Original Article

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Anatomy Section

# Morphological Study of Menisci of Knee Joint in Human Cadavers

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## ABSTRACT

**Introduction:** Menisci are fibrocartilaginous discs present in between femur and tibia in knee joint. These are prone to damage and as being weight bearing structures; they are commonly replaced once injured, by arthroscopic or open procedure. There are marked differences in morphology of the medial and lateral menisci in adult knee joint.Variations in form of thickness and width of menisci have determined the different injury mechanisms. However, data related to morphology of menisci are limited.

**Aim:** To find length at the outer circumference, thickness and width of menisci at three different points: anterior, middle and posterior and compare data among medial and lateral menisci.

**Material and Methods:** After dissecting knee joint, 60 healthy menisci were collected and labelled .These specimen were kept in formalin solution. Then the length at outer circumference, width at three points: anterior, middle, posterior and thickness at three points: anterior, middle and posterior were measured. Different parameters of menisci were measured with digital Vernier callipers and analysed with the help of Microsoft Excel.

**Results:** The width of the medial and lateral menisci were measured and analysed. A statistically significant difference ($p<0.05$) in three points: anterior, middle and posterior was found. In present study no significant difference was observed in length at outer circumference and thickness in both menisci.

**Conclusion:** With increasing incidence of sedentary life style and obesity, there is simultaneous rise in meniscal injuries and osteoarthritis. The variation and morphology has drawn the attention of Surgeons, Orthopaedicians, Radiologists and Interventionists alike. The study seems to contribute towards further advancements in orthopaedic surgeries, arthroscopies, meniscus and knee-transplant surgeries, menisectomy as well as for diagnostic and therapeutic approaches. Similarly, the manufacturer of meniscal prosthesis also seem to be benefited from this study.Such variations and morphology can determine the possibility and the kind of injury.

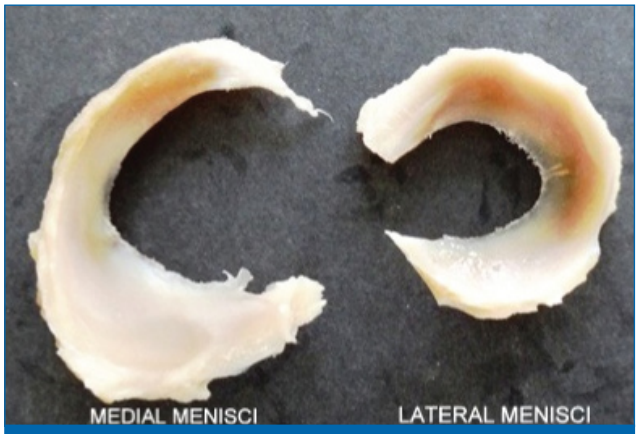
**Keywords:** Knee Injury, Lateral Meniscus, Medial Meniscus, Osteoarthritis

## INTRODUCTION

Understanding of normal human body is essential for science of medicine and is a science of facts about structures and their normal anatomical variation. The word meniscus comes from the greek word me-niskos, meaning “crescent” meaning “moon” [1]. A meniscus is a crescentic intracapsular structure divides the joint cavity only partly. Both lateral and medial menisci [Table/Fig-1] provide organisational solidarity during tension & torsion to the knee. However, there are notable differences in the morphometry & insertion of the two menisci which is of much clinical significance in meniscal injury [2]. Therefore, morphological parameters must be the prime focus while performing arthroscopy procedure, knee joint transplant surgery, meniscal transplant surgeries. Also apt consideration must be given to the same in case of accidental injuries of knee joint, meniscal injury repair by Surgeons, Orthopaedicians, Radiologists, and Interventionists. So the aim of the study is to find out morphometry, particularly thickness, length and width of menisci and also to compare data between medial and lateral menisci.

## MATERIALS AND METHODS

This cross sectional analytical study was conducted after taking permission from the Institutional Ethical Committee for Human Research (IECHR) at Medical College, Baroda, Gujarat. All embalmed cadavers at Department of Anatomy available during the study were included for data collection. Previously operated in lower limb region, cadavers having musculoskeletal abnormalities in lower limb region were excluded from the study. After dissecting knee joint [3], 60



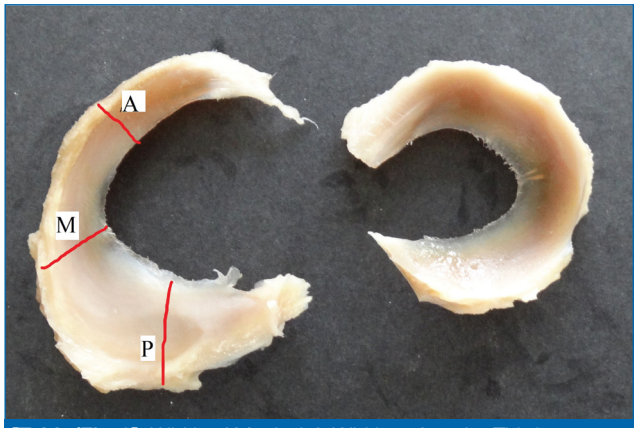

**[Table/Fig-1]:** Normal Pattern of Menisci of Both Sides.

healthy menisci were collected and labelled. These specimens were kept in formalin solution. Data collection and analysis was done during February 2015 to February 2016. Different parameters of menisci were measured as follow [4,5].

**1. Length of Menisci:** The length of the menisci was measured from the apex of anterior horn to the apex of posterior horn, by placing a non-elastic cotton thread across the outer circumference of the meniscus, with the help of a digital vernier calliper in cm and recorded as length of menisci at outer circumference [Table/Fig-2].

**[Table/Fig-2]:** Length of Menisci.

**2. Width of menisci:** Width was measured at three points, anterior, middle and posterior. One thread was positioned on the outer circumference of the menisci and other thread was positioned on the inner circumference of the same menisci (starting from apex of anterior horn to apex of the posterior horn end point).The length of both the thread were measured by digital Vernier calliper in mm and recorded. Then the three points anterior, medial and posterior were established on the thread by dividing length by four. Such established three points of outer and inner circumference were transferred on the menisci, and the distance between both anterior points, both middle points and both posterior points were measured by digital Vernier calliper in mm and recorded as width point at anterior, middle and posterior [Table/Fig-3].




**[Table/Fig-3]:** Width of Menisci-A-Width at Anterior Third.
M: Width at Middle Third; P: Width at Posterior Third

**3. Thickness of the menisci:** First, the length at the outer circumference of the meniscus was determined by positioning a thread from the apex of the anterior horn to the apex of the posterior horn.The length of the thread was measured with the help of digital Vernier calliper in mm. The value was recorded and divided by four, establishing three points on the thread and same three points was transferred on the meniscus by positioning same thread again on the outer circumference. These points were referred as anterior, middle and posterior. Thickness of outer circumference was recorded from above mentioned three points by using digital vernier caliper in mm from superior surface to inferior surface of menisci.

All above measured data was recorded and presented as Mean±SD.

## STATISTICAL ANALYSIS

Different parameters of menisci were measured with digital Vernier Caliper and analysed with the help of Microsoft Excel. All measured data was recorded and presented as Mean±SD. Student's t-test was applied to the data.

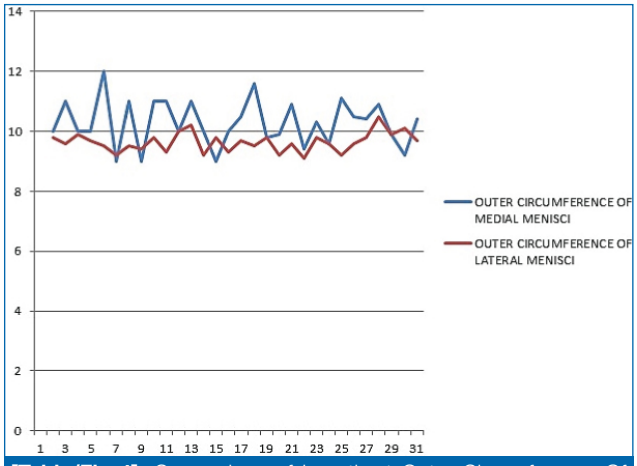
## RESULTS

In the present study, total number of 60 menisci were studied, out of which 30 menisci were medial menisci and 30 menisci were lateral menisci. Following tables and charts shows the observations made during the study. Data were presented as Mean±SD.

In present study, it is observed that the length at outer circumference of medial meniscus is 10.28±0.77 c.m and that of lateral meniscus is 9.64±0.33 cm [Table/Fig-4].In the present study, no statistically significant difference in thickness was

observed among anterior, middle and posterior thirds of the medial menisci. However, in the lateral meniscus middle third was thickest part. In comparison of Medial with Lateral menisci, the anterior and posterior thirds of medial menisci were more thick than lateral menisci.The individual analysis of each menisci shows that no much difference were observed among anterior, middle and posterior thirds of medial menisci while in lateral menisci anterior third was thinnest part [Table/Fig-5].

In present study, with regard to the width of the lateral meniscus, there was no significant difference between the anterior (11.82±0.80 mm), middle (12.53±0.72mm), and posterior thirds (12.03±0.79 mm). However, in the medial meniscus, the posterior third was the widest part (15.39± 0.78 mm) followed by middle third (11.10±0.50 mm) and the anterior third (9.05±0.70 mm). Comparing the width of the medial and lateral menisci, a statistically significant difference ($p<0.05$) in three points was found [Table/Fig-6].




**[Table/Fig-4]:** Comparison of Length at Outer Circumference Of Medial And Lateral Menisci.

| Observation | Thickness | | | | | |
|---|---|---|---|---|---|---|
| | Anterior Third (A) | | Middle Third (M) | | Posterior Third (P) | |
| | MM | LM | MM | LM | MM | LM |
| Mean | 6.22 | 4.15 | 6.18 | 5.86 | 6.30 | 5.63 |
| Standard Deviation | 0.60 | 0.50 | 0.56 | 0.61 | 0.42 | 0.60 |
| Statistical Parameter | t-test 14.46, p<0.0001 | | t-test 2.107, p<0.0395 | | t-test 4.983, p<0.0001 | |

**[Table/Fig-5]:** Comparison of Thickness of Medial and Lateral Menisci at Anterior,Middle and Posterior Points.

## DISCUSSION

There has been an association of meniscus injury and consequent osteoarthritis with increased weight and sedentary lifestyle. Morphometry of menisci and in particular, thickness and width of the menisci can determine the kind of injury, mode of treatment and its prognosis [6].

Various authors have conducted a study on the morphological parameters of menisci of knee joint from time to time. Among them more comprehensive study on the menisci were done by Almeida K.S et al[4]in 2004, Rao N et al[6]in 2014, Braz et al., [7] in 2010, Bhatt CR et al., [8] in 2014,.

Present study was compared the morphological parameters of menisci of knee joint with those of other authors and their observations are as mentioned [Table/Fig-7,8].

In present study length at outer circumference of medial menisci is 10.28±0.77 cm and of lateral is 9.64±0.33 cm. These findings closely matches with the results of study of Braz et al., [7] and Bhatt CR et al., [8]. According to Murlimanju BV et al., [9] length of medical meniscus is 7.52±0.7c.m and that of lateral meniscus is 6.8±1.2 cm. These findings are different from present study.

| Observation | Width | | | | | |
|---|---|---|---|---|---|---|
| | Anterior Third (A) | | Middle Third (M) | | Posterior Third (P) | |
| | MM | LM | MM | LM | MM | LM |
| Mean | 9.05 | 11.82 | 11.10 | 12.53 | 15.39 | 12.03 |
| Standard Deviation | 0.70 | 0.80 | 0.50 | 0.72 | 0.78 | 0.79 |
| Statistical Parameter | t-test 14.31, P<0.0001 | | t-test 9.039, P<0.0001 | | t-test 16.492, P<0.05 | |

**[Table/Fig-6]:** Comparison Of Width Of Medial And Lateral Menisci At Anterior, Middle & Posterior Points.

| Parameters | | Present Study | Braz et al [7] (2010) | Almeida K.S et al [4] (2004) | Bhatt C.R et al [8] (2014) | Rao N et al [6] (2014) |
|---|---|---|---|---|---|---|
| Length of Menisci (cm) | | 10.28±0.77 | 9.185±0.566 | Not Observed | 10.46±1.14 | 8.64 |
| Thickness of Menisci (mm) | Anterior | 6.21±0.6 | 6.17±1.68 | 5.92±1.37 | 5.82±1.44 | 5.4 |
| | Middle | 6.18±0.55 | 6.31±1.73 | 5.31±1.06 | 5.64±1.26 | 5.6 |
| | Posterior | 6.30±0.42 | 5.18±1.55 | 5.91±1.13 | 5.86±1.06 | 5.4 |
| Width of Menisci (mm) | Anterior | 9.05±0.70 | 7.68±1.36 | 9.02±1.59 | 8.78±2.12 | 8.4 |
| | Middle | 11.10±0.45 | 9.32±2.24 | 12.16±2.58 | 12.08±2.52 | 8.4 |
| | Posterior | 15.39±0.8 | 14.96±2.66 | 17.37±2.22 | 16.46±2.18 | 15 |

**[Table/Fig-7]:** Medial Menisci Morphological Study & Compare With Other Study.

| Parameters | | Present Study | Braz et al[7] (2010) | Almeida K.S et al[4] (2004) | Bhatt C.R et al[8] (2014) | Rao N et al[6] (2014) |
|---|---|---|---|---|---|---|
| Length of Menisci (cm) | | 9.64±0.33 | 9.280±0.752 | Not Observed | 9.53±0.82 | 8.74 |
| Thickness of Menisci (mm) | Anterior | 4.15±0.5 | 4.40±0.83 | 3.71±1.15 | 3.7±1.52 | 5 |
| | Middle | 5.90±0.61 | 6.52±1.81 | 6.10±1.04 | 5.78±1.22 | 5.9 |
| | Posterior | 5.63±0.60 | 5.46±1.19 | 5.29±0.78 | 5.2±0.98 | 5.7 |
| Width of Menisci (mm) | Anterior | 11.82±0.81 | 11.32±1.46 | 11.86±1.81 | 11.3±1.3 | 10 |
| | Middle | 12.53±0.72 | 11.16±1.64 | 11.97±2.56 | 11.66±1.48 | 10 |
| | Posterior | 12.03±0.8 | 11.67±1.54 | 11.44±1.07 | 11.50±1.34 | 9.8 |

**[Table/Fig-8]:** Lateral Menisci Morphological Study & Compare With Other Study

In the present study, the morphological variables thickness and width of menisci were analysed in three different points: anterior, middle and posterior thirds.

Related to thickness of lateral menisci middle (5.90±0.61 mm) third was thickest followed by posterior (5.63±0.60 mm) and anterior (4.15±0.5 mm) thirds with average thickness 5.21 mm. Statistical analysis shows significant difference in the thickness between anterior, middle and posterior point in the lateral menisci, which correlates with results of studies by Almeida KS et al., [4], Rao N et al., [6], Braz et al., [7], Bhatt C.R et al., [8]

Related to the medial meniscal thickness at anterior, middle and posterior points middle third (6.18 ±0.55 mm) is thinnest which correlates with study done by Almeida KS et al., [4] and Bhatt CR et al., [8] while these findings did not correlates with study done by Rao N et al., [6] and Braz et al., [7]. Rico and Ayala (1997) [10], through arthroscopic revision, determined that meniscal rupture is topographically more frequently injured in middle third of medial meniscus followed by the posterior third.The one of the reasons for the meniscal rupture is that the middle portion is the thinnest portion in the medial menisci [8].According to Dr. Nimje B. P, the thickness of lateral meniscus is more than the medial meniscus [11].

According to Almeida KS et al., [4] average width of medial meniscus was 12.85 mm and of lateral meniscus was 11.76 mm. In present study average width of medial menisci is 11.57 mm and of lateral menisci is 12.12 mm, which correlates with the study done by Rao N et al., [6], Braz et al., [7] and Bhatt CR et al., [8]. Amandeep K et at., [12] suggest that mean width of medial meniscus at anterior, middle and posterior point is 9mm,11mm and 15mm respectively while in present study it is 9.05mm,11.10mm and 15.39mm at anterior, middle and posterior points, these findings correlates with the finding of present study.

Smillie [13] shows that the lateral meniscus shows a width, higher and more uniform than the medial meniscus. He also suggests that the morphological differences of menisci, particularly, in the thickness and width can determine not only the possibility of an injury, but also the location and the kind of injury. He determined that wider meniscus is more susceptible to rupture than the narrow. This hypothesis is justified by the fact that narrow menisci is subject to less action of femoral condyle. A higher evidence of this fact is proposed by the lesser frequency of injuries of the anterior third of medial menisci, as related by Rico & Ayala (1997) [10]. In this study, the posterior third of medial meniscus, is the widest part, while the anterior third is the narrowest part of meniscus [4].

## LIMITATIONS

The limitations of present study are that study has been done on the specimen of unknown age and sex in central Gujarat region. A large radiological, clinical and anatomical study from other regions is required for better support.

## CONCLUSION

Morphology of menisci is important to Surgeons, Orthopaedicians, Radiologists and Interventionists for Performing advanced orthopaedic surgeries arthroscopy, knee-transplant surgery, meniscal transplant surgery, meniscectomy. This anatomical knowledge of meniscal morphometry is useful for diagnostic and therapeutic procedures.

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