part was the thickest in both the menisci.

Rashmi BN et al., studied morphometry of menisci in 25 adult cadavers. The posterior part was widest in medial menisci and middle part in lateral menisci [21]. The present study with fetuses showed similar results. The widest part was similar in both the adult and foetal menisci.

Dhananjaya KVN et al., studied the morphometry of 40 knee joints by using MRI images. In this study the wider part in both the menisci was the posterior part but in the present study, posterior part was widest in medial menisci and middle part in lateral menisci [26]. The posterior part was the thickest part in both the menisci which was like the present study [26].

Itagi V et al., studied 60 adult medial menisci. The peripheral length was significantly larger on the left side than the right side. The other parameters do not show any significant difference between right and left side [22]. There was no significant difference between the sides in the present study.

Bloeker K et al., in 60 osteoarthritic knee joints, the structural therapeutic benefits were measured in radiographic joint space. The radiographic joint space was the standard reference for osteoarthritis. Three dimensional (3D) measures of menisci and cartilage provide significant details in explaining the side differences in joint space radiography in fixed flexion radiographs [27].

Bloecker K et al., studied the morphometric parameters in knee joints of 47 men and 75 women and compared between medial and lateral menisci by using 3D analysis by MRI. The tibial plateau was occupied more by the lateral menisci than the medial menisci. Both the menisci had similar volume. The physiological extrusion of the lateral menisci was less than medial menisci. The physiological extrusion was greatest in the anterior horn of medial menisci and in midbody of lateral menisci. The mean thickness of lateral menisci was significantly greater than the medial menisci. There was no statistically significant difference in the width of lateral and medial menisci. The thickness in the posterior horn was greater than the middle and anterior horn [28].

Shen X et al., studied morphometry in 116 knee joints and revealed that the thickness of both the menisci does not have significant difference between genders. The correlation between the thickness and the height of the 3D reconstructed menisci was not significant. The author suggested that thickness is not a key factor to be considered while designing the prosthesis or sizing of the graft. There was a positive correlation between thickness and Body Mass Index (BMI) and body weight [29].

The meniscal tear was treated by meniscal repair or meniscectomy. Meniscal allograft transplantation was done after meniscectomy. Clinical results are good at short term and midterm follow-up. It also increases the knee function. The acceptance rate and failure rate of transplanted menisci was also acceptable [11].

Clinical implications: The menisci present in the knee joint is more prone to injuries. The morphometric parameters of the menisci can determine the most common area of injury. These parameters add to the morphometric data of the foetuses. This study suggests a clinical finding that width of anterior third of medial menisci was significantly narrower than the other parts and hence less prone for injury.

Limitation(s)

The limitations of this study include small sample size. Each morphometric parameters showed differences, but it was statistically insignificant. This may be because of the small sample size. The measurement was taken in a simplistic technique by linear measurement of a non linear structure. This can be rectified by using software's like image analyser to study the morphometric parameters.

CONCLUSION(S)

In this study, the width of the anterior 1/3rd of the medial menisci was significantly narrower than the other parts. This justifies the hypothesis of least prone area for injury. The values of the parameters vary between different studies among the foetuses and adult menisci. This discrepancy may be due to racial difference and mesenchymal differentiation. The study can be conducted in large sample size with various gestational age and can be compared and the reason for the different morphology can be studied. The impact of the morphometry on the structure and function of the menisci can be studied.

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AUTHOR DECLARATION:

- Financial or Other Competing Interests: None
- Was Ethics Committee Approval Obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? No
- For any images presented appropriate consent has been obtained from the subjects. No

PLAGIARISM CHECKING METHODS: [Jain H et al.]

- Plagiarism X-checker: Sep 11, 2021
- Manual Googling: Dec 16, 2021
- iThenticate Software: Apr 27, 2022 (5%)

ETYMOLOGY: Author Origin

Date of Submission: **Sep 10, 2021**
Date of Peer Review: **Oct 30, 2022**
Date of Acceptance: **Jan 27, 2022**
Date of Publishing: **Jul 01, 2022**