

## Retrospective Cross Sectional MRI Study of Morphometry of Menisci of Knee Joint

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### ABSTRACT

**Introduction:** Meniscal tears are commonly encountered in clinical practice and cause significant musculoskeletal morbidity. Most of the data available on Morphometry of menisci in Indian population are through cadaveric studies and very few MRI studies are available to substantiate the available data.

**Aim of the study:** To gather data on the Morphometry of menisci in South Indian population and compare it with the existing literature.

**Material and Method:** 100 MRI images collected retrospectively were used to study menisci. Height and width of MM and LM were measured both in sagittal and coronal planes.

**Results:** It was observed that in both sexes the height of the Anterior horn of Medial meniscus was significantly higher than that of Lateral meniscus. Width of the Anterior horn and body showed significantly higher values in Lateral meniscus whereas width of Posterior horn of Medial meniscus showed significantly higher values in both sexes. Height of Medial meniscus in all the segments was higher in males though the difference was significant only in anterior horn and Posterior horn segments. Height of Lateral meniscus was significantly higher in males in all the segments.

**Conclusion:** Results of this study will add to the existing literature on the Morphometry of menisci and will serve as a database for patients undergoing meniscal allografts.

**KEY WORDS:** Medial meniscus, Lateral meniscus, Meniscal tears, musculoskeletal morbidity.

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### INTRODUCTION

Menisci are crescentic intracapsular fibrocartilaginous lamina. They increase the depth and width of the tibial surface which receives the condyles of femur thereby improving stability

of the knee joint. Their peripheral attached borders are vascular, inner borders are avascular and thin [1]. Meniscal tears are common in sports persons especially football players. They are more common in inner zone

of menisci and therefore seldom heal spontaneously mandating surgical resection. Peripheral tears heal satisfactorily after surgical repair.

Medial meniscus (MM) - It has a semicircular shape with broad posterior aspect and narrow anterior aspect. It is attached by its anterior horn (AH) to the anterior tibial intercondylar area. Posterior horn (PH) is attached to the posterior intercondylar area.

Lateral meniscus (LM) - It is circular having almost uniform width from anterior to posterior aspect unlike medial meniscus, and covers a larger area of tibial plateau than medial meniscus. Its anterior horn (AH) is attached close to attachment of Anterior cruciate ligament anterior to the intercondylar eminence. Its posterior horn (PH) is attached in front of the posterior horn of the MM [1]. Lateral meniscal tears are usually associated with tears of Anterior cruciate ligament. These differences in the attachments between the two menisci govern the possibility and type of injury [2].

There are many cadaveric studies pertaining to dimensions of menisci in Indian population but very few in vivo studies have been conducted in Indian populations. The data obtained from this study would add to the existing literature, thus helping in designing meniscal allografts.

## **MATERIALS AND METHODS**

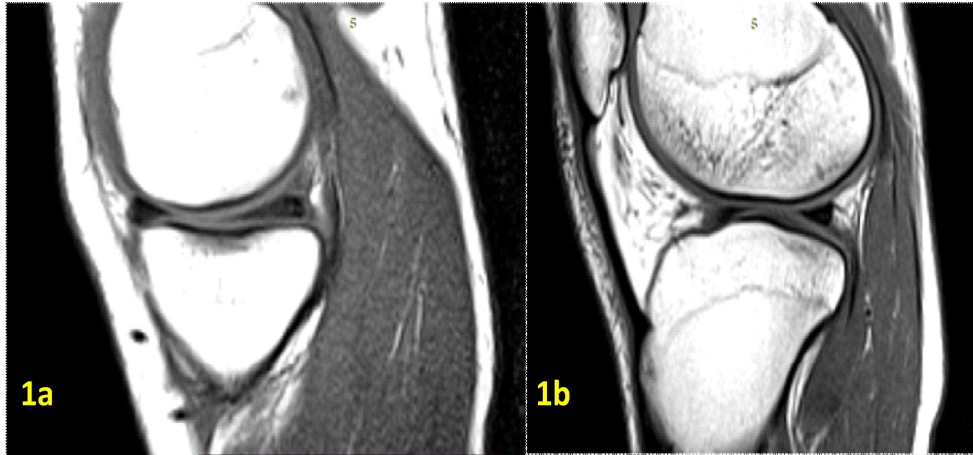
The study was undertaken by the Department of Radiodiagnosis of MVJ Medical College and Research Hospital after obtaining Institutional ethical clearance. Type of study –Retrospective cross sectional study. MRI images of adult knees of both sexes age ranging from 18-45 years were reviewed over a period of 6 months. The study sample included 100 patients with internal derangement of knee who underwent MRI studies of knee. Informed consent was obtained from all the patients prior to undertaking the study. Those patients who were referred to the Department of Radiodiagnosis for MRI study of the knee between 18 and 45 years of age were considered in this study. The inclusion criteria for this study were - routine MR examinations

performed for a variety of reasons, such as non-specific knee pain, swelling, clinical concern for popliteal cyst and trauma. The exclusion criteria were – MRI studies of menisci with any pathological or abnormal signal intensity changes suggesting meniscal degeneration, traumatic or degenerative tear, discoid meniscus and parameniscal cysts, post surgical repair of previous meniscal tear including partial and total meniscectomy and other general contra-indications to MR imaging (MR incompatible orthopaedic metallic implants, aneurysm clips, cochlear implants, cardiac pacemakers, prosthetic heart valves, severe claustrophobia and morbid obesity). None of the MRI studies involved the administration of contrast material.

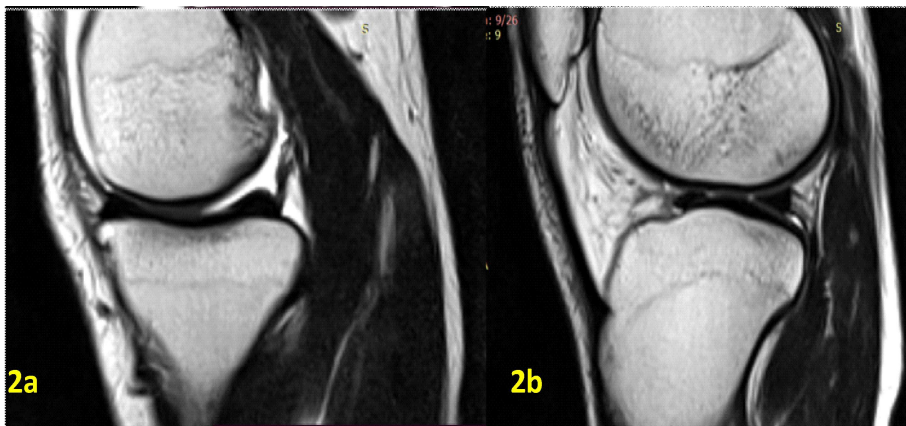
Siemens Magnetom Essenza (a Tim and Dot system) with a field strength of 1.5 Tesla magnet using an 8-channel phased array receiver flex coil (knee coil supplied by vendor) was used for the MRI studies.

The patient was instructed to lie down in the supine position with the knee in external rotation of 10-15 degrees. Initial localiser sequences were obtained in all three planes through the Patello-femoral and Tibio-femoral joints, which were used for subsequent axial, sagittal and coronal image planning. The sequences used to perform the MRI studies were – multi-slice, conventional spin echo T1W sagittal (TR-500/TE-15), Turbo Spin Echo T2W (TR-5200/TE-85) sagittal, coronal and axial, Turbo Spin Echo Proton Density Fat Saturated (TSE PD FS) sagittal and axial and Short Tau Inversion Recovery (STIR) coronal. The slice thickness was 3.5 mm with interslice gap of 1.2mm, image matrix 206 x 256. The images were reviewed for the measurements which were performed using the SIEMENS SYNGO platform. The measurements for this study were performed manually using the calipers inbuilt in the image analysis software (OSIRIX) by a single radiologist in all the MRI studies. Sagittal plane was used for assessing menisci with coronal and axial images used for secondary confirmation of pathology, if any. On MRI, the normal menisci are visualized as uniform low-signal (dark) triangular structures on routine T1W, T2W, STIR and TSE PD FS pulse

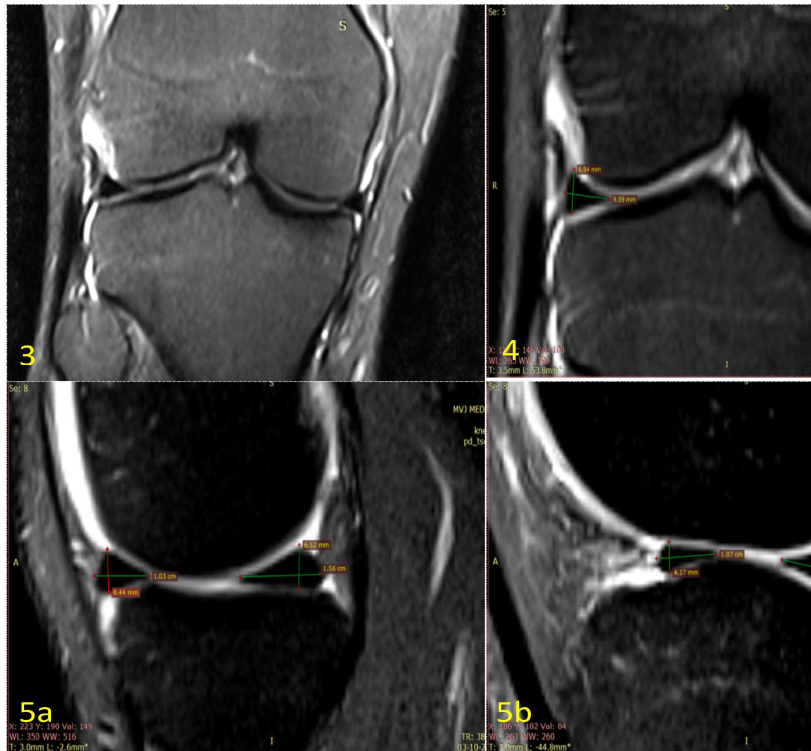
sequences (Figures 1 - 3).



**Fig. 1A & 1B:** T1W Sagittal images through the mid portion of AH and PH of 1a) medial meniscus & 1b) lateral meniscus which displays uniform, low signal triangular morphology.



**Fig. 2A & 2B:** T2W Sagittal images through the mid portion of AH and PH of 2a) medial menisci & 2b) lateral menisci which displays uniform, low signal triangular morphology.



**Fig. 3:** STIR Coronal image through the mid bodies of medial and lateral menisci; displaying uniform, low signal triangular morphology. Fig 4: PD FS TSE coronal image through the mid bodies of medial and lateral menisci. Fig 5A & 5B: PD FS TSE sagittal image through the mid portion of AH and PH of 5a) medial meniscus & 5b) lateral meniscus.

Only those MRI studies in which both the menisci appeared completely normal in all sequences and planes were used in this study. The menisci were studied in three segments - AH, mid body and PH. They were measured as follows: (1) thickness and width of the mid portion of the AH and PH of the MM in the sagittal plane (Figure 4); (2) thickness and width of the mid portion of the AH and PH of the LM in the sagittal plane (Figure 4b); (3) thickness and width of the mid-portion of the body of MM in the coronal plane (Figure5); (4) thickness and width of the mid-portion of the body of LM in the coronal plane (Figure5);

### RESULTS

The height of MM and LM in all the three segments i.e anterior horn, body and posterior horn was compared in both sexes. (Table 1)

It was observed that in females the height of the AH of medial meniscus was significantly higher than that of LM .However the height of body and PH were more in LM but the difference was not significant.

In males height of AH was significantly higher in MM compared to LM similar to that observed in females. No significant difference in height were observed between the two menisci in PH. Body of LM showed a significantly higher value in males unlike females where it was not significant.

Width of the MM and LM in all the three segments were compared in both males and females. (Table 2) Width of the AH and body showed significantly higher values in LM in both females and males. Width of PH of MM showed significantly higher values compared to LM in both sexes.

Height of MM in all the segments i.e anterior horn, body and post horn was higher in males though the difference was significant only in AH and PH segments. Height of LM was significantly higher in males in all the segments. (Table 3)

Width of the MM showed significantly higher values in males in all the segments. Width of the LM showed higher values in all the segments in males but significant differences were observed only in body and PH (Table4).

**Table 1:** Comparison of the height/thickness of medial and lateral meniscus in males and females.

	Female				p value	Male				p value
	Medial Meniscus		Lateral Meniscus			Medial Meniscus		Lateral Meniscus		
	Mean	S. D	Mean	S. D		Mean	S.D	Mean	S.D	
Anterior Horn	5.34	0.541	3.84	0.453	0	5.74	0.598	4.119	0.46	0
Body	5.136	0.396	5.286	0.664	0.23	5.362	0.576	6.081	1.475	0
Posterior Horn	5.056	0.739	5.253	0.564	0.107	5.603	0.679	5.681	0.527	0.297

**Table 2:** Comparison of the width of medial and lateral meniscus in males and females.

	Female				p value	Male				p value
	Medial Meniscus		Lateral Meniscus			Medial Meniscus		Lateral Meniscus		
	Mean	S. D	Mean	S. D		Mean	S.D	Mean	S.D	
Anterior Horn	7.713	0.882	8.943	1.23	0	8.537	0.861	9.406	1.118	0
Body	7.117	1.001	8.13	0.947	0	7.893	0.811	9.082	1.012	0
Posterior Horn	11.17	1.274	8.88	0.906	0	12.92	1.15	10.08	1.013	0

**Table 3:** Comparison of height/thickness in different segments of medial and lateral meniscus in males and females.

	Medial Meniscus				p value	Lateral Meniscus				p value
	Female		Male			Female		Male		
	Mean	S. D	Mean	S. D		Mean	S.D	Mean	S.D	
Anterior Horn	5.34	0.541	5.74	0.598	0.002	3.84	0.454	4.119	0.46	0.006
Body	5.136	0.396	5.362	0.576	0.052	5.287	0.664	6.081	1.475	0.006
Posterior Horn	5.057	0.739	5.603	0.679	0	5.253	0.564	5.681	0.527	0

**Table 4:** Comparison of width in different segments of medial and lateral meniscus in males and females.

	Medial meniscus				p value	Lateral Meniscus				p value
	Female		Male			Female		Male		
	Mean	S. D	Mean	S. D		Mean	S.D	Mean	S.D	
Anterior Horn	7.71	0.881	8.54	0.861	0	8.94	1.23	9.41	1.11	0.067
Body	7.12	1.001	7.89	0.811	0	8.13	0.947	9.08	1.012	0
Posterior Horn	11.17	1.274	12.91	1.15	0	8.88	0.906	10.08	1.013	0

**Table 5:** Comparison of MRI Studies on Morphometry of Menisci.

Variables	Bloker 2012 [8]		Dhananjay 2014 [11]		Araki 1994 [12]		Erbagci 2010 [4]		Our study 2021	
	MM	LM	MM	LM	MM	LM	MM	LM	MM	LM
Height of ant horn	2.41	2.42	6.3	4.8	3.5	5.32	4.33	5.6	4	
Height of mid body	2.56	2.59	5.2	6.4	6.3	5.03	4.94	5.7	5.8	
Height of post horn	3.11	2.88	6.9	7	7.7	5.53	5.36	5.4	5.5	
Width of ant horn			10.5	11.8		7.78	8.88	8.2	9.2	
Width of mid body			7.8	8.6		9.6	7.37	8.37	7.6	8.8
Width of post horn			13.9	12		11.71	9.7	12.4	9.7	

## DISCUSSION

Meniscal tears are commonly encountered in clinical practice. Surgical replacement of a torn meniscus mandates the need for morphometric data on menisci for best results. MRI of contralateral knee is commonly performed to gather morphometric data of the menisci to aid correct sizing of the menisci in the affected knee (3). Of all the parameters involving the dimensions of menisci, the width and thickness are of utmost importance as they determine the severity of injury [4].

Braz and Selva [5] studied the morphometry of menisci in cadavers and observed no significant difference in width in the different segments of lateral meniscus i.e AH, body and PH whereas in our study width of the AH and body showed significantly higher values in LM in both males and females (Table 1).

As far as dimensions of MM was concerned, PH showed the greatest width followed by body and AH in the study by Braz and Selva [5]. Our study showed similar findings in females but males showed a widest PH followed by AH and midbody (Table2). Our study also showed the dimensions of PH in MM being more than LM in both males and females which was statistically significant. Similar findings were reported by Almeida [4]. Width of the mid body of LM was more than that of MM in both males and females unlike the study by Almeida where no statistical

difference was observed in mid body dimensions. LM showed a wider AH in both males and females in our study which are consistent with the findings of Almeida. Kaur et al [6] studied the morphometry of MM in cadavers and compared its dimensions (weight, outer and inner circumference and width of MM in different segments) based on laterality. They observed that posterior segment of MM showed the maximum width followed by midbody and anterior segment unlike the current study which showed maximum width in PH followed by AH and body in both males and females; however in our study LM showed the same pattern in males but in females anterior segment showed maximum width followed by posterior segment and midbody.

Bloker et al [7] studied the morphometry of LM and MM in relation to volume, thickness and relative positions of MM and LM using MRI.

AH showed a greater thickness/height in LM compared to MM whereas body showed no significant difference between the two menisci. PH was more thick in MM than LM. However our study showed similar findings in the body segment but thicker AH in medial meniscus and a thicker posterior horn in LM.

Hunter et al [8] studied the morphometry of menisci in knees with evidence of osteoarthritis. They reported a height of 5.4 + 2.5 mm in

the body segment for LM which was in line with the study by Bloker et al [8]. However, body of MM displayed a height of 2.9 +2.0 mm, much less than the study by Bloker et al [8]. Our study also showed higher values of body segment height in LM but the difference in height for the body segment between the two menisci was not substantial similar to the findings of Bloker et al [8].

The dimensions of MM (Height and width) in our study is in accordance with the study by Erbagci H [9]. However Erbagci did not compare the dimensions of menisci in male and females as in our study.

Dhananjaya et al [10] also studied the Morphometry of menisci in South Indian population using MRI. The findings in his study are comparable to ours, wherein the height of mid body and PH along with width of AH and mid body are greater in LM than MM. Only Height of AH and width of PH were greater in medial meniscus.

Araki et al [11] studied the morphometry of LM in both normal knees and knees with discoid meniscus. His findings were comparable to the findings in our study except the data on height of PH and width of mid body which showed higher values in his study compared to ours.

## CONCLUSION

Meniscal injuries are commonly observed in clinical practice. Severe degree of tears mandate transplantation to restore contact mechanisms. Most of the data available on the morphometry of menisci are obtained as a result of cadaveric studies. Not many MRI studies are available on the morphometry of menisci especially of Indian origin. This study has generated valuable data on morphometry of menisci taking into account the gender considerations also. The study will add value to the existing literature and will aid in accurate sizing of meniscal allografts.

## ABBREVIATIONS

**MM** - Medial meniscus

**AH** - Anterior horn

**PH** - Posterior horn

**LM** - Lateral meniscus

**Conflicts of Interests: None**

## Author Contributions

**Sandhya H:** Data collection and editing the article, have given final approval of the version to be published.

**Sangeeta M:** Literature review, conception and design, drafting article.

**Khizer Hussain Afroze M:** Analysis and interpretation of data.

**Varalakshmi KL:** Revising it critically for important intellectual content

The proof reading of the final version of manuscript was done by all the authors.

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