

# Study the Morphometry and Histology of Human Menisci

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## Abstract

**Background:** The composition, structure, and morphology of the meniscus play a significant role in the biomechanics of knee joints. The objective is to study the Morphometry and Histology of Human menisci. **Material and Methods:** A descriptive study was carried out in the Department of Anatomy, Jawaharlal Institute of Postgraduate Medical Education and Research (JIPMER), Puducherry, from January 2019 to September 2021. The Departmental PostGraduate Research Monitoring Committee approved the study (approval No. PGRMC2 dated 13.05.2109) and Institute Ethics Committee (vide approval No. JIP/IEC/2019/227 dated 22.07.2019). **Results:** The medial meniscus was broader posteriorly and was almost semicircular in shape and the lateral meniscus form approximately four-fifths of a circle. The mean thickness of medial meniscus measured from the present study at anterior horn, body and posterior horn were 5.95 mm, 5.74 mm and 5.89 mm respectively (figure 13) and the mean thickness of lateral meniscus measured from the present study at anterior horn, body and posterior horn were 4.83 mm, 5.93 mm and 5.98 mm respectively (figure 14). The mean width of medial meniscus measured from the present study at anterior horn, body and posterior horn were 8.77 mm, 10.05 mm and 15.27 mm respectively (figure 15) and the mean thickness of lateral meniscus measured from the present study at anterior horn, body and posterior horn were 10.13 mm, 10.64 mm and 10.45 mm respectively (figure 16). The average number and luminal area of the vessels in the medial meniscus in anterior horn, body and posterior horn were 6.2, 16.5, 3.9 and 3971.52  $\mu\text{m}^2$ , 7927.49  $\mu\text{m}^2$ , 2559.74  $\mu\text{m}^2$  respectively. The average number and luminal area of the vessels in the lateral meniscus in anterior horn, body and posterior horn were 6.2, 16.65, 4.07 and 4257.86  $\mu\text{m}^2$ , 7855.12  $\mu\text{m}^2$ , 2576.62  $\mu\text{m}^2$  respectively. The observation from the results found out that. **Conclusion:** The vascular distribution of menisci showed wide variations in the distribution in different parts. The peripheral border of the menisci was found to be more vascularised than the inner border of the meniscus, in which the body of the menisci was well vascularised.

**Keywords:** Morphometry, Histology, Human Menisci.

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## INTRODUCTION

Because of their complex anatomy, the menisci perform a variety of biomechanical functions, including load-bearing, forming a contact area, guiding rotation, and stabilizing translation. The medial meniscus is broader than the lateral meniscus, although its body is slightly thinner. The menisci are made up of approximately 75% water, 20% type 1 collagen fibres, and 5% non-collagenous substances such as proteoglycans, matrix glycoprotein, and Elastin.<sup>[1]</sup> As a result, the meniscal material is homogeneous and composite, consisting of a hydrophilic matrix reinforced with collagen fibres. The biomechanics of materials are primarily determined by their microstructure, but they are also affected by their attachment to surrounding structures. Load transmission, shock absorption, stability, joint lubrication, and proprioception are all biomechanical functions of the menisci. These functions aid in reducing contact stresses and increasing knee contact area and congruency. When carrying a load, the knee joint is compressed. The compressive force over a joint produces stress due to contact which is inversely proportional to the area of contact. Greater its contact less is the stress or pressure developed in that area. Because of this there is a limitaton for full approximity of the joint surfaces which helps to reduce the contact pressure.<sup>[2]</sup> Meniscectomized knee studies have revealed the importance

of the meniscus in knee function. Fairbank described the degenerative changes in the meniscectomized knee in 1948, including narrowing of osteophyte production, flattening of the femoral condyle, and loss of joint space due to meniscus loss.<sup>[3]</sup> According to biomechanical reports from the studies, the meniscus receives more load when knee is extended which could be approximately around 40-60%. Inflection increases by up to 90%. During weight bearing, the axial compresses the meniscus and creates stress, which converts the axial force into tensile strength via the meniscus's circumferential collagen fibres. Several studies have shown that when the meniscus is intact, load is evenly distributed.<sup>[4]</sup>

The undamaged meniscus restricts excessive motion in all directions, which stabilizes the joint. The superior surface of menisci is concave, which contributes to the absurd articulation

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between the convex femoral condyles and the flat tibial plateau. Various studies been conducted to demonstrate the function of menisci in mechanical support in ACL-deficient meniscectomized or meniscus-torn knees<sup>7</sup>. Hence, this study was conducted to study the Morphometry and Histology of Human menisci.

## MATERIALS AND METHODS

A descriptive study was carried out in the Department of Anatomy, Jawaharlal Institute of Postgraduate Medical Education and Research (JIPMER), Puducherry, from January 2019 to September 2021. The Departmental PostGraduate Research Monitoring Committee approved the study (approval No. PGRMC2 dated 13.05.2109) and Institute Ethics Committee (vide approval No. JIP/IEC/2019/227 dated 22.07.2019). The Study is Outlined under The Following Headings:

1. Selection of Study Participants
2. Specimen Collection
3. Histological Processing of Tissue
4. Sectioning
5. Staining, mounting and capturing of images

A total of 48 limbs from 24 cadavers were included in study, after subjecting to inclusion and exclusion criteria.

### Inclusion Criteria

All embalmed cadavers fit to be dissected were included in the study.

### Exclusion Criteria

Cadavers with any evidence of damage or loss of tissues in the region region of the knee joint were excluded.

### Specimen Collection<sup>5</sup>

The meniscus was dissected out from the knee joint The overall appearance of the menisci was noticed. The morphometric parameters (length, width, and thickness of the entire menisci) were noted with the help of Mitutoyo digital Vernier calipers. The menisci were severed from the knee joint. After the gross observations, menisci were kept in 50 ml of 10% neutral buffered formalin for 2 days for fixation.

### Histological Processing of Tissue<sup>6-8</sup>

#### Procedure

#### Grossing

After fixation, the menisci were divided into three parts as anterior and posterior horn and the body. Three parts of the menisci were processed separately with the help of the labelled tissue cassettes

#### Stages of processing

#### Dehydration

- Tissues were subjected to dehydration using ascending grades of alcohol for 1 hour each in the following sequence.
- 50% alcohol, 70% alcohol, 90% alcohol, Absolute ethanol – three changes

#### Clearing

The tissues were then put through the xylene clearing agent for three changes with each lasting for 45 minutes.

#### Impregnation

The tissues were then put through the molten paraffin chamber through three changes for 2 hours each.

**Embedding:** It was carried out in the “Thermo scientific Histostar ” embedding station. The tissues were oriented properly in the paraffin filled metal base mold and blocks were made using plastic embedding rings. The blocks were cooled and detached from the base mold.

#### Storage:

Paraffin blocks were kept in the refrigerator at 4–8°C till further processing.



Figure 1: Tissue cassettes



Figure 2: Paraffin embedded tissue blocks



Figure 3: Thermo scientific tissue embedding station



Figure 4: Thermo scientific tissue cold station

**Sectioning.**<sup>[6-8]</sup>

**Procedure for sectioning**

- Tissue sections of about 5 µm thickness were made from the rotary microtome from menisci. Three sections were used for histological processing.
- Then the ribbons were made to float on a floatation bath.
- Appropriate tissue sections were separated and retrieved from the tank using the adhesive coated slide.
- Then the slides were air-dried for 2 hours, 56°C in the incubator for histological processing and at 37°C overnight for immunohistochemistry procedure.
- For histological processing, Mayer's egg albumin coated slides and for immunohistochemistry, APES coated slides were used for slide preparat

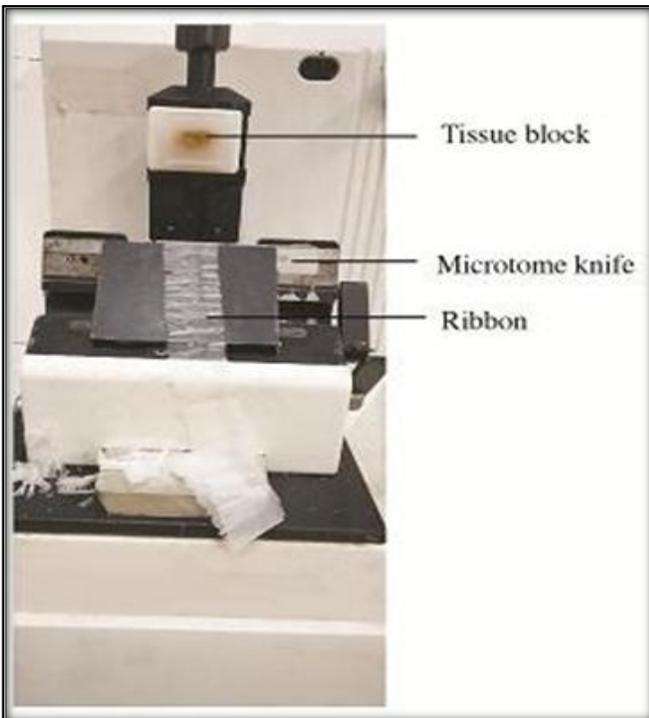


Figure 5: Microtome with tissue block and ribbon of tissue sections



Figure 6: Tissue floatation hot water bath

**Staining, Mounting and Capturing of Images<sup>6-8</sup>**

**Staining procedure**

- **Deparaffinization**  
Three changes of xylene for 5 minutes were used.
- **Rehydration**  
Descending grades of alcohol (90% alcohol, 70% alcohol, 50% alcohol), distilled water for 1 minute each were used for complete rehydration.
- **Nuclear staining**  
Rehydrated tissues were stained with the haematoxylin stain for 10 minutes
- **Differentiation**  
The excess stain was removed by dipping in 1 % acid alcohol for five seconds.
- **Bluing**  
Running tap water for 10 minutes was used for bluing.
- **Counterstain**  
Sections were treated with eosin stain for 2 minutes.
- **Dehydration**  
Sections were rapidly dehydrated (1 minute) using graded alcohol.
- **Clearing and mounting**  
Sections were rapidly cleared with 2 changes of xylene for 1 minute and mounted using DPX

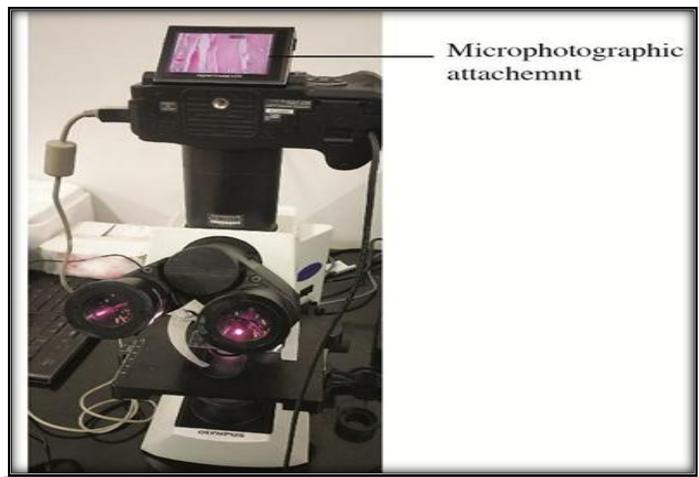
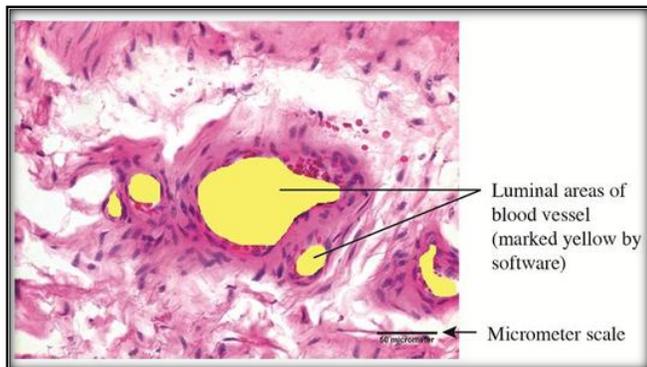


Figure 7: Bright field, compound binocular microscope (Olympus, CX 41, Japan)

**Slide examination and image capturing**

The stained slides were examined under an Olympus CX41 RF bright field microscope and the tissues were captured from the attached digital camera. The obtained images were transferred to Image J software for luminal area measurements of the vessels. Each value was taken twice and the average of three was taken as final. Slides were examined under the Olympus CX41 RF bright field microscope for collagen bundle distribution



**Figure 8: Measurement of luminal area of blood vessels from light microscopic picture using ImageJ software (X400, hametoxilin and eosin stain)**

**RESULTS**

**Morphometry of Meniscus**

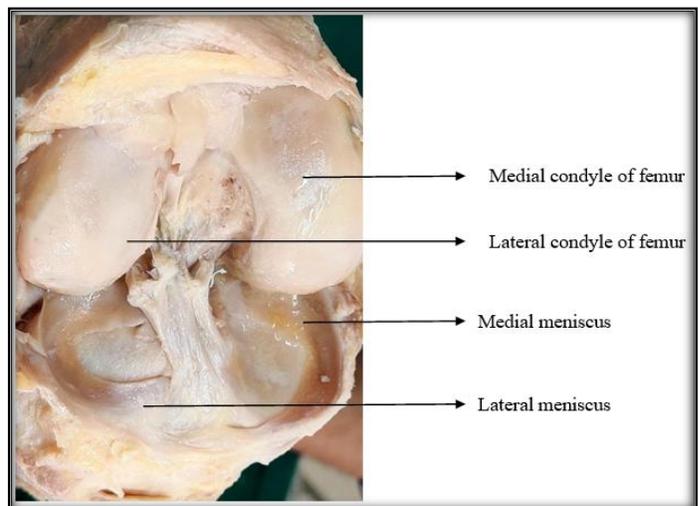
**Morphological appearance of Meniscus**

The laminae of the menisci were crescentic, intracapsular, and fibrocartilaginous. Their attached peripheral borders were thick and convex, while their free, inner borders were thin and concave. Capillary loops from the synovial membrane and fibrous capsule vascularised their periphery, while their inner regions were less vascular. The proximal surfaces were smooth and concave, with articular cartilage on the femoral condyles. The distal surfaces were smooth and flat, resting on the articular cartilage of the tibia.

**Shape of Menisci:** The posteriorly broader medial meniscus

has been almost semicircular in shape. Its anterior horn connects to the anterior tibial intercondylar area in front of the anterior cruciate ligament; its posterior fibres were continuous with the transverse ligament of the knee. The posterior horn was attached to the back intercondylar area between the lateral meniscus and the posterior cruciate ligament.<sup>[9]</sup>

The lateral meniscus is 4/5th of the circle in size and covers a greater area than the medial meniscus. Its anterior horn was connected in front of the intercondylar prominence, posterolateral to the anterior cruciate ligament, with which it merges in part. Its posterior horn was connected behind the eminence, in front of the medial meniscus's posterior horn.<sup>[2]</sup>



**Figure 9: Menisci (medial and lateral) (right knee joint opened ventrally and the menisci exposed within the joint cavity)**

**Thickness of Menisci:** The thickness of the menisci was measured with a Mitutoyo Vernier calliper and recorded. The mean thicknesses of medial meniscus in the anterior horn, body, and posterior horn were 5.95 mm, 5.74 mm, and 5.89 mm, respectively, and the mean thicknesses of lateral meniscus were 4.83 mm, 5.93 mm, and 5.98 mm, respectively.

**Table 1: Measurement of Thickness in three parts of medial meniscus and lateral meniscus**

Meniscus	Site	Mean Thickness (mm)	SD	Minimum (mm)	Maximum (mm)
Medial meniscus	Anterior horn	5.95	0.32	4.92	6.42
	Body	5.74	0.31	5.20	6.32
	Posterior horn	5.89	0.32	4.84	6.40
Lateral meniscus	Anterior horn	4.83	0.67	3.70	5.90
	Body	5.93	0.51	5.08	6.74
	Posterior horn	5.98	0.52	5.14	7.02

SD: Standard Deviation

**Table 2: Measurement of mean thickness in three parts of medial meniscus and lateral meniscus**

Site	Meniscus	Mean thickness (mm)	N	SD	Paired t-test P-value
Anterior horn	Medial	5.94	40	0.31	<0.001
	Lateral	4.82	40	0.66	
Body	Medial	5.73	40	0.31	<0.001
	Lateral	5.90	40	0.50	
Posterior horn	Medial	5.85	40	0.32	<0.001
	Lateral	5.97	40	0.52	

N: Number of sample SD: Standard Deviation p-value < 0.05 is significant.

**Width of Menisci:** The width of menisci measured using Mitutoyo Vernier caliper was tabulated (table 3 & table 4). The mean observed width of medial meniscus in the anterior horn, body, and posterior horn were 8.77 mm, 10.05 mm, and

15.27 mm, respectively. The mean observed width of lateral meniscus were 10.13 mm, 10.64 mm, and 10.45 mm, respectively.

**Table 3: Measurement of width in three parts of medial meniscus and lateral meniscus**

Meniscus	Width Site	Mean	SD	Minimum	Maximum
Medial meniscus	Anterior horn	8.77	0.76	7.38	10.04
	Body	10.05	1.32	7.84	12.14
	Posterior horn	15.27	1.05	13.94	17.36
Lateral meniscus	Anterior horn	10.13	1.06	7.86	11.86
	Body	10.64	1.31	8.56	12.52
	Posterior horn	10.45	0.98	8.84	12.08

**Table 4: Measurement of mean width in three parts of medial meniscus and lateral meniscus**

Site	Meniscus	Mean width	N	SD	Paired t-test P-value
Anterior horn	Medial	8.77	40	0.76	<0.001
	Lateral	10.12	40	1.06	
Body	Medial	10.04	40	1.32	<0.042
	Lateral	10.63	40	1.31	
Posterior horn	Medial	15.27	40	1.05	<0.001
	Lateral	10.44	40	0.98	

N: Number of sample SD: Standard Deviation p-value < 0.05 is significant.

**Light Microscopy of Menisci**

Microscopic observations of menisci were made by the hematoxylin and eosin staining method.

Microscopic observation of menisci using hematoxylin and eosin staining method.

The cytoplasm of connective tissue cells except for lipid compartments of adipocytes, red blood cells, and collagen bundles are taken up the eosin stain and appeared in varying shades of pink. In the fibroblast nucleus, endothelial cells have taken up the hematoxylin stain and appeared in blue-purple.

Sections of menisci from the outer two-thirds had lots of fibrous tissue. The primary orientation of fibers was circumferential with intermingled radial fibers. These radial

fibers were radiating in various directions in relation to circumferential fibers, which were seen to be running along the length of the meniscus (figure 24). Cells like fibroblasts were the most commonly found and interposed in the interlacing network of collagen fibers. The majority of cells were present in rows. The nuclei of cells were seen as small, elongated, or spindle-shaped. Fusiform or spindle-shaped cells without lacunae which resembled fibroblasts were present more at peripheral two-thirds and decreased toward the inner concave margin (figure 26). Round or oval cells lying in the lacunae resembling cartilage cells were interspersed along with fibrocytes, more in the substance and toward the inner margin.

**Table 5: Measurement of number of blood vessels in three parts of medial meniscus and lateral meniscus by light microscopy**

Meniscus	Site of observation	Mean (No.)	SD	Minimum	Maximum
Medial meniscus	Anterior horn	6.2	2.1	0.0	9.0
	Body	16.5	2.3	12.0	22.0
	Posterior horn	3.9	2.7	0.0	9.0
Lateral meniscus	Anterior horn	6.2	2.0	0.0	9.0
	Body	16.7	2.3	12.0	22.0
	Posterior horn	4.1	2.6	0.0	9.0

SD: Standard Deviation

**Table 6: Measurement of blood vessels (mean) in three parts of medial meniscus & lateral meniscus by light microscopy**

Site of observation	Meniscus	Mean no. of vessels	N	SD	Paired t-test P-value
Anterior horn	Medial	6.225	40	2.0938	<0.001
	Lateral	6.225	40	2.0190	
Body	Medial	16.500	40	2.2758	<0.001
	Lateral	16.650	40	2.2595	
Posterior horn	Medial	3.900	40	2.6583	<0.001
	Lateral	4.075	40	2.5759	

N: Number of samples SD: Standard Deviation, p-value < 0.05 is significant.

Comparison of luminal area of vessels between parts of medial and lateral meniscus using histology. The luminal area of vessels in the different parts of both

(anterior horn, body and posterior horn) was measured. [Table 7]. The median luminal area of vessels in these parts of medial meniscus are 3971.52 μm<sup>2</sup> (SD ±1327.37),

7927.49  $\mu\text{m}^2$  (SD $\pm$ 1425.11), 2559.74  $\mu\text{m}^2$  (SD  $\pm$ 1912.99) respectively. The median luminal area of vessels in these parts of lateral meniscus are 4257.86  $\mu\text{m}^2$  (SD  $\pm$ 1337.32),

7855.12  $\mu\text{m}^2$  (SD  $\pm$ 1159.82), 2576.62  $\mu\text{m}^2$  (SD  $\pm$ 1829.56) respectively.

**Table 7: Measurement of blood vessels Luminal area in three parts of Medial Meniscus & Lateral Meniscus by Light Microscopy**

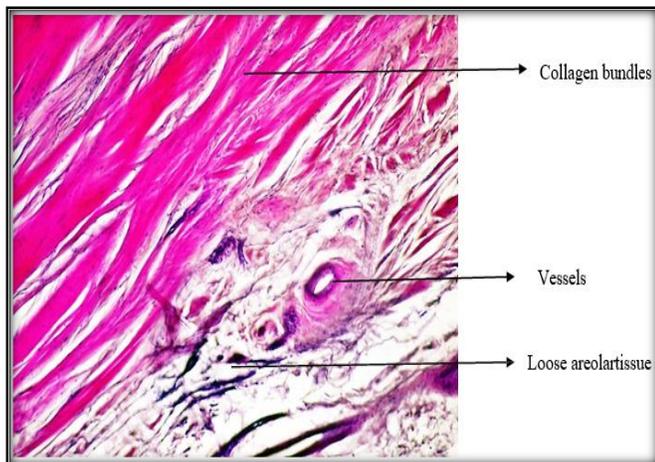
Meniscus	Luminal area of blood vessels	Mean ( $\mu\text{m}^2$ )	SD	Minimum	Maximum
Medial meniscus	Anterior horn	3971.52	1328.37	0.00	4936.25
	Body	7927.49	1425.11	2135.58	9856.24
	Posterior horn	2559.74	1912.99	0.00	5378.12
Lateral meniscus	Anterior horn	4257.86	1337.32	0.00	6895.78
	Body	7855.12	1159.82	4802.26	9856.24
	Posterior horn	2576.62	1829.56	0.00	5378.12

SD: Standard Deviation

**Table 8: Measurement of blood vessels Mean Luminal area in three parts of Medial Meniscus & Lateral Meniscus by Light Microscopy**

Site	Meniscus	Mean luminal area of blood vessels ( $\mu\text{m}^2$ )	N	SD	Paired t-test P-value
Anterior horn	Medial	3971.52	40	1328.36	<0.001
	Lateral	4257.86	40	1337.32	
Body	Medial	7927.48	40	1425.11	<0.001
	Lateral	7855.11	40	1159.817	
Posterior horn	Medial	2559.74	40	1912.98	<0.001
	Lateral	2576.61	40	1829.56	

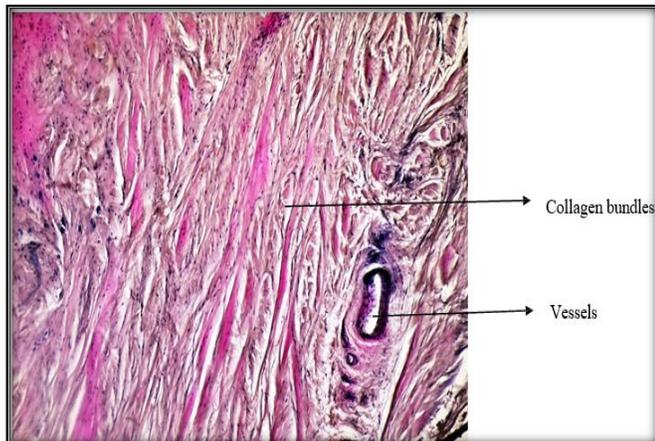
N: Number of samples SD: Standard Deviation p-value < 0.05 is significant.



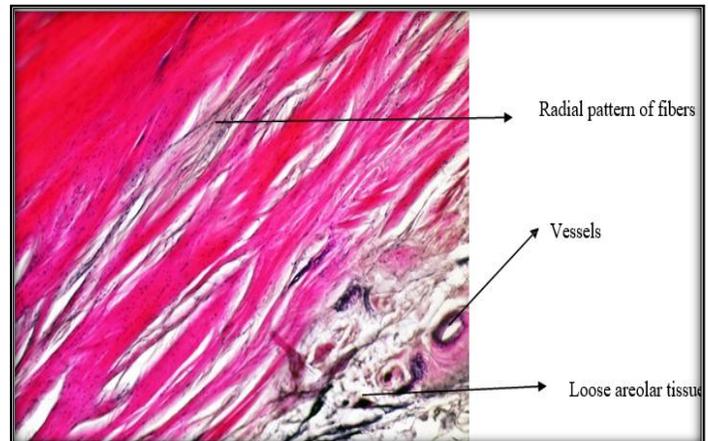
**Figure 10: Photomicrograph: Loose areolar tissue surrounding menisci. It consists of a collagen bundle and vessels of variable diameter. (X100, hematoxylin and eosin stain)**



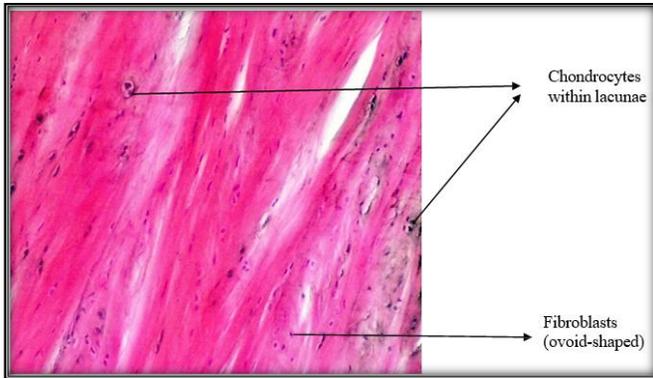
**Figure 12: Photomicrograph: Loose areolar tissue surrounding menisci. It consists of a collagen bundle, and fibroblasts. (X100, hematoxylin and eosin stain)**



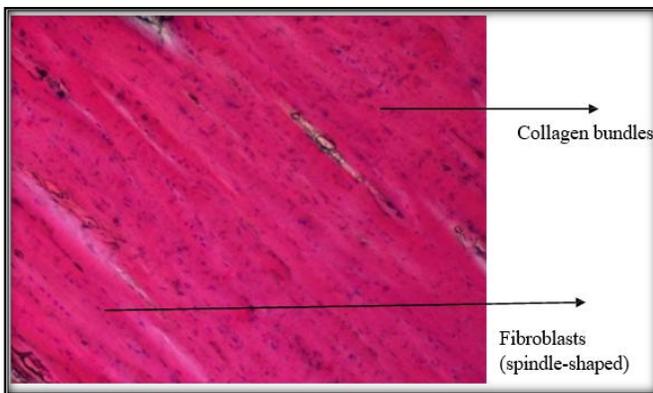
**Figure 11: Photomicrograph: Loose areolar tissue surrounding menisci. It consists of a collagen bundle and vessels of variable diameter. (X100, hematoxylin and eosin stain)**



**Figure 13: Photomicrograph: Loose areolar tissue surrounding menisci. They are showing radial patterns of collagen bundles and vessels of variable diameter. (X100, hematoxylin, and eosin stain)**



**Figure 14: Photomicrograph: Loose areolar tissue surrounding menisci. It consists of collagen bundle, chondrocytes arranged as ovoid cells in rows within the lacunae and ovoid-shaped fibroblasts. (X100, hematoxylin and eosin stain)**



**Figure 15: Photomicrograph: Loose areolar tissue surrounding menisci. It consists of a collagen bundle and spindle-shaped fibroblasts. (X100, hematoxylin and eosin stain)**

## DISCUSSION

The meniscus was made visualized after dissection and observed for its gross appearance. With the help of vernier calipers, the morphometric parameters were measured. The microstructure of meniscus was studied by using haematoxylin and eosin stains. The immunohistochemistry was proceeded to find out the difference between the blood and lymphatic vessels. The number of blood vessels was counted on microscopic examination and the luminal area was measured using Image J software.

The outcome variables are discussed under the following headings:

- Gross morphometry
- Light microscopic analysis of vessels in menisci

### Gross Morphometry

#### Overall appearance of meniscus

Menisci seem to be semicircular-shaped fibrocartilagenous structures with bony attachments on the dorsal and ventral aspects of the tibial plateau that are tucked between the femoral condyles and the tibial plateau on the lateral and medial sides of the knee. Itagi et al described the various shapes of menisci, finding that normal variants of the meniscus are relatively common and usually asymptomatic, whereas discoid menisci have a higher propensity to tear.<sup>[10]</sup>

**Menisci Shape:** The meniscus is a wedge-shaped piece of cartilage that fits between the knee bones and acts as a cushion to protect them during strenuous activity. Anatomical difference in the structures joint have become increasingly relevant with the advent of knee arthroscopy and other imaging modalities, as these variations impact the frequency and severity of knee injuries. Muralimanju et al studied the anatomy of the meniscus using 27 human cadavers from the South Indian population.<sup>[11]</sup> Morphological variants include sickle-shaped medial menisci, sided U-shaped medial menisci, sided V-shaped medial menisci, crescent-shaped medial menisci, and C-shaped medial menisci. The lateral menisci were identified as crescent-shaped, C-shaped, and discoid-shaped. Discoid menisci are more likely than others to be torn. The vast majority of discoid menisci were lateral, with medial discoid menisci being extremely rare.<sup>[12]</sup> For discoid menisci, the partial, full, and hyper mobile wrisberg classifications were used once more. An incomplete discoid meniscus was common, among other things. From the present study it has been observed that most of medial meniscus were semicircular and lateral meniscus appears to be more circular.

**Thickness of menisci:** Knowledge about the menisci thickness helps in preparing appropriate graft size. It was observed that knowing the complete morphometry of meniscus had more advantageous effect which leads to development of proper native meniscus in case of repair of the injured one or replacement. Researchers have employed various methodologies and approaches in cadavers and living persons to calculate the thickness of menisci. The thickness of menisci is measured with the use of a non- elastic cotton thread at three separate levels: anterior, middle, and posterior, with the help of a Digital Vernier caliper. Dhanajaya et al examined the parameters in 40 cadavers using sagittal and coronal T1 weighted and T2 weighted MRI images.<sup>[13]</sup> Bloecker et al used Magnetic Resonance Imaging/3D morphometric analysis on healthy male volunteers to determine the maximum thickness of both menisci<sup>14</sup>. This is the first study to assess the morphometry of knee menisci in osteoarthritic and healthy adult knees.<sup>[14]</sup> Result of various studies were compared with the present study and tabulated below. It has been observed that the medial meniscus is thinnest at the middle (body), whereas in lateral meniscus it is thinnest in anterior horn.

**Width of menisci:** The width of the menisci is another important parameter in determining the possibility and type of injury. Many researchers measured the width of menisci in cadavers and living subjects using techniques that had previously been used to measure menisci thickness. The most common technique for measuring width is to use a digital Vernier caliper. Sagittal and coronal T1 and T2 weighted MRI images, as well as an MR imaging technique, were also used. The results of various studies are mentioned in [Table 13 and 14]. It has been observed in present study that in medial meniscus there is significant difference in width of posterior horn which is higher compared to the anterior horn and body (figure 14) and in lateral meniscus the body has more width compared to the other two regions [Figure 13].

#### Light Microscopic Structure of Menisci

The meniscus cross section was microscopically described as having three distinct layers: a) a meshwork of thin fibrils covering the tibial and femoral sides of the meniscal surface; b) beneath this superficial network collagen fibril bundles are

present; c) Because the most of collagen fibrils in the meniscus are situated in the central and based in a circular pattern, the large percentage of tears in meniscal tissue are longitudinally directed.<sup>[15]</sup>

The meniscus is highly hydrated, with 72% water and the rest 28% organic matter, which consists primarily of extracellular matrix and cells. The primary constituents of this organic matter are collagen and elastin. Although collagen is the most abundant fibrillar component of the meniscus, different collagen types exist in varying amounts in each region of the meniscus. Collagen type I predominates in the red zone, accounting for approximately 80% of the dry weight, with other collagen types such as type 2, 3, 4, 6, and 17 also present. Collagen constitutes 70% of the tissue by dry weight in the white zone; with collagen type II accounting for 60% and collagen type I accounting for 40%.<sup>[16]</sup>

In terms of collagen organization, meniscus tissue is similar to ligament tissue, with collagen primary oriented in circumferential directions in all regions of the meniscus and along the direction of loading in ligaments.<sup>[16]</sup> Bullough et al proposed that the fibres were oriented in such a way that they could withstand tension, and that the radially exposed fibres likely acted as a tie to prevent longitudinal splitting of the meniscus. He discovered that the strength of tissues that were perpendicularly oriented differed little from those in which the fibres were parallel to the tensile axis.<sup>[17]</sup>

In human menisci, the situation is slightly different in that there are quite a few relatively large mature elastic fibres (i.e. fibres containing more elastin than electron-dense filaments) and many smaller elastic fibres present, but a few electron-dense fibrils appear to persist.

According to studies, the cells in the outer zone have an oval, fusiform shape and behave similarly to fibroblasts. The major constituent is type 1 collagen, with a small percentage of glycoprotein and type 3 and 4 collagen. The cells in the inner portion were rounder and embedded in an ECM made up primarily of type 2 collagen with minor amounts of type 1 collagen and glycosaminoglycan. In the present study it has been noted that the fibroblasts were dispersed over the meniscal substance. They were present in the loose areolar tissue admixed along with the adipose cells. The fibroblasts in the meniscal substance has appeared along with the collagen bundles in the direction of the collagen fibers. Fibroblasts with elongated nucleus were found all over the ligaments and predominantly observed in the proximal part of the menisci. The nucleus of the fibroblasts was elliptical in the middle part of the menisci and spherical in the distal part of the menisci. There was an ovoid cell arranged in rows surrounded by small lacunae and haematoxylin-stained homogenous extracellular matrix. These cells resemble fibrocytes making the part of meniscus as fibrocartilage.<sup>[16]</sup>

#### Light Microscopic Analysis of Vessels in Menisci

The lateral medial genicular arteries supply the majority of the circulatory supply to the human knee's both menisci. Branches from these capillaries form a perimeniscal capillary plexus within the synovial and capsular tissues of the knee joint. The perimeniscal microvascular plexus is an arborizing network of vessels that supplies blood to the menisci's external border via their connection to the joint capsule.

These perimeniscal vessels were oriented primarily circumferential, with radial branches pointing toward the joint's centre. The vascular synovial coverings of the proximal and distal horn attachments provide vessels to the menisci via a few output branches of both genicular arteries and the middle genicular arteries.<sup>[18]</sup>

**Medial meniscus:** A vascular synovial tissue layer covers the anterior horn attachment of the medial meniscus. Endoligamentous vessels travel shorter distance through the meniscal stroma of the anterior horn before terminating as small capillary loops. The peripheral attachment of the meniscus to the capsular and synovial tissues allows artery to enter the meniscus body. The extent of vascular penetration into the body's periphery varied between specimens. A smooth layer of synovial tissue covers the posterior horn connection of the medial meniscus. These synovial vessels invade the posterior attachment and give rise to ligamentous vessels, which enter the posterior horn of the meniscus for a short distance and terminate in capillary loops.<sup>[18]</sup>

**Lateral meniscus:** The micro - vascular anatomy of the lateral meniscus is very comparable to the medial meniscus. The vascular synovial sheath that encircles the cruciate ligaments appears to be consistent with vascular synovial sheath that encircles anterior and posterior horn attachments. Vessels within these horn attachments travel through meniscal tissue before terminating in terminal capillary loops. The lateral inferior genicular artery, which runs close to the lateral meniscus's outer border and deep to the lateral collateral ligament, provides the lateral meniscus's body with circumferential and radial branches.<sup>48</sup> It is agreed in the present study that peripheral border of body of meniscus and anterior horn has more vascularity and there is an avascular zone in the inner four-fifths of the meniscus.

## CONCLUSION

The present study documented the vascular distribution of the menisci. The vascular distribution of menisci showed wide variations in the distribution in different parts. The peripheral border of the menisci was found to be more vascularised than the inner border of the meniscus, in which the body of the menisci was well vascularised. There were avascular regions in the menisci, like the inner border and the body and posterior horn.

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