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Research Article

MORPHOMETRIC STUDY OF MENISCI OF KNEE JOINT IN THE WEST REGION

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ABSTRACT
The menisci are cartilaginous tissues that provide structural integrity to the knee when it undergoes tension and torsion. Variations of form and in particular of thickness and width of menisci can determine the possibility and the kind of injury. We have studied 50 pair of menisci to determine the thickness of outer circumference and the width of menisci, the distance between anterior and posterior cornua and the relation between the area of menisci and the area of corresponding tibial plates. The results of this study showed that there is an important relation between the morphometric data of menisci and the data found in clinic, which would explain the incidence of injuries in specific points of each meniscus.

Keywords: *Menisci of Knee, Morphometric Study*

Introduction
The menisci are cartilaginous tissues that provide structural integrity to the knee when it undergoes tension and torsion. The menisci are considered main elements for a perfect articulation among the articular osseous surfaces (Testut and Latarjet, 1977; Olmedillo *et al.*, 1990, Xavier *et al.*, 1998), performing mechanical functions, such as supporting the corporal weight, shock absorption, stabilization and rotational facilitation (Whiting and Zernicke, 2001). The function of stabilization in every plan, but mainly, the rotational is one of the most important and it is directly related to the meniscal traumatisms (Xavier *et al.*, 1998). Variations of form and in particular of thickness and width of menisci can determine the possibility and the kind of injury. However, the data related to the morphometric parameters of these structures are scarce. Because of it, the aim of our work was to determine the thickness of outer circumference and the width of menisci, the distance between anterior and posterior cornua and the relation between the area of menisci and the area of corresponding tibial plates

MATERIALS AND METHODS
We have studied 50 pair of menisci from 25 cadavers during the routine dissection at the Government medical college, Surat for last 5 years. To measure the thickness of outer circumference of menisci, firstly was determined its length. For this, a nylon thread was positioned from the apex of anterior cornu to the apex of posterior cornu of menisci. The length of the nylon thread was measured with Vernier Calipers - 0.02mm. The values were registered and divided by four (25%), establishing three points on the line: one anterior, one medium and one posterior. After, this thread was positioned again on the outer circumference of meniscus, enabling that the three points were transferred for it. From each point, and using the outer measurement of vernier caliper, the length of menisci was measured. The width of menisci was determined by using the same points of the thickness. As the same way in the outer circumference the inner circumference had been measured. The tree point had been taken in the inner circumference also. Using a pair of set point, from each point, one line was drawn from the peripheral margin to the central margin of meniscus, and using the inner measurement of vernier, the width was measured.
To calculate the area of menisci and tibial plates, the adopted procedure was the measurement by comparison, draws of the contour of menisci and tibial plates were obtained using a litmus paper. Then, its area was calculated by the graph paper. We took circumference of the menisci and tibial plate by the litmus paper and posted it on the graph paper. No of the small square in the circumference gives the area in mm2. The ratio of menisci area with the tibial plate had been measured. The weight of these

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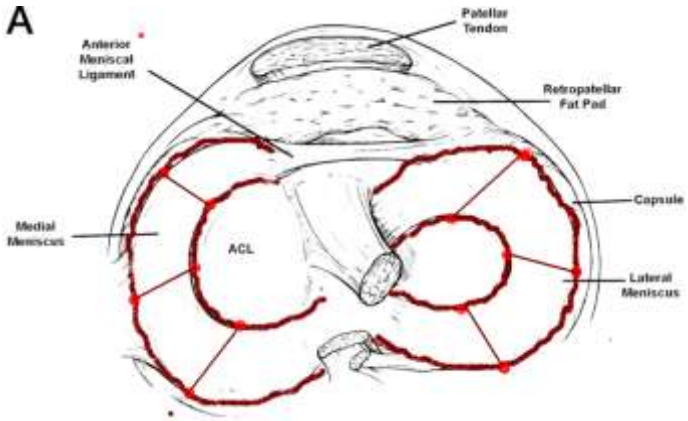
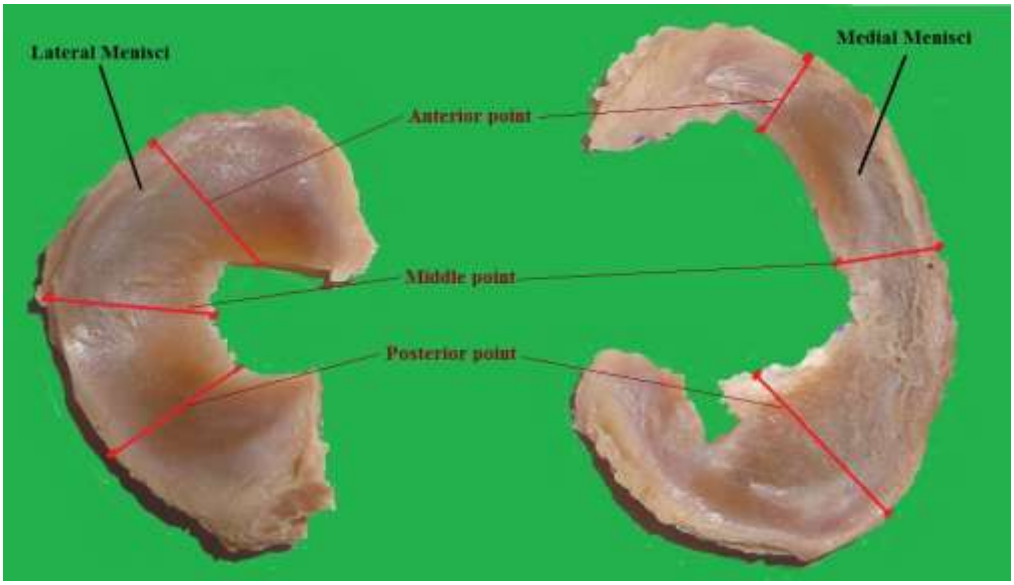
circumferences was measured by a digital scale, and after, a mathematical relation was established between the area of the circumference and its weight, then, its area was calculated by the graph paper.



We took circumference of the menisci by the litmus paper and posted it on the graph paper. No of the small square in the circumference gives the area in mm2.The weight of these circumferences was measured by a digital scale, and after, a mathematical relation was established between the area of the circumference and its weight, enabling to calculate the area of each meniscus by its weight previously determined. At the end, was measured the distance between the apex of anterior and posterior cornu of lateral and medial menisci. The data were statistically analyzed by the T test of Student for independent samples. We have discarded the pathological menisci like discoid menisci or the menisci with the tear or menisci with the degenerative changes.



RESULTS AND DISCUSSION

We observed in our study the outer circumference of the medial menisci is 10.46±1.14 cm and a lateral meniscus is 9.53±0.82 cm. There is statically significant difference between outer circumference of the medial and lateral menisci ($z_{cal} > z_{obs}$ at 0.05 significance level). The range is between mean±2 Standard deviation with n=50 (Statistical analysis by z-test at $p<0.05$). Area of medial menisci is 450.88±70.36 mm^2. Area of lateral menisci is 468.68±78.38 mm^2 which is measured by the graph paper method.
Area of tibial plate of medial side is 622.62 ±111.56 and lateral side is773.62± 123.46 mm^2

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Table 1: Thickness of the menisci

	Medial menisci	***Lateral Menisci***
Anterior	5.82±1.44	3.7±1.52
Middle	5.64±1.26	5.78±1.22
Posterior	5.86±1.06	5.20±0.98

The range is between Mean±2 SD

Table 2: Width of the menisci

	Medial menisci	***Lateral Menisci***
Anterior	8.78±2.12	11.3±1.30
Middle	12.08±2.52	11.66±1.48
Posterior	16.46±2.18	11.50±1.34

Related to the thickness of outer circumference of meniscus, a difference statistically significant was not observed ($p>0.05$) among the anterior, middle and posterior thirds of medial meniscus. However, in the lateral meniscus, the middle third was the thickest part ($p<0.05$) (Table I). Comparing the average values of medial meniscus with the values of lateral meniscus, was observed that in the anterior and posterior thirds, the medial meniscus was significantly more thick ($p<0.05$) relating to the lateral meniscus. (Table I). The individual analysis of each meniscus showed that the posterior third was the widest part of the medial meniscus $p<0.05$); while in the lateral meniscus was observed difference statistically significant ($p<0.05$) among the three examined points (Table II) In the medium third, there was difference statistically significant when comparing the lateral and the medial menisci ($p<0.05$). The anterior and the posterior thirds showed a difference statistically significant between the two groups. The relation area of meniscus / area of tibial plate showed a percentage average value of 72.62% in the medial part and 60.69% in the lateral part ($p<0.05$).

DISCUSSION

The data referring to the dimensions of semilunar cartilages are varied. Testut and Latarjet in a more generalized description of the morphometry of menisci, mention that the average thickness of outer circumference is 8mm for the lateral meniscus and 6mm for the medial meniscus, and that the average width of menisci is 10-12mm. Motta Filho *et al.*, (1999), on the other hand, described in their studies an average thickness of 4-5mm and an average width of approximately 12mm for the lateral meniscus.

According to Cailliet (1976), the lateral meniscus shows an average width of 12-13mm, while the medial meniscus has an average width of 10mm. Hayashi *et al.*, (1988), talking about the necessity of to reduce substantially the thickness and the width of discoid meniscus during the surgical procedure, describes that the normal menisci show thickness and width of 6-8mm and 12-13mm, respectively

As in following table we are comparing our study with the other studies results.

Table 3: Medial menisci morphological study and comparison with other study

	Our study		***Almeida et. al (2004)***		***Testut and Latarjet (1975)***	***Cailliet (1976)***
Length of menisci	10.46±1.14 cm		Not observed			
Thickness of menisci	Anterior	5.82±1.44mm	Anterior	5,92 ± 1,37*	6mm	
	Middle	5.64±1.26mm	Medium	5,31 ± 1,06		
	posterior	5.86±1.06mm	posterior	5,91 ± 1,13		
width of menisci	Anterior	8.78±2.12mm	Anterior	9,02 ± 1,59	12mm	10mm
	Middle	12.08±2.52mm	Medium	12,16 ± 2,58		
	Posterior	16.46±2.18mm	Posterior	17,37 ±2,22*		
Ratio of area of tibial plate and menisci	72.62%		54.70±7.32%			

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Table 4: Lateral menisci morphological study and comparison with other study.

	Our study		*Almeida et. al (2004)*		*Testut and Latarjet (1975)*	*Cailliet (1976)*
Length of menisci	9.53± 0.82 cm		Not observed			
Thickness of menisci	Anterior	3.7±1.52mm	Anterior	3,71 ± 1,15	8mm	
	Middle	5.78±1.22mm	Medium	6,10 ± 1,04		
	posterior	5.20±0.98mm	Posterior	5,29 ± 0,78		
width of menisci	Anterior	11.3±1.30mm	Anterior	11,86 ± 1,81	10-12mm	12-13mm
	Middle	11.66±1.48mm	Medium	11,97 ± 2,56		
	posterior	11.50±1.34mm	Posterior	11,44 ± 1,07		
Ratio of area of tibial plate and menisci	60.69%		48.67± 4.43%			

In this study, the morphometric variables thickness and width of menisci were analized in three different points: anterior, middle and posterior thirds. Relating to the thickness, the middle third of medial meniscus was the less thick (5.64mm) followed by the anterior (5.82mm) and posterior (5.86mm) thirds, showing an average value of 5.77mm. Statistical analysis shows significant difference in the thickness between anterior, middle and the posterior point in the medial meniscus (at the 5% level of significance). To correlate our results as seen in the table III and IV and graph I that study done by ALMEDIA S K S(2004) shows the thickness of middle third(5.31) is less followed by posterior(5.91) and then the anterior one(5.92). The comparison of the above two studies also shows that there is not much difference in the thickness of the anterior and the posterior portion. Rico and Ayala (1997), in an arthroscopic revision which aim was to determine the topographic location of meniscal ruptures, observed that the middle third of medial meniscus is the local more frequently injured, 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.

The lateral meniscus showed a significant difference in the thickness among the anterior (3.7mm), middle (5.78mm) and posterior (5.20mm) thirds, with the medium as the thickest point of the meniscus. According to Figueroa *et al.,* (1999) the lateral meniscus is liable to higher variations in its general configuration than the medial meniscus, appearing frequently wider in the body.

According to Smillie the lateral meniscus shows a width higher and more uniform than the medial meniscus. However, Testut and Latarjet and Didio, mention that is common the medial meniscus be a little wider than the lateral meniscus. Study done by Almedia (2004) found an average width for the medial meniscus of 12,85mm and for the lateral meniscus of 11,76mm.In our study we found the average width for medial meniscus 12.44mm and for the lateral meniscus 11.48mm.

According to Smillie the morphological differences of menisci, in particular, in the thickness and width can determine not only the possibility of an injury, but also the location and the kind of injury. This author also suggests that the narrow meniscus is less prone to ruptures than the wide. This supposition is justified because the narrow meniscus is liable to a less action of femoral condyle. A higher evidence of this context is suggested by the rarity of injuries of the anterior third of medial menisci, as related by Alonso *et al.,* (1996) and Rico and Ayala (1997). In our study, the posterior third of medial meniscus was the widest part, while the anterior third was the narrowest part of meniscus. Our study shows significant difference in the width of the anterior, medial and lateral portion of the medial and lateral menisci.

The MRI study of the menisci of knee joint was done by Erbagci *et al.*, in year 2003 found that posterior and anterior horns and mid-body of the normal lateral meniscus are 8.8 mm, 9.70 mm, 8.37 mm wide, respectively, and the posterior horn of the normal medial meniscus is the largest part (11.71 mm). Anterior horn and the mid body width of the medial menisci are 7.78 and 7.37mm respectively.

According to Cohen *et al.,* (1993), the menisci cover from 1/2 to 2/3 of articular surface of corresponding tibial plate, with the lateral meniscus covering an area higher than the medial meniscus. According to Smillie and Filho *et al.,* (1985), the lateral meniscus cover a higher area of the tibial plate, due to its semicircular format, been near the insertions of its cornua. Actually, in this study we established that the

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distance between the anterior and posterior cornua of lateral meniscus is significant less than the medial meniscus, giving an aspect in which the lateral meniscus shows the form of a ring almost complete. This high proximity between the insertions of its cornua would be one of the reasons for the lateral meniscus be less prone to lacerations (Kapandji, 1998; Miranda, 2000). The our study area of medial menisci is 450.88±70.36 mm^2 and area of lateral menisci is 468.68±78.38 mm^2

Where as area of tibial plate of medial side is 622.62 ±111.56 and lateral side is 773.62± 123.46 mm^2**.** The ratio of the area of menisci/area of tibial plate in medial side 72.62% and on lateral side 60.69%. In our study the meniscal area was not significantly different between the lateral and medial sides, although the area of the tibial plate was significantly larger in the medial side than in the lateral side ($P < 0.05$). The study done by Messner and Gao in 1998 shows that In adults, the meniscal area was not significantly different between the lateral (464.6 ± 98.0 mm^2) and medial (445.0 ± 93.3 mm^2) sides, although the area of the tibial plateau was significantly larger in the medial side (743.7 ± 167.0 mm^2) than in the lateral side (615.2 ± 114.0 mm^2) . After analyzed the relation meniscus area/ tibial plate area, we verified that the medial meniscus covers an area of tibial plate significant higher (72.62%) than the lateral meniscus (60.69%) which justifies the higher incidence of injuries of medial meniscus because it suffers a higher action of femoral condyle. The study done by us shows the morphometrical data of the menisci helps the future prospectus to develop more precise and more comprehensive graft that shows minimum post operative complication like swelling in the limb; thrombophlebitis.

Conclusions and future directions

The menisci and their entheses to bone are a func¬tional unit and should not be regarded as separate structures. They possess a complex structure, which shows substantial variations in tissue composition and configuration at different locations reflecting different functional demands. The results of this study showed that there is an important relation between the morphometric data of menisci and the data found in clinic, which would explain the incidence of injuries in specific points of each meniscus.

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