Morphological study of the menisci of the knee joint in human cadaver in Jharkhand population

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ABSTRACT

Introduction: Sports are the leading cause of joint injuries, particularly in the knees. Knee menisci are an important functional unit that aids in load distribution and hence reduces stress on the knee joint. Meniscal morphology provides information on exact size and shape, which is important for meniscal transplantation in cases of meniscal damage. The study's goal is to determine the morphological variation in the shape of menisci, as well as the width and thickness of menisci. Method: This study was conducted at the Rajendra Institute of Medical Sciences (RIMS) Ranchi, Department of Anatomy. In this study, 100 menisci were taken from 50 adult cadaver knee joints available in the dissection hall. Result: Six morphological kinds of menisci were identified after a morphological and morphometric study of 100 menisci. The most common crescent-shaped menisci (96%) were found in 50 medial menisci (MM), while the most common C-shaped menisci were found in 50 lateral menisci (LM, 94%). There was no statistically significant difference in thickness between the anterior, middle, and posterior thirds of the MM in the morphometric analysis. The thickest section of the lateral meniscus (LM) was in the middle third. There was no significant variation in the width of the LM among the different thirds in the current study. The posterior portion of the medial meniscus (MM), on the other hand, was the widest. Conclusion: The findings of this study support meniscal anatomy in terms of surgical technique and arthroscopy of the knee joint, as well as contributing to a better understanding of meniscal architecture and meniscal transplantation. As a result, health workers who treat meniscal injuries should be aware of the probable anatomical differences.

Keywords: Knee joint, meniscal anatomy, meniscal injuries

Introduction

The menisci of the knee joint are an important functional unit that can improve joint congruence and load distribution, lowering stress on the knee joint and preventing osteoarthritis. The menisci play several roles in the knee's ability to function properly. Meniscal injuries are widespread in the workplace, sports, and everyday activities, and they can be devastating.[1]

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the underlying bone from the considerable forces generated during extremes of flexion and extension by increasing the congruity of articulation. They also provide proprioceptive feedback, assist lubrication, and cushion the underlying bone from the considerable forces generated during extremes of flexion and extension.\[3\] The importance of structural anomalies and variations of the intraarticular structures of the knee joint has increased with the introduction of new techniques such as arthroscopy, computed tomography, and magnetic resonance imaging (MRI).\[3\] The loss of a meniscus increases the chance of getting arthritis in the knee significantly. The use of allograft tissue to replace a missing meniscus can help to alleviate symptoms and lower the risk of future arthritis.\[4\] When it comes to meniscal transplantation, knowing the right size and shape is crucial.\[5\] Knee pain due to meniscal tear is commonly seen by primary care physicians in the society. Morphological variants of menisci are prone to tear. This study helps family physicians in understanding the importance of different varieties of menisci and meniscal tears leading to knee problems. The aim of our study was (1) to study the morphological differences in the form of menisci, (2) to study the menisci’s width and thickness, (3) comparison of medial menisci (MM) and lateral menisci (LM) of the knee joint.

**Material and Methods**

The research was conducted from November 2017 to October 2019 in the Department of Anatomy, RIMS Ranchi.

The following resources were used in the research: Human adult knee joints were used in this study, which was available in the anatomy dissection hall. A total of 100 menisci from 50 adult cadaver knee joints were used in the study. Menisci measurements were taken with a digital Vernier caliper [Figure 1].

**Morphological Study**

The approaches to the menisci were conducted after dissection of the skin and muscles, opening anteriorly by a longitudinal incision on each side of the joint capsule, cutting the patellar ligament and collateral ligaments transversely. The joint capsule and intraarticular ligaments were cut to expose the menisci, and the condyles were circumferentially separated from their soft tissue attachments and excised to reveal the tibial plateau. All dissections were carried out methodically, with the data collected on a standardized collection sheet. The forms of the menisci were observed and categorized based on their morphological variations: sickle-shaped, sided U-shaped, sides V-shaped, crescent-shaped, and C-shaped MM [Figure 2]. The LM was divided into three categories: crescent (semilunar), C-shaped, and discoid-shaped. The meniscus is said to be discoid when it covers the tibial plateau in a circular pattern. Menisci classified as crescent (semilunar) kinds featured slender anterior and posterior horns and thin bodies. Sickle-shaped menisci were classified as those with slender anterior and posterior horns and thick bodies. Menisci with any structural alterations, such as injuries or advanced degenerative changes, were not included in the study.

**Morphometric Study**

To determine the breadth and thickness of the menisci, a digital Vernier caliper was used. The breadth of the menisci was measured using the anterior third, middle third, and posterior third of the menisci. From each site, a line was drawn from the peripheral margin of the meniscus to the inner margin of the meniscus [Figures 3]. The total was calculated. Using the same breadth points, the thickness of the meniscus was measured solely between the top and bottom margins of the outside circumference. The data were tabulated and statistically analyzed using Microsoft Excel. All measurements were taken, and the findings were given as a mean standard deviation. A student’s t-test was used to analyze the data.

**Discussion**

**Morphological study of menisci**

Meniscal differentiation or the development of the vasculature early in embryonic life may cause changes in the form of the meniscus. The possibility of damage can be determined by morphological changes in the menisci. The contour and insertion of the LM and medial meniscus (MM) vary significantly, which is crucial in terms of injury processes. Meniscal form abnormalities, known as hypoplasia or hyperplasia, have been described in men. Meniscal hyperplasia, also known as discoid menisci, has been the subject of numerous researches because it is a common cause of symptoms.

Parsons discovered that the MM is usually crescentic in shape in primates, but the LM can be crescent or disc in shape. Vallois corroborated this observation and investigated the anatomy of the knee joint in primates.\[6\][7]

The MM was described by Flick and Rudolph as half, two-third, or three-fourth ellipse, while the LM was compared to an almost complete circle.\[8\] Charles, on the other hand, categorized the menisci based on the relative size of the anterior and posterior cornua as well as the degree of curvature.\[8\] A discoid LM in a cadaver specimen was described by Young\[9\] in 1889. The meniscus of the knee, particularly the LM, is discoid rather than semilunar in shape, which is an atavistic abnormality. The discoid meniscus was most likely a congenital aberration that usually occurred laterally, according to the information provided. Furthermore, it was noted that the discoid form resulted in greater tibia coverage and was often related to increased meniscus thickness, which could lead to aberrant shearing stresses across the knee joint.\[10\]

A discoid meniscus is the most frequent congenital anomaly of the meniscus in men, with a frequency of 0.4–17% and the vast majority occurring on the lateral side of the knee. In a research conducted by Rao and Rao\[12\] in South India, 177 (5.59%) discoid
LM were discovered in 3167 knee arthroscopies performed between 1993 and 2004.

The frequency of discoid meniscus is 1.4–4.5% for the LM and 0.3% for the MM, according to Smillie (1948) and Nathan (1969). However, the current investigation discovered an incomplete discoid meniscus in 1% of the LM and no discoid meniscus on the medial scale. Kale et al.,[13] in 2006, discovered six morphological categories of menisci forms: 18.8% of the MM was crescent-shaped, 22.72% was sided V-shaped, 9.09% was sided U-shaped, 36.36% was sickle-shaped, 13.63% was C-shaped and 0% discoid shaped. There were 54.54% partial discoid shapes and 22.72% discoid shapes among the discoid shapes. There was...
no evidence of a discoid MM, and 73% of the cadavers had the same meniscus morphology on both sides. Kale et al.,[13] 2006, discovered six morphological types of menisci forms: Horseshoe, sickle, sided U-shaped, C-shaped, and discoid are some of the shapes. They discovered discoid LM in 77% of cases and no discoid MM. The experiment was carried out on 11 neonatal cadavers with 22 knee joints.[16] Horseshoe-shaped structures, on the other hand, were not seen in the current investigation. Muralimanju et al.[15] discovered four different morphological forms of menisci shapes in adult cadavers. In 50% of cases, the MM were crescent-shaped, V-shaped in 38.9%, and sided U-shaped in 11.1%. In 61.1% of cases, the LM was C-shaped, while in 38.9%, it was crescent-shaped, and no discoid medial or LM was found. They discovered that the MM shape was different on each side in 54.71% of the cadavers.

The morphological kinds of menisci were determined in this study, with crescent-shaped MM accounting for 96%, sided V-shaped MM accounting for 2%, sickle-shaped MM accounting for 2%, and no discoid MM accounting for 2%. In terms of LM shape, 94% were C-shaped, 4% were sided U-shaped, and 1% were incomplete discoid, which is more or less in line with Itagi et al.[16] findings [Tables 1 and 2 and Figure 4-7].
Morphometric study of menisci

Increased weight and sedentary lifestyle have been linked to meniscus injury and subsequent osteoarthritis. The type of injury, treatment method, and prognosis can be determined by the morphology of the menisci, namely the thickness and width of the menisci. Because the knowledge of meniscal morphometry is limited, the goal of this study was to examine the morphometric variations found in the human meniscus, adding knowledge to the subject, and correlating these variations with the possibility, location, and type of lesion.

From time to time, several authors have researched the morphological features of the menisci of the knee joint. Almeida et al. (2004),[17] Braz and Silva (2010),[18] Bhatt et al. (2014),[19] and Hathila et al. (2018)[20] were among the more extensive studies on the menisci.

The present study compared the morphological parameters of the menisci of the knee joint with those of other authors and their observations areas mentioned here [Tables 3 and 4].

The anterior third (5.960.60 mm) of the medial meniscal thickness at the anterior, middle, and posterior locations is the thinnest, which does not connect with the study done by Almeida et al.[17] (2004), Braz and Silva,[18] 2010, Bhatt et al.[19] (2014), and Hathila et al.[20] (2018).

The average thickness of the MM was 5.71 mm, while the LM was 5.03 mm, according to Almeida et al. (2004).[17] The average thickness of the MM was 5.87 mm, and the LM was 5.46 mm, according to Braz and Silva,[18] 2010. The average thickness of the MM was 5.77 mm, and the LM was 4.89 mm, according to Bhatt et al.[19] Studies of Hathila et al.[20] discovered that the MM is 6.23 mm thick and the LM is 5.22 mm thick. The average thickness of the MM is 6.08 mm, while the LM is 5.21 mm, according to the current study. When compared to the LM, the MM has a greater

![Figure 11: Width of medial & lateral meniscus](image1)

![Figure 12: Pie diagram showing the incidence of different shapes of lateral meniscus](image2)

| Parameters                        | Present study | Almeida et al. (2004)[17] | Braz and Silva (2010)[18] | Bhatt et al. (2014)[19] | Hathila et al. (2018)[20] |
|-----------------------------------|---------------|--------------------------|--------------------------|------------------------|--------------------------|
| The thickness of medial menisci (mm) |               |                          |                          |                        |                          |
| Anterior 1/3                      | 5.96±0.60     | 5.92±1.37                | 6.17±1.68                | 5.82±1.44              | 6.21±0.60                |
| Middle 1/3                        | 6.10±0.69     | 5.31±1.06                | 6.31±1.73                | 5.64±1.26              | 6.18±0.55                |
| Posterior 1/3                     | 6.20±0.60     | 5.91±1.13                | 5.18±1.55                | 5.86±1.06              | 6.30±0.42                |
| Width of MM (mm)                  |               |                          |                          |                        |                          |
| Anterior 1/3                      | 8.60±0.63     | 9.02±1.59                | 7.68±1.36                | 8.78±2.12              | 9.05±0.70                |
| Middle 1/3                        | 11.24±1.17    | 12.16±2.58               | 9.32±2.24                | 12.08±2.52             | 11.10±0.45               |
| Posterior 1/3                     | 15.58±1.02    | 17.37±2.22               | 14.96±2.66               | 16.46±2.18             | 15.39±0.80               |

| Parameters                        | Present study | Almeida et al. (2004)[17] | Braz and Silva (2010)[18] | Bhatt et al. (2014)[19] | Hathila et al. (2018)[20] |
|-----------------------------------|---------------|--------------------------|--------------------------|------------------------|--------------------------|
| The thickness of LM (mm)          |               |                          |                          |                        |                          |
| Anterior 1/3                      | 4.20±0.55     | 3.71±1.15                | 4.40±0.83                | 3.70±1.52              | 4.15±0.50                |
| Middle 1/3                        | 5.93±0.42     | 6.10±1.04                | 6.52±1.81                | 5.78±1.22              | 5.90±0.61                |
| Posterior 1/3                     | 5.50±0.35     | 5.29±0.78                | 5.46±1.19                | 5.20±0.98              | 5.63±0.60                |
| Width of LM (mm)                  |               |                          |                          |                        |                          |
| Anterior 1/3                      | 11.56±0.82    | 11.86±1.81               | 11.32±1.46               | 11.30±1.30             | 11.82±0.81               |
| Middle 1/3                        | 12.12±0.95    | 11.97±2.56               | 11.16±1.64               | 11.66±1.48             | 12.53±0.72               |
| Posterior 1/3                     | 11.85±0.83    | 11.44±1.07               | 11.67±1.54               | 11.50±1.34             | 12.03±0.80               |
thickness. When compared to prior studies, the thickness of the MM and LM in the current study is greater, except the Hathila et al. [20] study, which is more than the current study.

The average width of the MM was 12.85 mm and the LM was 11.76 mm, according to Almeida et al. (2004).[17] The average width of the MM was 10.65 mm, while the LM was 11.38 mm, according to Braz and Silva (2010).[18] The average width of the MM was 11.48 mm, while the LM was 12.44 mm, according to Bhatt et al.[19] The average width of the LM is 11.84 mm, and the LM is 12.12 mm, according to Hathila et al.[20] The average width of the medial canal was discovered in this investigation. The LM are wider than the MM, according to Smillie.[5] He further claims that meniscal morphological characteristics, notably in thickness and width, can indicate not only the likelihood of injury but also the location and type of injury. He discovered that a broader meniscus is more prone to rupture than a narrow one. The width of the middle third of the LM was found to be greater than the posterior third, according to Almeida et al. (2004).[17] In this study, the posterior third of the MM is the broadest, while the anterior third is the narrowest, and the middle third of the LM is the widest, while the anterior third is the narrowest.

Overall the present study revealed the following observation:

The LM is thicker when compared to the LM [Table 5].

The width of the LM is more than that of the MM [Table 6 and Figure 8-13].

The paired t test of parameters of the MM and LM [Table 7].

Relevance to the practice of primary care physicians

Meniscal injury is very common due to road traffic accidents (RTA) and sports. This injury is a very common cause of knee pain and osteoarthritis. Essential facilities are lacking in primary and secondary health centers, such as MRI and specialist doctors.
Hence, such patients need to be referred to specialized centers. Our study helps the physicians posted in remote areas to know the variations in the morphology of menisci and meniscal injury to refer the patient to a specialized care center after primary treatment.

**Conclusion**

The findings of this study will support meniscal anatomy about surgical procedures including arthroscopy of the knee joint. The findings contributed to a better understanding of meniscal anatomy and implications for allograft meniscus transplantation by providing further information on the various morphologies of the MM and LM. As a result, health practitioners who treat meniscal injuries should be aware of any anatomical variances that may exist in the meniscus, which will help with the rehabilitation process.

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**Conflicts of interest**

There are no conflicts of interest.

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