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A Morphometric Study of Menisci of Knee Joint in Human Cadavers

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ABSTRACT

Menisci are the cartilaginous 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. For such meniscus transplants, calculation of proper size of allograft is important as in knee joints with improper sized menisci, arthritis is common to occur. Thus to improvise the knowledge of dimensions of menisci, this study is aimed to study the morphometric parameters of menisci of knee joint in human cadavers. The methodology used for this study is dissection of knee joint so as to visualize the interior of knee joint. For this, unclaimed knee joints which were embalmed were dissected to expose the menisci by reflecting patella attached to ligamentum patellae inferiorly. Dimensions of menisci were calculated and were compared on two sides as well as laterality. Correlation of parameters of menisci with those of tibial plateau was calculated as ratio. As a result, it is observed that meniscus is approximately 0.8 to 0.9 times the length and 0.25 to 0.27 times the width of tibial plateau. To conclude, this data can be correlated with the classical method of sizing of menisci for transplantation by getting anteroposterior and lateral X rays and multiplying it with multiplication factor after correction of magnification and thus change observed with classical method is 0.1 for both menisci.

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1. Introduction

Meniscus injury is common in day to day life as well as in sports. Meniscus can get damaged in isolation or along with the ligaments surrounding it, e.g. anterior cruciate ligament and medial collateral ligament. Due to lack of understanding of the biomechanics of meniscus function, meniscus excision was favored early on [1].

The meniscus plays an important role in load sharing, shock absorption, joint stability, joint nutrition, and overall protection of articular cartilage [2]. Loss of a meniscus leads to a significant increase in the risk of developing arthritis in the knee. Replacement of a missing meniscus with allograft tissue can reduce symptoms and may potentially reduce the risk of future arthritis [3]. Many studies show that meniscectomy leads to progressive degenerative osteoarthritis [4,5]. Thus to reduce the process of knee degeneration after meniscectomy, meniscus allograft transplantation has been considered as a preferred choice [6,7,8].

For transplantation of menisci, sizing of menisci is an important requirement. Most commonly used method for sizing of the

allograft is by plain radiographs [9, 10]. It is interesting to correlate the allograft sizing with dimensions of cadaveric menisci. Cadaveric dissection can help in sizing the grafts accurately. Thus in this study, knees were dissected to expose menisci and dimensions of menisci were calculated by using vernier caliper. These parameters can be useful in accurate sizing of meniscus allograft for transplantation.

2. MATERIAL AND METHODS

30 sides of 15 embalmed cadavers supplied to a renowned medical college for MBBS dissection were included in this study.

Inclusion criteria: Cadavers of either sex between age 25 to 80 which were unclaimed and embalmed were included in the study.

Exclusion criteria: Fractured or dislocated knees, arthritic knees, which can change the dimensions of menisci, were excluded from the study.

With extended legs in supine position, incisions were taken to remove the skin of knee joints dorsally and then pronated to remove the skin ventrally. Muscular and ligamentous attachments around the knee joint were separated. Neurovascular structures around the knee joint were cut and reflected. Patella was reflected inferiorly by reflecting ligamentum patellae. Capsule of knee joint

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was cut open as near possible as femur. Measurements of parameters listed in table 1 were taken by vernier caliper. Mean and standard deviation of parameters were taken to compare two sides.

W is the maximum transverse length of tibial plateau measured with vernier caliper. A and B are the maximum anteroposterior length of tibial plateau and meniscus respectively. C is the transverse distance taken from the corresponding intercondylar eminence and the lateral margin of tibial plateau at 'W'. D is the width of meniscus taken at 'W'. E and F are width of anterior and posterior horns before they insert into intercondylar area. G is the thickness of meniscus measured at 'W' and H is the maximum width of the medial meniscus.

RESULTS:

The mean values of measurements of the parameters described above are given in Table 1.

Side/Mean	Meniscus	Abr.	Right(cm)		Left(cm)	
			Medial	Lateral	Medial	Lateral
Transverse length of tibial plateau	W		7.17		7.2	
Anteroposterior (AP) length of tibial plateau	A		4.55	4.19	4.51	4.09
Anteroposterior(AP) length of meniscus	B		4.02	3.38	4.07	3.39
Width of tibial plateau	C		3.37	3.3	3.43	3.34
Width of meniscus	D		0.89	0.86	0.86	0.89
Width of anterior horn	E		0.72	0.79	0.74	0.77
Width of posterior horn	F		0.75	0.64	0.67	0.67
Thickness of meniscus	G		0.45	0.58	0.45	0.55
Maximum width of medial meniscus	H		1.67		1.8	

Transverse length of tibial plateau ranges from 7.17 to 7.20 cm both sides.

AP length of tibial plateau is found to be more on medial side (4.51 to 4.55 cm) than lateral side (4.09 to 4.19 cm); dimensions on right side larger as compared to left side. AP length medial meniscus of is found to be more (4.02 to 4.07 cm) than lateral meniscus (3.38 to 3.39 cm). Dimensions on left side are larger as compared to right side which suggests that the menisci are found more extensive and adhered to capsule on left side as compared to right side.

Width of tibial plateau is found to be more on medial side (3.37 to 3.43cm) than lateral side (3.30 to 3.34 cm) suggesting that tibial plateau is wider on medial side than that of lateral side to accommodate wide meniscus. Dimensions on right side are smaller as compared to left side. Width of medial meniscus of right side is found to equal to width of lateral meniscus of left side (0.89cm) and vice versa (0.86cm).

Anterior horn width of medial meniscus (0.72 to 0.74 cm) is smaller than that of the lateral meniscus (0.77 to 0.79 cm). Posterior horn width of both medial and lateral menisci is equal on left side (0.67cm) while posterior horn width of medial meniscus is more on medial side (0.75cm) than that of the lateral side (0.64cm).

Thickness of lateral meniscus (0.55 to 0.58 cm) is more than that of medial meniscus (0.45 cm) on both right and left sides. Maximum width of medial meniscus ranges from 1.67 cm to 1.80cm.

Side/Mean	Meniscus	Abr.	Right(cm)		Left(cm)	
			Medial	Lateral	Medial	Lateral
AP length (meniscus: tibial plateau)		B:A	0.88	0.8	0.9	0.83
Width (meniscus: tibial plateau)		D:C	0.26	0.26	0.25	0.27
Width: maximum width of medial meniscus		D:H	0.53		0.48	

Ratio of anteroposterior length of medial meniscus to tibial plateau ranges from 0.88 to 0.90 while that of lateral meniscus to tibial plateau ranges from 0.80 to 0.83. Ratio of width of medial meniscus to tibial plateau ranges from 0.25 to 0.26 while that of lateral meniscus to tibial plateau ranges from 0.26 to 0.27. Ratio of width to the maximum width of medial meniscus ranges from 0.48 to 0.53.

DISCUSSION:

Study by Greis et al. mentions that medial meniscus is C shaped; posterior horn is larger than anterior horn in anteroposterior dimension [11]. Studies by Pollard et al. and Shaffer et al. describes medial meniscus as semicircular in shape with the posterior horn wider than the anterior horn [9, 10]. Study done by Brantigan et al. says that the medial meniscus is much larger in diameter, thinner about the periphery, usually narrower [12]. Lateral meniscus is smaller in diameter, thicker about the periphery, and usually wider than medial [12]. These observations about the width of medial meniscus as well as thickness of both menisci are confirmed by the present study (Table 1).

(Millimeters)	Testut and Latarjet [13]	Motta Filho et al [14]	Cailliet [15]	Hayashi et al [16]	Present study	
					Medial	Lateral
Width of meniscus				12-13	9	9
Thickness of meniscus	8(L), 6(M)	12(L), 5(M)	12-13 (L)	6-8	5	6

According to the Table 3, width of menisci, both medial and lateral approximates to those of Hayashi et al study. Thickness of medial meniscus observed in present study approximates that of the studies of Testut et al. [13], Motta Filho et al. [14] and Hayashi et al. [16]. Thickness of lateral meniscus observed in present study approximates that of the studies of Testut et al. [13], and Hayashi et al. [16]. Thickness of lateral meniscus observed in present study contradicts that of the studies of Motta Filho et al. [14] and Cailliet [15] which is almost half of their studies. Regarding anteroposterior dimensions of tibial plateau and menisci, this study becomes a pioneering cadaveric study which can be helpful for sizing of allograft.

CONCLUSIONS:

As meniscus allografts are side- and compartment-specific, using the contralateral meniscus is not an acceptable method to estimate allograft size. The best method for estimating the

appropriate size of an absent meniscus is with plain radiographs [17, 18]. While newer information is emerging in support of MRI, MRI and CT scans were not recommended previously as they had been implicated in misjudging the size of the allograft. The surgeon should also be aware of the sizing techniques used by the tissue provider to ensure a size match. The technique described by Pollard is commonly used [19].

Preoperatively, measurements are made on anteroposterior and lateral radiographs, with magnification markers placed on the skin at the level of the proximal tibia. The meniscal width is calculated based on the width of the compartment as seen on an anteroposterior radiograph after correction for magnification. The meniscal length is based on a lateral radiograph using the sagittal length of the tibial plateau. Following correction for magnification, the length is multiplied by 0.8 for the medial meniscus and by 0.7 for the lateral meniscus [19].

The multiplication factor for anteroposterior length and width of the menisci come to be 0.9 for medial and 0.8 for lateral meniscus. This cadaveric study is useful in such a way that actual dimensions of menisci are calculated instead of radiological one.

Being a cadaveric study, it approximates the living values but do not give the actual living values. Thus there is a scope of further research by doing CT and MRI of the knee joints and calculating the dimensions of menisci and thus correlating those with the living will give actual parameters for allografts to be transplanted in recipient knee.

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