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MORPHOMETRIC STUDY OF MENISCUS OF THE KNEE JOINT

Anatomy

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ABSTRACT

BACKGROUND: The menisci are considered main elements for a perfect articulation among the articular surfaces. Injuries to the menisci usually occur during weight bearing, and frequently involve a twisting or pivoting motion. The study was to determine the peripheral border length, inner border length, thickness, width and distance among anterior and posterior horn of the adult menisci. A total of 104 menisci from 52 formalin fixed knee joints were utilized for the study at Anatomy department, SMIMS, Sikkim. The peripheral border length and inner border length of medial meniscus was 84.27 ± 7.34mm and 53.98 ± 4.51mm significantly more than lateral meniscus 75.41 ± 6.28mm and 40.19 ± 4.62. A difference statistically significant was observed among the anterior, middle, and posterior thirds of lateral meniscus in which middle thirds was thickest (5.15 ± 0.75mm) ($p<0.05$) than anterior thirds (3.81 ± 0.688mm) and posterior thirds (4.97 ± 0.827mm) ($p< 0.05$).The individual analysis of each meniscus showed that the posterior thirds (12.25 ± 2.22mm) was the widest part of medial meniscus ($p< 0.05$) than the anterior (6.76 ± 0.942mm) and middle thirds (6.63 ± 0.969). In the lateral meniscus the posterior third (9.26 ± 1.42mm) part was the widest ($P< 0.05$) compared to anterior third (8.89 ± 1.73mm) and middle third (9.2 ± 1.53mm).

CONCLUSION:. The result of this study showed that there is an important relationship between the morphometric data of the menisci. Hence, this study is not only important for orthopedic surgeons, but also for morphologists and embryologist.

KEYWORDS

Meniscus, Knee, Circumference

INTRODUCTION

The menisci are considered main elements for a perfect articulation among the articular surfaces. Performing mechanical functions, such as supporting the corporal weight, shock absorption, stabilization and rotational facilitation. The functions of the meniscus include load transmission, shock absorption, stress reduction, increase joint congruence, improve joint stability, limit extreme flexion and extension, proprioception, and joint lubrication and nutrition[1].

The medial meniscus is C shaped and it is wider anteriorly than posteriorly[2]. Its covers 50% of the medial tibial plateau and is connected firmly to the joint capsule (coronary, meniscotibial and deep medial collateral ligament). Its anterior insertion is fan shaped, and is attached to the tibial plateau and to the inter condylar notch above anterior cruciate ligament[3].

Injuries to the menisci usually occur during weight bearing, and frequently involve a twisting or pivoting motion. Although the meniscus has little role in stability in the intact joint, tears occasionally produce symptoms of instability. So menisci are now known to be essential structures for normal knee function. The meniscus has several roles that contribute to the successful function of the knee. Injuries to the meniscus are common in work, sports and everyday activities, and can be disabling[4].

Variations of form and in particular of thickness and width of menisci can determine the possibility and the kind of injury and also may help in the treatment. Currently efforts to treat meniscal injuries are by replacement with allografts and the search for a synthetic replacement material.

The knowledge of these variants menisci of the knee joint will provide support to meniscal anatomy which is necessary for various surgical procedures and also for arthroscopy of the knee joint. The knowledge of exact size and shape is essential for meniscal transplantation in meniscal injuries[5,6].

It is now known that the menisci serve several important purposes.

1) They share a great responsibility in load bearing in the knee joint.
2) Their concave superior surfaces results in increased articular conformity with the femoral condyles.

Finally, the relationship of their peripheral margin with the synovium makes their surfaces optimal for the distribution of synovial fluid across the weight bearing surface. The medial meniscus can act as a posterior wedge to anterior tibial translation, whereas the lateral meniscus is not capable of this function.

However, the data related to the morphometric parameters of these structures are scares. Because of it the aim of our work was to determine the peripheral border length, Inner border length, thickness and the width of the menisci, the distance among anterior and posterior cornua. Hope that normal variation of these morphometry will throw light on the treatment of injury, surgery and to possible recovery.

MATERIALS AND METHODS

A total of 104 menisci from 52 formalin fixed knee joints were utilized for the study. These knee joints were obtained from the Anatomy department, Sikkim Manipal Institute of Medical Sciences (SMIMS), Tadong, Gangtok, Sikkim.

Dissection of the knee joints in above mention colleges was done. After the removal of skin and muscles, the menisci were approached anteriorly by a longitudinal incision on each side of the joint capsule, cutting the patellar ligament and the collateral ligament transversely. In order to expose the menisci clearly, the joint capsule and the intra articular ligaments were cut, and the condyles were circumferentially detached from their soft tissue attachments, exposing the tibial plateau. All dissections were performed in a systematic fashion and data were recorded on a standardized collection sheet.

Measurement of peripheral border length and inner border length was taken with non-elastic cotton thread. Measurement of this thread was taken by digital caliper, which gives peripheral border length and inner border length. Peripheral border length and inner border length was divided in three segments i.e. Anterior1/3rd**,** Middle 1/3rd, Posterior 1/3rd. After that a measurement was taken through digital caliper. Digital caliper was put in the central part of each segment. Distance among anterior horn and posterior horn of menisci was taken by digital caliper.

The data were statistically analyzed by "t"-test of sample considering level of significance of 0.05 (α=0.05).

Fig. No.1 Digital Caliper

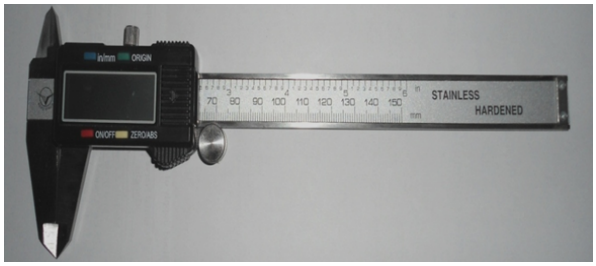

Fig. No. 2 Pointed forcep, Scalpel, Toothed forcep, Blunt forcep.

Fig. No. 3 : Showing measurement of width by digital caliper (AH –Anterior horn, PH- Posterior horn, MM Medial meniscus, LM-Lateral meniscus).

Fig. No. 4 : Showing measurement of thickness by digital caliper,(AH –Anterior horn, PH- Posterior horn MM-Medial meniscus, LM –Lateral meniscus).

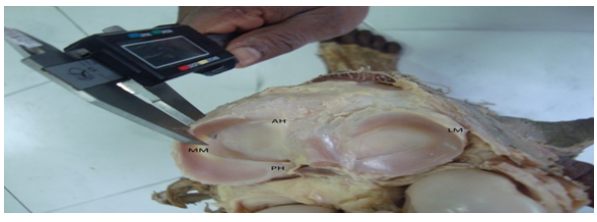

Fig. No. 5 : Showing measurement of inner border length by cotton thread ,(AH- Anterior horn, PH- Posterior horn, MM-Medial meniscus, LM- Lateral Meniscus, TH- Thread).

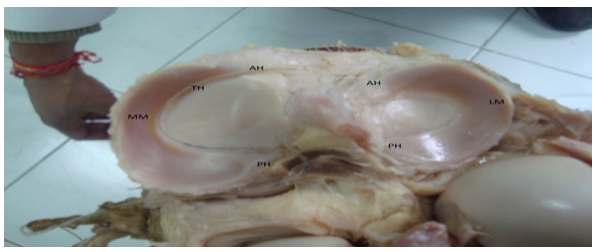

Fig. No. 6 : Showing measurement of distance among anterior and posterior horn of medial meniscus by digital caliper,(AH- Anterior horn, PH- Posterior horn).

RESULTS

There were some statistically significant morphometrical differences found among the medial and lateral meniscus of the joint of unknown sex.

The peripheral border length and inner border length of medial meniscus (84.27 ± 7.34mm and 53.98 ± 4.51mm) was significantly more than ($p< 0.05$) the lateral meniscus (75.41 ± 6.28mm and 40.19 ± 4.62) in table 1.

The distance among anterior and posterior horn of medial meniscus (23.66 ± 2.05mm) were significantly more than ($p< 0.05$) the lateral meniscus (12.28 ± 2.73mm) table 2.

Related to thickness of outer circumference of meniscus, the anterior third (4.64 ± 0.854mm) of the medial meniscus was the thinnest part compared to middle third and posterior thirds.

Posterior thirds (6.92 ± 1.42mm) of the medial meniscus was the thickest part ($p< 0.05$) compared to the anterior third (4.64 ± 0.854mm) and middle third (5.34 ± 0.993mm).

There was statistically significant difference found among the anterior and middle thirds ($p< 0.05$).

A difference statistically significant was observed among the anterior, middle, and posterior thirds of lateral meniscus in which middle thirds was thickest (5.15 ± 0.75mm) ($p<0.05$) than anterior thirds (3.81 ± 0.688mm) and posterior thirds (4.97 ± 0.827mm) ($p< 0.05$), Table-3.

The individual analysis of each meniscus showed that the posterior thirds (12.25±2.22mm) was the widest part of medial meniscus ($p< 0.05$) than the anterior (6.76 ± 0.942mm) and middle thirds (6.63±0.969). There was statistically significant difference found among anterior and middle thirds ($p< 0.05$) in table 4.

In the lateral meniscus the posterior third (9.26 ± 1.42mm) part was the widest ($P< 0.05$) compared to anterior third (8.89 ± 1.73mm) and middle third (9.2 ± 1.53mm). There was statistically significant difference among anterior and posterior thirds ($p< 0.05$).

Table 1- COMPARISON OF PERIPHERAL BORDER LENGTH AND INNER BORDER LENGTH OF ADULT MENISCI (n=104)

Length(in mm)	Medial Meniscus	Lateral Meniscus
Peripheral Border Length	84.27±7.34	75.41±6.28
Inner Border Length	53.98±4.51	40.19±4.62

Values are Mean ±SD
P-Value=0.049, P-Value<0.05=1.96

Table 2-COMPARISON OF DISTANCE AMONG ANTERIOR HORN AND POSTERIOR HORN OF ADULT MENISCI (n=104)

Distance(in mm)	Medial meniscus	Lateral Meniscus
Distance among anterior horn and posterior horn	23.66±2.05	12.28±2.73

Values are Mean ±SD
P-Value=0.049

Table 3- COMPARISON OF THICKNESS OF ADULT MENISCI AT DIFFERENT REGIONS (n=156)
(Thickness in mm)

	Medial Meniscus	Lateral Meniscus
Ant.1/3	4.64±0.854	3.81±0.688
Midd.1/3	5.34±0.993	5.15±0.75
Post.1/3	6.92±1.42	4.97±0.827

Values are Mean ±SD
P-Value=0.04
P-Value<0.05=1.96

Table 4- COMPARISON OF WIDTH OF ADULT MENISCI AT DIFFERENT REGIONS (n=156)

Width in mm	Medial Meniscus	Lateral Meniscus
Ant.1/3	6.76±0.942	8.89±1.73
Midd.1/3	6.63±0.969	9.2±1.53
Post.1/3	12.25±2.22	9.26±1.42

Values are Mean ±SD
P-Value=0.04 it is <0.05=1.96

Since, the calculated value of" t" is less than the table value of" t" at 0.05 probability level, it can be concluded that there is significant evidence of having differences in outer circumference length, inner border length ,Distance among anterior horn and posterior horn, thickness and width of medial and lateral meniscus of unknown sex.

DISCUSSION

The data related to the morphology of the menisci are scarce; therefore the main objective of this study was to analyse the morphometric variations presently in the human meniscus, enriching the literature on this subject, and correlating these variations with the possibility, location and type of lesion.

Almeida et al. reported that data referring to the dimensions of the menisci are varied[6]. Although the morphometric data related to the menisci of the adults have been reported by few authors like Testut and Laterjet 1975, Cailliet et al. 1976, Hayashi et al. 1988.[7,8,9]

In the present study, we determined that there were some statistically significant differences found among medial and lateral meniscus of knee joints of unknown sex.

Kohn and Moreno 1995[10], reports that, if bony fixation of meniscal substitute should be attempted, the entire circumferential length of the meniscus plus both the insertion ligaments must be known.This length in the adult menisci has been described previously by Kohn and Moreno[10].

Here we also reported that both the peripheral border length and inner border length and found that peripheral and inner border length was more in medial meniscus than lateral meniscus.

Distance among anterior horn and posterior horn were more in medial meniscus than lateral meniscus. Variations of form and in particular, thickness and width of menisci can determine the possibility and kind of injury.

However, the data related to the morphometric Parameters of these structures are scarce (Almeida et al, 2004)[6].

According to Rico and Ayala (1997)[11], in an arthroscopic revision carried out to determine the topographic location of meniscal ruptures, it was found that the middle third part of medial meniscus is more frequently injured, followed by posterior third.

Related to thickness of outer circumference of meniscus, we found that the posterior third of the medial meniscus was thickest part compared to anterior and middle thirds. There was statistically significant difference observed among the anterior, middle and posterior thirds of lateral meniscus relating to thickness of present study Whereas Almeida et al.[6] reported that middle third region of the lateral meniscus was the thickest in their specimens.

In our specimen middle third of lateral meniscus was thickest in comparison among the three parts of the medial meniscus with the lateral, Significant statistical difference was observed in the present study relating to thickness.

In our specimen, the posterior third was the widest part of medial meniscus than anterior and middle thirds which was in accordance with a study done by Almeida et al.[6] who also reported that the posterior third region was the widest followed middle third region and the anterior third region.

In the present study anterior third and middle third of the lateral meniscus was wider than medial meniscus but posterior thirds of medial meniscus was wider than lateral meniscus. According to Murlimanju(2010,2011)[12,13] all the three regions of the lateral meniscus was wider than medial meniscus.

The lateral meniscus showed a significant difference among the anterior, middle and posterior thirds among which middle third was the thickest part of the meniscus. According to Figueroa et al. (1999)[14], the lateral meniscus is liable to higher variations in its general configuration than the medial meniscus, appearing frequently in the body. However, in this study significant statistical difference was observed in the width of anterior, middle and posterior thirds of lateral meniscus.

On the other hand, the medial meniscus as described by Didio (2002)[15], shows that posterior horn was quite wider whereas an anterior extremity was sharp and thin. This description was according to the results of our statistical study which showed that medial meniscus was wider on the posterior third, followed by the middle third, and in the end by the anterior third.

According to Smillie(1975)[5] the lateral meniscus shows a width higher and more uniform than the medial meniscus , however, Testut and Laterjet (1975)[7] and Didio(2002)[15], mentioned that medial meniscus is little wider than the lateral meniscus.

In this study, we found that maximum width of medial meniscus was (12.25±2.22 mm) and width of lateral meniscus was (9.26 ± 1.42mm). According to Smillie (1975)[5] the morphological differences of menisci, in Particular the thickness and width can determine not only the possibility of injury, but also the location and the kind of injury.

This present study suggests that the narrow meniscus is less prone to ruptures than wider meniscus because the narrow meniscus is liable to a less action of femoral condyle which was supported by the study done by Rico and Ayala 1997[11].

In our study, the posterior third of medial meniscus was the widest part, while the anterior third was the narrowest part of meniscus. The reason according to Cohen et al. (1993)[16], was that the menisci cover from ½ to 2/3 of articular surface of corresponding tibial plateau, with the lateral meniscus covering an area higher than the medial meniscus.

According to Smillie(1975)[5] and Farias Filho et al. (1985)[17] the lateral meniscus cover a higher area of the tibia plate, due to its semicircular format, been near the insertion of its cornua.

Actually, in this study we established that the distance among the anterior and posterior horn of lateral meniscus is significantly less than the medial, giving an aspect in which the lateral meniscus shows the form of an almost complete.

This high proximity among the insertions of its cornua would be one of the reasons for the lateral meniscus is less prone to lacerations (Kapandji, 1998; Miranda, 2000)[18,19].

In both anatomical and orthopedic literature, attention to the form of the menisci of the knee joint has been directed for the most part to the occurance of a discoid type of lateral meniscus[20].

CONCLUSION

Meniscal injuries in children and adolescents are being seen with increased frequency. The snapping knee syndrome is usually related with the tear of meniscus and is more often in children and young adolescents. There are marked differences in the contour and insertion among the lateral and medial menisci which are important in relation to the injury mechanism (smillie1975)[5]. Variations of form and in particular, the thickness and width of the menisci can determine the possibility and kind of injury (Almeida 2004)[6].

In this study we established that the distance among the anterior and posterior horn of lateral meniscus is significantly less than the medial meniscus giving an aspect in which lateral meniscus shows the form of a ring almost complete. This high proximity among the insertion of its cornua or horn would be one of the reasons for the lateral meniscus is less prone to lacerations (Kapandji 1998, Mirinda 2000)[18,20]. After analyzing the relation of meniscus area/tibial surface area, we found that lateral meniscus covers an area of tibial surface significantly higher than the medial meniscus which justifies the higher incidence of injuries of medial meniscus. Lateral meniscus is less frequently injured, and some authors believe that this is the result of well-controlled movement of the meniscus by its attachments to the popliteus and the meniscofemoral ligaments[21].

Normal variants of the meniscus are relatively uncommon and are frequently asymptomatic, although there is greater propensity for discoid menisci to tear. However recognizing these variants is important, as they can be misinterpreted for more significant pathology

on MRI. Therefore, health professionals who work with the treatment of meniscal injuries should be aware of the possible anatomical variations that may exist in the meniscus facilitating the rehabilitation process. Hence, this study is not only important for orthopedic surgeons, but also for morphologists and embryologist.

Conflicts of Interests: None

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