CHAPTER IV

The process of carefully employing statistical and logical approaches to describe, illustrate, condense, summarize, and evaluate the data collected is known as data analysis. This chapter is an important aspect of the study process since it answers questions about the intervention and post-test phases. In the initial phase, the literature knowledge applied and cadaveric knee was assessed for morphometric and morphological analysis. For this total ninety (N=90) cadaveric knee joints were dissected (Right = 45, Left = 45) with known gender (62 Males and 28 Females). All the data were taken from the Department of Anatomy from various colleges, and data was measured by digital vernier calipers, measuring tape and non-elastic thread. The data is categorized and analyzed in accordance with the study's objectives under the following broad headings:

A. Morphometric results on the bones contributing in formation of the knee joint;
B. Morphological and morphometric analysis of menisci of knee joint;
C. Morphometric analysis and anatomical variations observed in the various ligaments of knee joint;
D. Other anatomical variations in relations to the evaluation of cadaveric knee joint.

The morphometric results were measured for both the sides and gender as the maximum linear dimension. The outcomes were analyzed for the both sided and gender as mean ± SD and standard error of mean. The statistical difference in the means was calculated by using paired and unpaired "t" test significant at $P < 0.001$ for appropriate corresponding groups.

The results of morphological variations of the structures in relation to the knee were directly observed, photographed and results were analyzed after recording the data.

The observed data is enlisted in the below tables in the detail.

A. MORPHOMETRIC RESULTS ON THE BONES CONTRIBUTING IN FORMATION OF THE KNEE JOINT;

The data pertaining to the Part-I is discussed under various headings such as results on the articular surface of the patella, results on the classification of the patella, results on the distal end of the femur, results on the proximal end of the tibia and their correlations, association and comparison of the variables by applying various statistical tests.

4.1 RESULTS OF MORPHOMETRIC LINEAR MEASUREMENTS OF THE PATELLA:

The term morphometric linear measurements of the patella refer to the particular characteristics of a patella bone. The demographic characteristics include Height, weight, stature, BMI, age, gender and side, race, culture and occupation. The socio-demographic profile of an individual has great relevance to various aspects of human being. Hence, this part of the thesis is devoted to the discussion of the cadaveric morphometric characteristics of the patella bone. This description is considered necessary as it provides a background to understanding the issues to be discussed in the succeeding parts. Therefore, an attempt has been made to sketch ad focus on the variables such as, side of the limb and gender of the cadaver. The gender of the cadaver is one of the significant variables in the present study. On the basis of above mentioned data attempt has also been made to classify the patella, to measure the Insall-salvati index to establish the correlation between the length of patella and length of patellar ligament, patellar width to thickness ration. As, every components have a significant importance clinically. The details of which has been discussed and interpreted in the other succeeding part of the present research. The morphometric linear measurements of the patella in right sided and left sided observed as shown in table 4.1.1and 4.1.2 and the mean values represented graphically in graph 4.1.1.The difference in means in both the variables, right sided and left sided was observed to be statistically insignificant for the length, width, thickness and width of lateral articular facet. While for the medial articular facet data is observed statistically significant. Because there is no difference between the two sides, a p-value of larger than 0.05 implies that the null hypothesis cannot be rejected.

MEASUREMENTS (in mm)	RIGHT SIDED (N= 45)			LEFT SIDED (N= 45)		
	Maximum	Minimum	Mode	Maximum	Minimum	Mode
Length of patella	60.00	30.00	38.00	45.00	26.00	45.00
Width of patella	72.00	30.00	46.00	55.00	32.00	46.00
Thickness of patella	22.00	14.00	18.00	23.00	50.00	18.00
Width of lateral articular facet	28.00	18.00	21.00	26.00	18.00	23.00
Width of medial articular facet	27.00	18.00	24.00	27.00	19.00	24.00

TABLE-4.1.1:MORPHOMETRIC LINEAR MEASUREMENTS OF PATELLA BONE IN RIGHT SIDED AND LEFT SIDED OF KNEE

MEASUREMENTS (in mm)	RIGHT SIDED (N= 45)			LEFT SIDED (N= 45)				
	Mean	SD	SEM	Mean	SD	SEM	t-value	p-value
Length of patella	38.37	0.554	0.083	37.40	0.542	0.081	1.197	0.230
Width of patella	48.95	0.724	0.109	47.40	0.485	0.073	1.115	0.260
Thickness of patella	18.68	0.171	0.025	18.40	0.170	0.172	0.913	0.360
Width of lateral articular facet	27.00	0.194	0.028	27.00	0.178	0.026	<0.001	0.500
Width of medial articular facet	22.57	0.224	0.033	26.00	0.168	0.025	1.488	0.070

TABLE- 4.1.2: STATISTICS MEASUREMENTS OF PATELLA BONE IN RIGHT SIDED AND LEFT SIDED OF KNEE

MEASUREMENTS (in mm)	MALE (N= 62)			FEMALE (N= 28)		
	Maximum	Minimum	Mode	Maximum	Minimum	Mode
Length of patella	60.00	30.00	38.00	42.00	26.00	30.00
Width of patella	72.00	30.00	48.00	58.00	35.00	46.00
Thickness of patella	23.00	14.00	18.00	22.00	16.00	18.00
Width of lateral articular facet	26.00	18.00	23.00	28.00	18.00	22.00
Width of medial articular facet	27.00	18.00	24.00	27.00	19.00	24.00

TABLE- 4.1.3: MORPHOMETRIC LINEAR MEASUREMENTS OF PATELLA BONE OF KNEE IN MALES ANDFEMALES

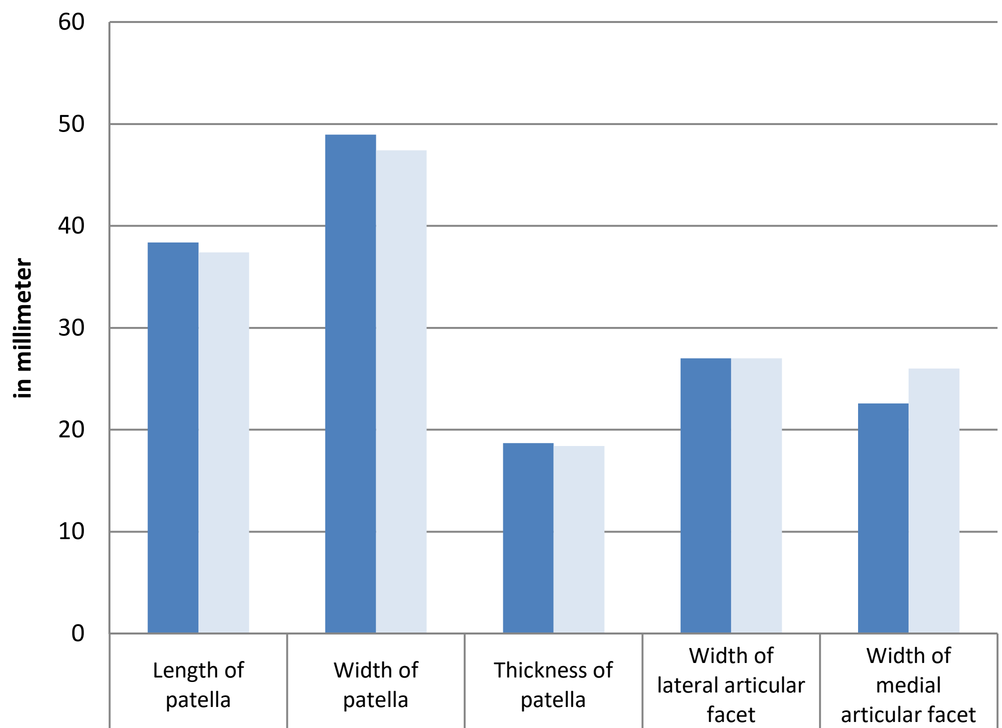
MEASUREMENTS (in mm)	MALE (N= 62)			FEMALE (N= 28)				
	Mean	SD	SEM	Mean	SD	SEM	t- value	p-value
Length of patella	39.54	0.506	0.064	33.82	0.427	0.080	5.199	<0.001
Width of patella	48.00	0.687	0.087	48.22	0.407	0.055	0.299	0.382
Thickness of patella	18.62	0.175	0.222	18.35	0.168	0.031	0.688	0.246
Width of lateral articular facet	22.69	0.188	0.023	23.32	0.219	0.041	1.388	0.084
Width of medial articular facet	16.69	0.187	0.023	16.96	0.181	0.034	0.639	0.262

TABLE- 4.1.4: STATISTICS MEASUREMENTS OF PATELLA BONE OF KNEE IN MALES AND FEMALES

The patella is involved in various sitting and squatting positions and hence shows cultural and gender variables. Furthermore, the right use of morphometrically matched prosthesis is fundamental to the knee arthroplasty procedure's success. It is consequently critical to have access to reliable morphometric data when developing and selecting prosthesis implant sizes. The morphometric linear measurements of patella in males and females observed as shown in table 4.1.3 and 4.1.4 above and the mean values represented graphically below in graph 4.1.2.

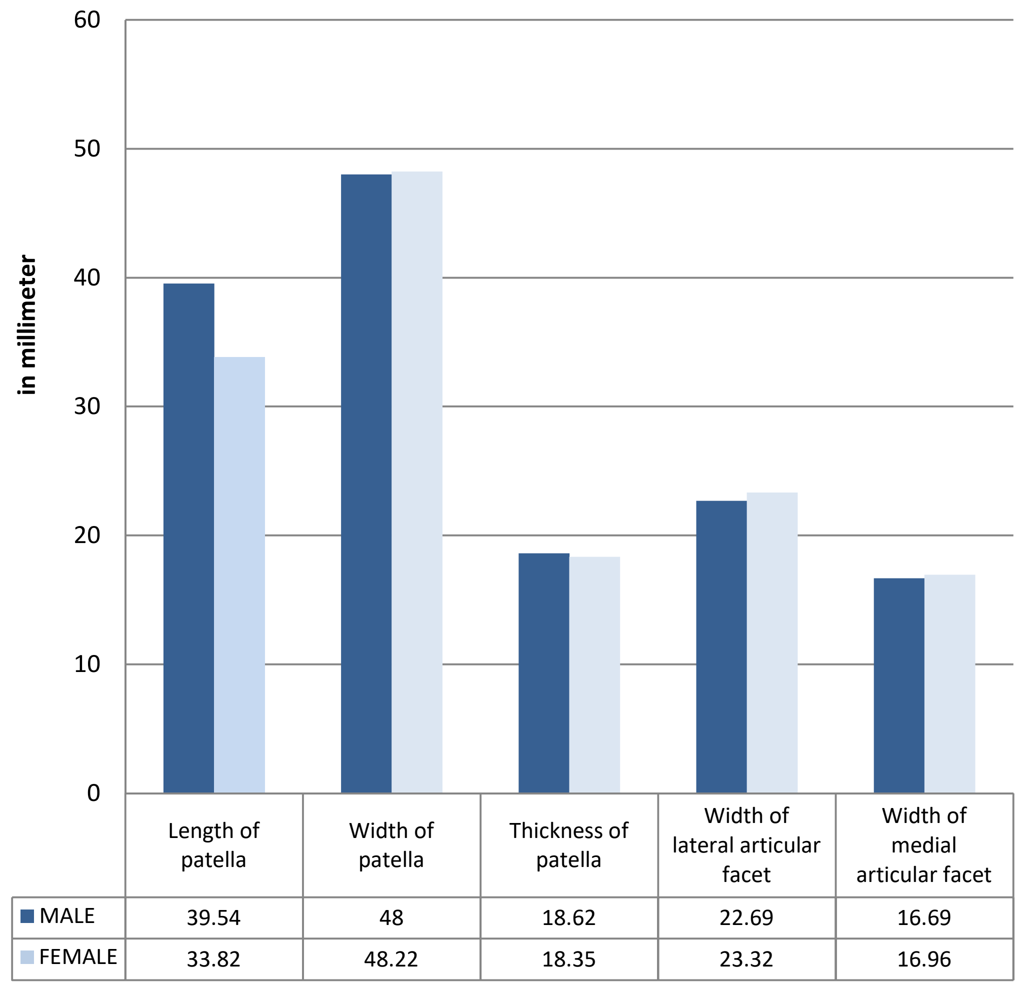
The difference in mean values in male and female cadaveric specimen for sex dimorphism was also found to be similar except for the length of patella and observed to be statistically significant. However, the difference in results may be due to difference in build and short stature of females. While for the width, thickness and width of lateral articular facet and medial articular facet of patella data was observed statistically significant.

Graph 4.1.1: Morphometric linear measurements of patella bone in right sided and left sided of knee



	Length of patella	Width of patella	Thickness of patella	Width of lateral articular facet	Width of medial articular facet
RIGHT	38.37	48.95	18.68	27	22.57
LEFT	37.4	47.4	18.4	27	26

Graph 4.1.2: Morphometric linear measurements of patella bone of knee in males and females



All of the information revealed in this study about patellar morphometry is useful in a wide variety of fields, including medicine, surgery, gross anatomy, anthropology, comparative anatomy, forensic medicine, and evolutionary biology. These findings could be extremely useful in the development of appropriately matched prostheses and their application in biomedical applications such as joint replacement and reconstructive knee surgery.

4.2 RESULTS OF MORPHOMETRIC MEASUREMENTS OF DISTAL END OF THE FEMUR:

The term morphometric linear measurements of the distal end of the femur refer to the particular characteristics of medial and lateral condyle of femur and intercondylar notch of the femur. In normal locomotion, the plane of the femoral condyles is horizontal to the surface, according to erect posture. The development of total joint replacement and internal fixation of tools in various surgical procedures depends on the computation of morphometric anatomy of the distal end of the femur. Hence, this part of the thesis is devoted to the discussion of the cadaveric morphometric characteristics of the distal end of femur bone. This description is considered necessary as it provides a background to understanding the issues to be discussed in the succeeding parts. Therefore, an attempt has been made to sketch and focus on the variables such as, side of the limb and gender of the cadaver. The gender of the cadaver is one of the significant variables in the present study

MEASUREMENTS (in mm)	RIGHT SIDED (N= 45)			LEFT SIDED (N= 45)		
	Maximum	**Minimum**	**Mode**	**Maximum**	**Minimum**	**Mode**
BCWF	83.00	64.00	81.00	81.00	61.00	79.00
MFCAPD	65.00	49.00	57.00	64.00	50.00	54.00
MFCTD	35.00	24.00	32.00	36.00	21.00	27.00
LFCAPD	58.00	52.64	52.00	60.00	47.00	54.00
LFCTD	40.00	24.00	31.00	42.00	29.00	36.00
ICNWF	25.00	12.00	14.00	25.00	12.00	17.00
ICNLF	28.00	21.00	24.00	29.00	23.00	24.00

TABLE- 4.2.1: MORPHOMETRIC MEASUREMENTS OF DISTAL END OF FEMUR RIGHT SIDED AND LEFT SIDED OF KNEE

MEASUREMENTS (in mm)	RIGHT SIDED (N= 45)			LEFT SIDED (N= 45)				
	Mean	SD	SEM	Mean	SD	SEM	t-value	p-value
BCWF	76.46	0.439	0.065	72.88	0.533	0.079	3.469	<0.001
MFCAPD	57.37	0.434	0.064	55.55	0.336	0.050	2.227	0.028
MFCTD	29.56	0.318	0.047	28.13	0.348	0.051	2.041	0.044
LFCAPD	52.64	0.315	0.047	53.51	0.340	0.050	1.251	0.214
LFCTD	32.22	0.358	0.053	35.44	0.312	0.046	4.550	<0.001
ICNWF	21.20	0.189	0.028	21.73	0.195	0.029	1.314	0.192
ICNLF	24.64	0.169	0.025	25.13	0.172	0.025	1.356	0.178

TABLE- 4.2.2: STATISTICS FOR VARIOUS MEASUREMENTS OF DISTAL END OF FEMUR IN RIGHT SIDED AND LEFT SIDED OF KNEE

Correct implant location and adequate soft tissue alignment are essential for successful joint replacement surgery. To retain the architecture and functional movement of the knee, it is fundamental to employ the proper femoral component. The morphometric linear measurements of distal articular surface of femur in right sided and left sided observed as shown in table 4.2.1and 4.2.2 above and the mean values represented graphically below in graph 4.2.1. The difference in means in both the variables, right sided and left sided was observed to be statistically significant for the bicondylar width of femur and transverse diameter of left femoral condyle. While for the Medial femoral condyle AP diameter, medial femoral condyle TD, Lateral femoral condyle AP diameter, Intercondylar notch width of femur and Intercondylar notch length of femur data was observed statistically insignificant. Because there is no difference between the two sides, a p-value of larger than 0.05 implies that the null hypothesis cannot be rejected. The adoption of morphometrically matched prosthesis is critical for knee arthroplasty success. All of the information revealed in this study about distal end femur morphometry is useful in a variety of fields, including medicine, surgery, gross anatomy, anthropology, comparative anatomy, forensic medicine, and evolutionary biology. These findings could be extremely useful in the development of appropriately matched prostheses and their application in biomedical applications such as joint replacement and reconstructive knee surgery.

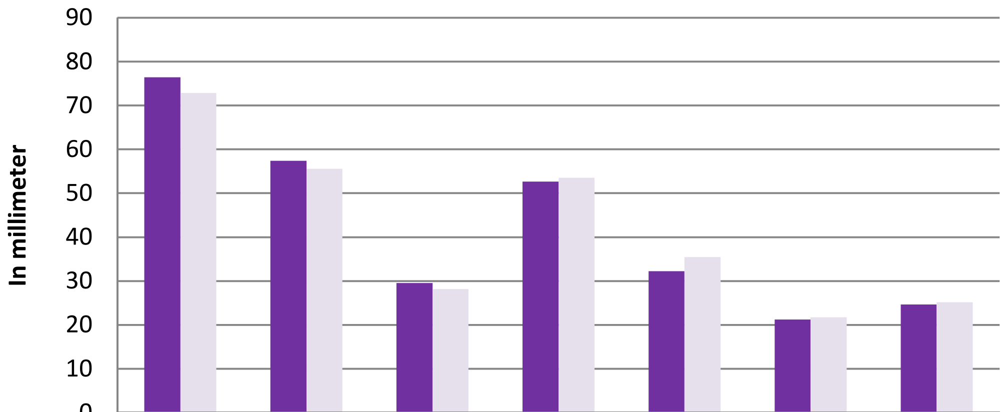
MEASUREMENTS (in mm)	MALE (N= 62)			FEMALE (N= 28)		
	Maximum	Minimum	Mode	Maximum	Minimum	Mode
BCWF	83.00	63.00	79.00	81.00	61.00	77.00
MFCAPD	65.00	49.00	54.00	63.00	50.00	56.00
MFCTD	36.00	21.00	31.00	35.00	24.00	32.00
LFCAPD	60.00	47.00	58.00	58.00	48.00	51.00
LFCTD	42.00	26.00	32.00	41.00	24.00	36.00
ICNWF	25.00	12.00	14.00	22.00	12.00	17.00
ICNLF	29.00	21.00	24.00	29.00	23.00	25.00

TABLE- 4.2.3: MORPHOMETRIC MEASUREMENTS OF DISTAL END OF FEMUR IN MALES AND FEMALES

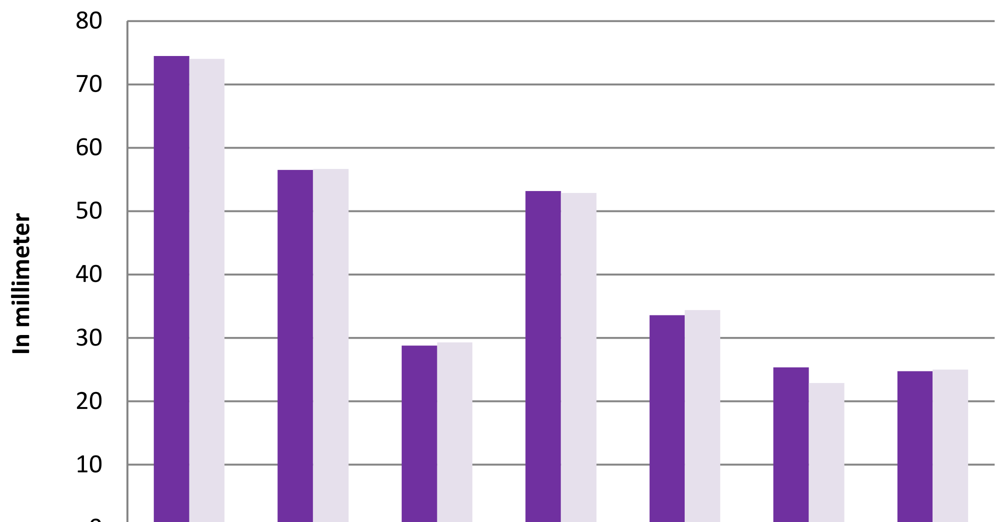
MEASUREMENTS (in mm)	MALE (N= 62)			FEMALE (N= 28)				
	Mean	SD	SEM	Mean	SD	SEM	t-value	p-value
BCWF	74.51	0.538	0.068	74.03	0.478	0.090	0.438	<0.001
MFCAPD	56.50	0.146	0.052	56.67	0.359	0.067	0.196	0.422
MFCTD	28.79	0.334	0.042	29.28	0.336	0.069	0.631	0.264
LFCAPD	53.16	0.438	0.044	52.89	0.287	0.054	0.356	0.361
LFCTD	33.58	0.361	0.045	34.39	0.931	0.074	0.960	0.169
ICNWF	25.33	0.174	0.022	22.88	0.230	0.043	0.934	<0.001
ICNLF	24.75	0.180	0.022	25.00	0.153	0.029	0.614	0.270

TABLE-4.2.4: STATISTICS FOR VARIOUS MEASUREMENTS OF DISTAL END OF FEMUR IN MALES AND FEMALES

The morphometric linear measurements of distal end of femur in males and females observed as shown in table 4.2.3 and 4.2.4 above and the mean values represented graphically below in graph 4.2.2. The difference in means in both the variables, right sided and left sided was observed to be statistically insignificant for all the metric parameters except for the bicondylar width of femur and intercondylar notch width of femur.



	BCWF	MFCAPD	MFCTD	LFCAPD	LFCTD	ICNWF	ICNLF
RIGHT	76.46	57.37	29.56	52.64	32.22	21.2	24.64
LEFT	72.88	55.55	28.13	53.51	35.44	21.73	25.13



	BCWF	MFCAPD	MFCTD	LFCAPD	LFCTD	ICNWF	ICNLF
Male	74.51	56.5	28.79	53.16	33.58	25.33	24.75
Female	74.03	56.67	29.28	52.89	34.39	22.88	25

4.3 RESULTS OF MORPHOMETIC MEASUREMENTS OF PROXIMAL END OF THE TIBIA:

MEASUREMENTS (in mm)	RIGHT SIDED (N= 45)			LEFT SIDED (N= 45)		
	Maximum	**Minimum**	**Mode**	**Maximum**	**Minimum**	**Mode**
BCWT	79.00	64.00	71.00	78.00	67.00	78.00
MTCAPD	49.00	36.00	39.00	49.00	36.00	43.00
MTCTD	38.00	27.00	31.00	38.00	27.00	30.00
LTCAPD	44.00	38.00	38.00	44.00	38.00	38.00
LTCTD	35.00	26.00	30.00	34.00	26.00	30.00
TOTAL AP ICA	52.00	44.00	48.00	52.00	44.00	48.00
AP AICA	33.00	18.00	30.00	34.00	18.00	31.00
AP PICA	28.00	12.00	21.00	27.00	14.00	18.00
TD ICA (Anterior part)	38.00	21.00	34.00	38.00	23.00	27.00
TD ICA (Middle part)	15.00	8.000	13.00	15.00	9 .000	11.00
TD ICA (Posterior part)	38.00	23.00	27.00	17.68	25.00	14.00
Distance from tibial-to-tibial tuberosity	71.00	54.00	70.00	71.00	48.00	70.00

TABLE- 4.3.1: MORPHOMETRIC MEASUREMENTS OF PROXIMAL END OF TIBIA IN RIGHT SIDED AND LEFT SIDED OF KNEE

MEASUREMENTS (in mm)	RIGHT SIDED (N= 45)			LEFT SIDED (N= 45)				
	Mean	SD	SEM	Mean	SD	SEM	t-Value	p-Value
BCWT	72.28	0.407	0.060	73.13	0.324	0.048	1.087	0.139
MTCAPD	41.28	0.316	0.047	42.77	0.341	0.050	2.144	0.038
MTCTD	31.28	0.295	0.044	32.44	0.282	0.042	1.895	0.061
LTCAPD	40.31	0.195	0.029	40.24	0.197	0.029	0.161	0.872
LTCTD	30.24	0.213	0.031	29.93	0.182	0.027	0.743	0.229
TOTAL AP ICA	48.77	0.169	0.025	49.00	0.162	0.024	0.635	0.263
AP AICA	26.48	0.469	0.069	27.04	0.447	0.066	0.574	0.283
AP PICA	20.46	0.436	0.065	20.15	0.432	0.051	0.376	0.353
TD ICA (Anterior part)	29.48	0.482	0.071	28.20	38.00	23.00	1.363	0.880
TD ICA (Middle part)	11.53	0.173	0.025	11.46	0.175	0.026	0.181	0.428
TD ICA (Posterior part)	28.20	0.411	0.061	17.68	0.390	0.058	1.252	0.106
Distance from tibial-to-tibial tuberosity	63.06	0.541	0.080	61.71	0.538	0.080	1.190	0.118

TABLE-4.3.2: STATISTICS FOR VARIOUS MEASUREMENTS OF PROXIMAL END OF TIBIA IN RIGHT SIDED AND LEFT SIDED OF KNEE

The morphometric linear measurements of proximal end of tibia in right sided and left sided observed as shown in table 4.3.1and 4.3.2 above and the mean values represented graphically below in graph 4.3.1. The difference in means in both the variables, right sided and left sided was observed to be statistically insignificant for all the metric parameters.

MEASUREMENTS (in mm)	MALE (N= 62)			FEMALE (N= 28)		
	Maximum	**Minimum**	**Mode**	**Maximum**	**Minimum**	**Mode**
BCWT	78.00	64.00	78.00	79.00	65.00	72.00
MTCAPD	49.00	36.00	41.00	49.00	36.00	43.00
MTCTD	38.00	27.00	29.00	38.00	28.00	30.00
LTCAPD	44.00	38.00	38.00	44.00	38.00	40.00
LTCTD	35.00	26.00	30.00	35.00	26.00	30.00
TOTAL AP ICA	52.00	44.00	48.00	51.00	47.00	50.00
AP AICA	34.00	18.00	30.00 & 32.00	33.00	18.00	31.00
AP PICA	28.00	12.00	21.00	28.00	15.00	18.00
TD ICA (anterior part)	38.00	21.00	25.00 & 24.00	38.00	22.00	31.00 & 27.00
TD ICA (middle part)	15.00	8.000	13.00	15.00	9.000	11.00
TD ICA (posterior part)	25.00	12.00	13.00 & 20.00	27.00	14.00	14.00
Distance from tibial to tibial tuberosity	71.00	48.00	64.00	71.00	56.00	62.00

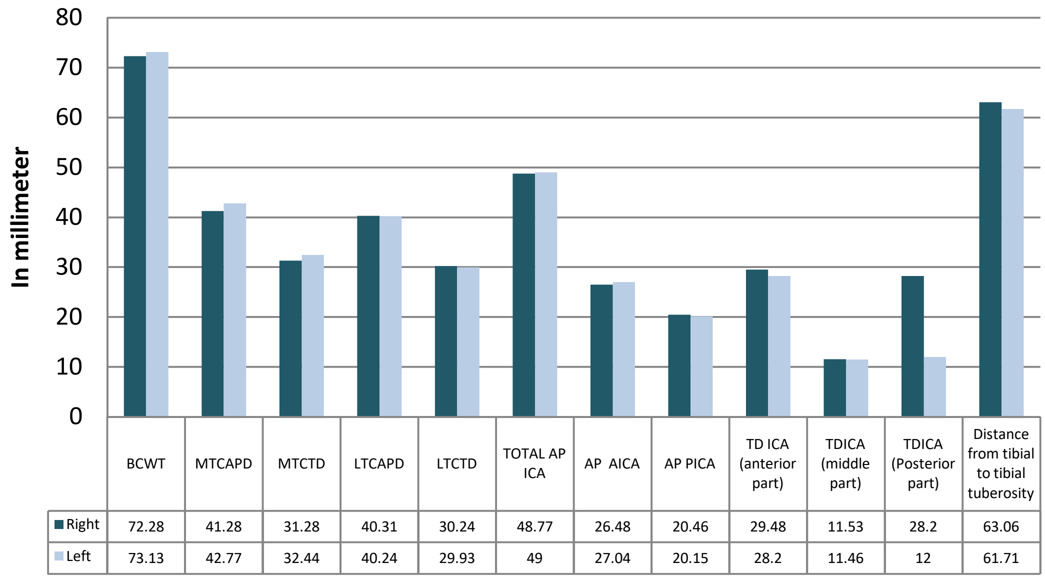
TABLE-4.3.3:MORPHOMETRIC MEASUREMENTS OF PROXIMAL END OF TIBIAIN MALES AND FEMALES

MEASUREMENTS (in mm)	MALE (N= 62)			FEMALE (N= 28)				
	Mean	SD	SEM	Mean	SD	SEM	t- value	p-value
BCWT	73.00	0.360	0.045	72.07	0.348	0.072	1.107	0.135
MTCAPD	42.00	0.337	0.042	42.14	0.336	0.063	0.185	0.426
MTCTD	31.61	0.312	0.039	32.35	0.295	0.055	0.318	0.375
LTCAPD	40.38	0.203	0.025	40.03	0.177	0.033	0.787	0.216
LTCTD	30.22	0.191	0.024	29.89	0.221	0.041	0.727	0.234
TOTAL AP ICA	48.74	0.174	0.022	49.21	0.139	0.026	1.259	0.105
AP AICA	27.03	0.466	0.059	26.17	0.435	0.082	0.819	0.207
AP PICA	20.19	0.407	0.051	20.57	0.355	0.067	0.423	0.336
TD ICA (Anterior part)	28.41	0.433	0.055	29.78	0.480	0.090	1.338	0.092
TD ICA (Middle part)	11.43	0.167	0.021	11.64	0.188	0.035	3.678	0.002
TD ICA (Posterior part)	17.48	0.386	0.049	19.92	0.455	0.086	2.625	0.005
Distance from tibial-to-tibial tuberosity	61.66	0.553	0.070	64.00	0.485	0.091	1.926	0.28

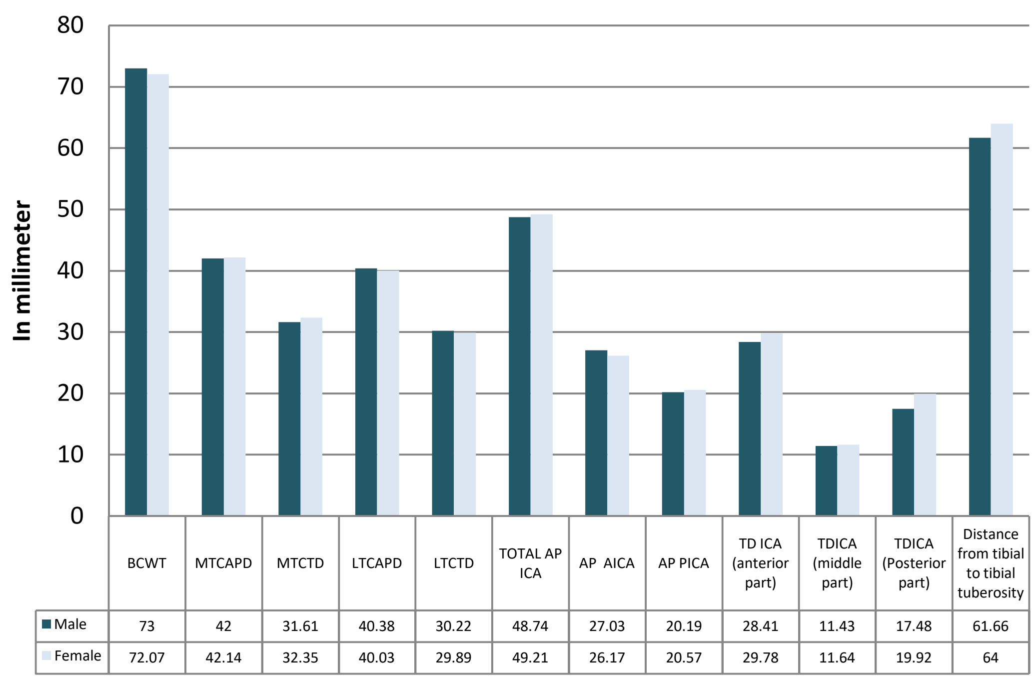
TABLE- 4.3.4: STATISTICS FOR VARIOUS MEASUREMENTS OF PROXIMAL END OF TIBIA IN MALES AND FEMALES

The morphometric linear measurements of Proximal end of tibia in males and females observed as shown in table 4.3.3 and 4.3.4 above and the mean values represented graphically in graph 4.3.2. The difference in means in both the variables, males and females was observed to be statistically insignificant for all the metric parameters.

Graph 4.3.1: Morphometric linear measurements of upper end of tibia in right sided and left sided of knee



Graph 4.3.2: Morphometric linear measurements of upper end of tibia in males and females



B.MORPHOLOGICAL AND MORPHOMETRIC ANALYSIS OF MENISCI OF KNEE JOINT

The study would be incomplete if the fibrocartilaginous disc; menisci are not taken into consideration for the cadaveric analysis of the knee joint. The morphological and morphometric analysis of menisci in human cadaveric knee can be well understood by the dissection. In the present study, healthy cadaveric knees were considered for the evaluation. Variables such as difference in the shapes of medial menisci and lateral menisci, morphometry difference for symmetrical and sex dimorphism were included to understand the anatomy of menisci for the better post-operative outcome in the various surgical procedures involving the knee.

4.4 RESULTS OF MORPHOLOGICAL VARIATIONS IN THE MENISCI OF KNEE:

4.4.1. Results of morphological variations in medial menisci of knee joint:

The morphological characteristics of menisci must be examined since they provide an idea of the course for ligament repair techniques in the knee. Because of modern procedures such as arthroscopy, CT scan, and MRI, the morphological differences and structural anomalies of the intra articular structures of the knee joint, namely the menisci, have recently become prominent. Clinically, understanding these variances is critical for defining morphological aspects for correct diagnosis and surgical operation success. The medial and lateral menisci were dissected out intact by splitting their attachments to the tibia in order to comprehend this. The morphological changes of the varied morphologies of medial and lateral menisci were noticed and characterized in the cadaveric knee.

We observed various morphological variations in the different shapes of medial menisci in the present study as shown in the figure.

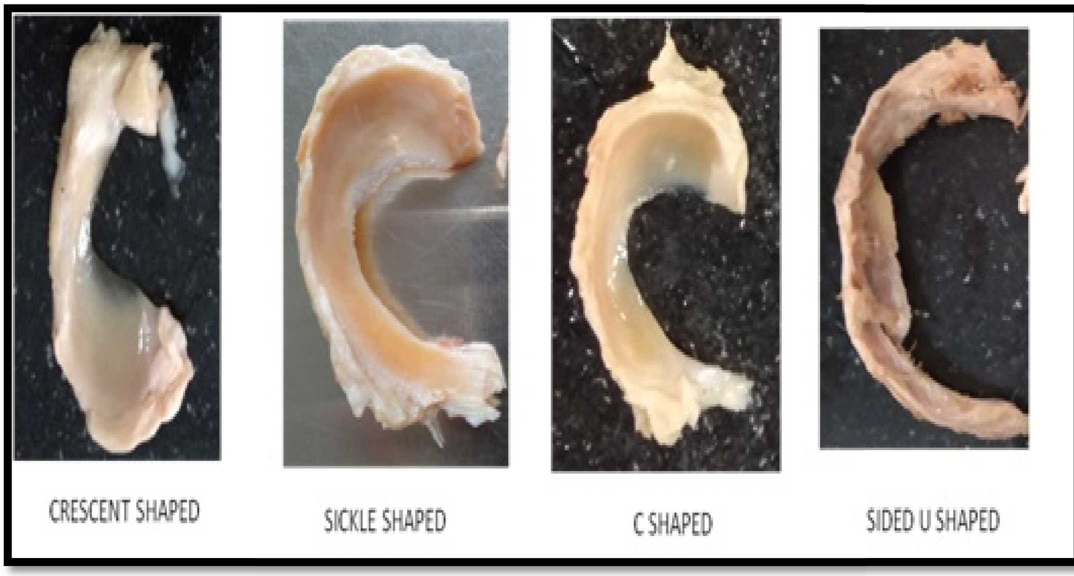
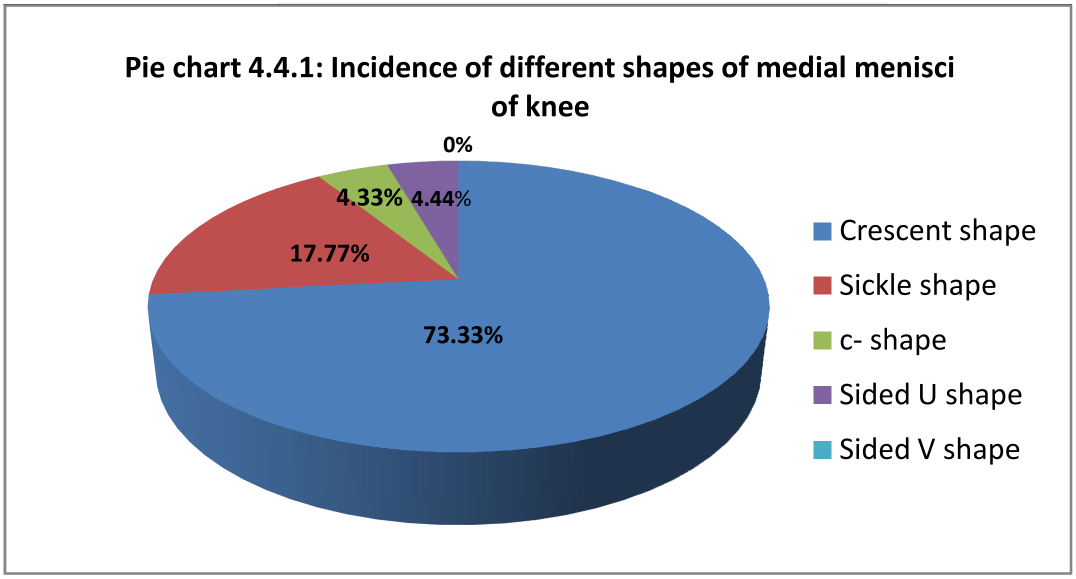


Figure 4.1: Showing different shapes of medial menisci of knee joint.

In the present study according to the findings we observed the highest incidence of crescent shaped medial menisci. The second highest prevalence was observed in sickle shaped medial menisci in 66 (73.33%) specimens. The equal proportionate incidence was observed with C- Shaped and Sided U shaped. No any meniscus with sided V-Shaped was observed in any of the specimen in the present study. The results of the study are shown in the table 4.4.1 and represented in the pie chart.

DIFFERENT SHAPES OF MEDIAL MENISCI	MEDIAL MENISCUS INCIDENCE	
	Total No. (N= 90)	Percentage (%)
Crescent shape	66	73.33%
Sickle shape	16	17.77%
C-shape	4	4.33%
Sided U-shape	4	4.33%
Sided V-shape	Nil	0.00%

TABLE- 4.4.1: SHOWING INCIDENCE OF DIFFERENT SHAPES OF MEDIAL MENISCI OF KNEE JOINT



4.4.2. Results of morphological variations of lateral menisci of knee joint

We observed various morphological variations in the different shapes of lateral menisci in the present study. Figure 4.2 Shows photograph of the lateral menisci showing various shapes observed in the present study.

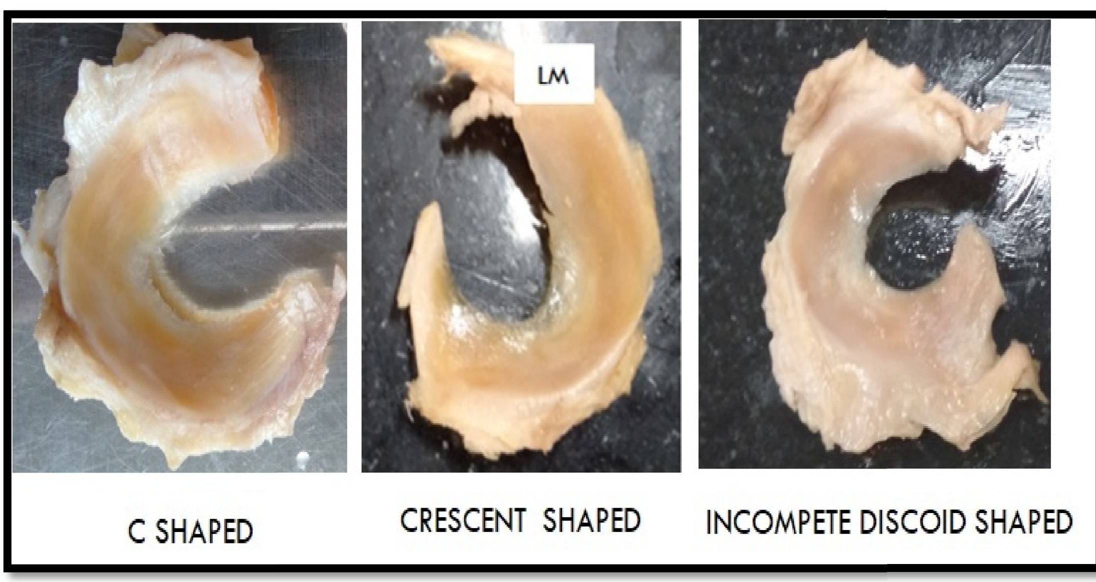


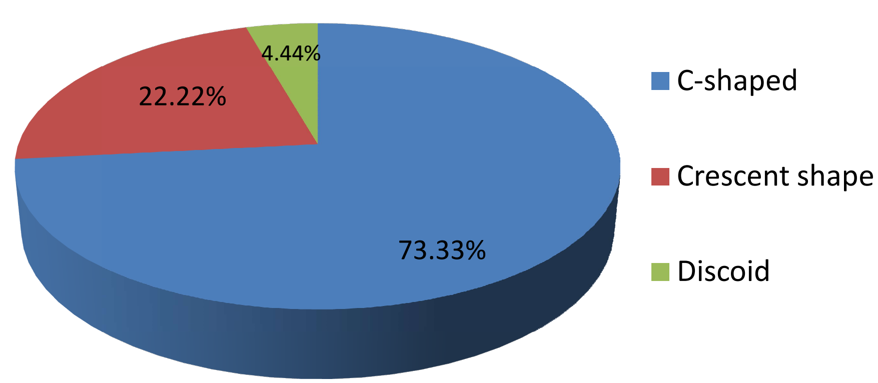
Figure 4.2: Showing different shapes of lateral menisci of knee joint.

In the present study, the subgroups of lateral menisci observed were C shaped, crescent shaped, and incomplete discoid shaped. The results of findings are shown in the table 4.4.2 and in the pie chart below. The most commonly observed morphology was crescent shaped in 66 (73.33%) specimens. In the present study we observed the highest incidence of C-shaped lateral menisci. The second highest prevalence was observed in crescent shaped lateral menisci. The lowest incidence was observed with discoid (incomplete) shaped lateral menisci.

DIFFERENT SHAPES OF LATERAL MENISCI	LATERAL MENISCI INCIDENCE	
	Total No. (N= 90)	Percentage (%)
C-shaped	66	73.33%
Crescent shaped	20	22.22%
Discoid(circular) shaped (Incomplete)	4	4.44%

TABLE- 4.4.2: SHOWING INCIDENCE OF DIFFERENT SHAPES OF LATERAL MENISCI OF KNEE JOINT

Pie chart 4.4.2: Incidence of different shapes of lateral menisci of knee



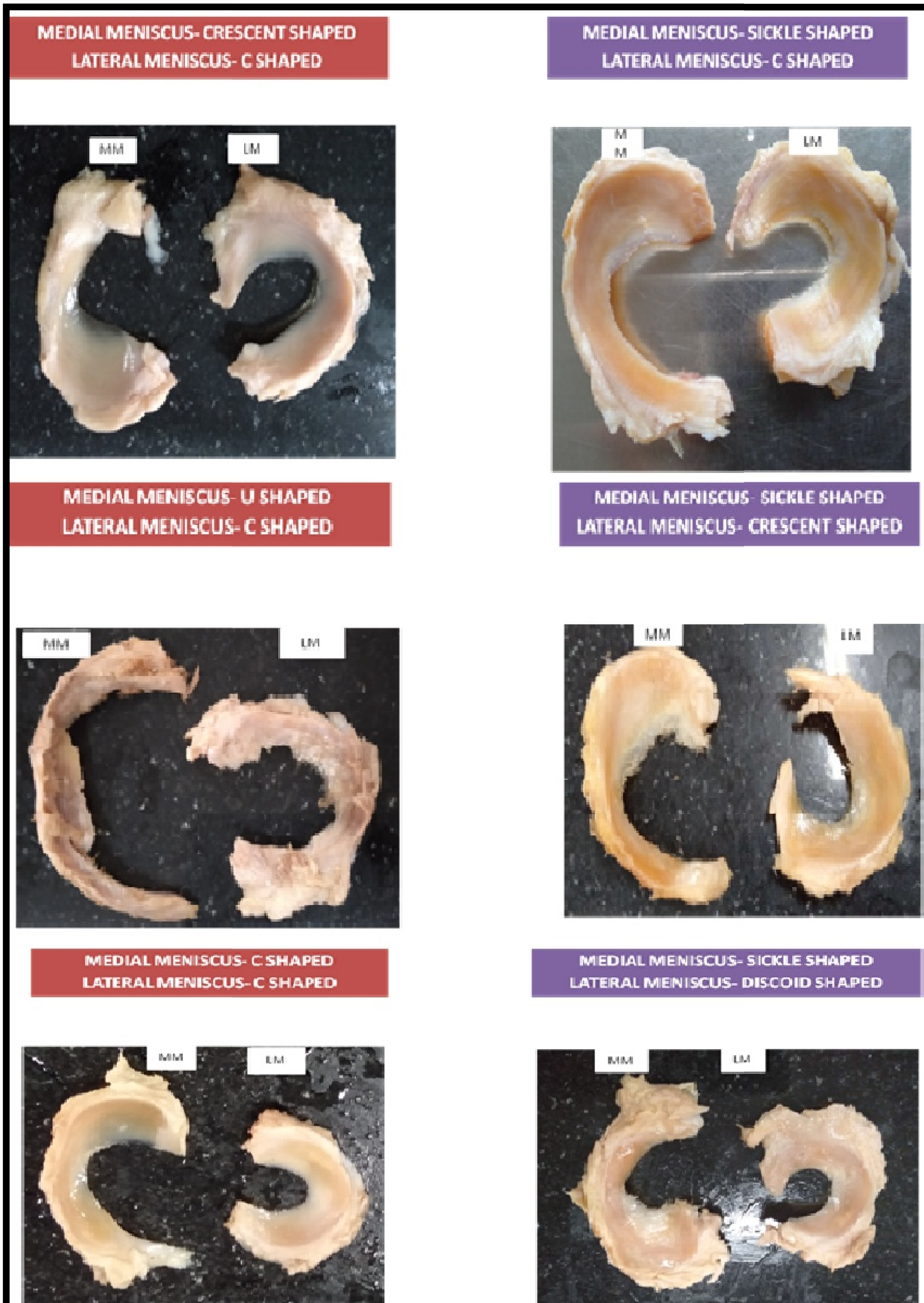


Figure 4.3: Showing different shapes of medial and lateral menisci of knee joint.

4.5. MORPHOMETRIC RESULTS OF THE MENISCI OF KNEE JOINT:

The menisci are anatomical structures that can be injured. This injury can occur as a result of rotational trauma, twisting or bending, as part of a joint degenerative process, or as a spontaneous injury resulting from progressive structural failure as a meniscal injury due to fatigue (Camanho, 2009). Whatever may the cause of the injury, its morphology and morphometry can be closely related to it. Furthermore, rather than removing a ruptured meniscus, it is now possible to repair it, but this is only possible if the meniscus tissue is otherwise viable and of good quality. Meniscal size is currently evaluated by measuring a combination of bony landmarks and soft-tissue insertion points through images obtained by radiography or magnetic resonance imaging in the more common cases with irreparable injury (Pollard et al., 1995). The study was carried out to determine the length, thickness of the outer circumference, width, and distance between the anterior and posterior horns of the menisci of the knee joint, all of which are clinically important.

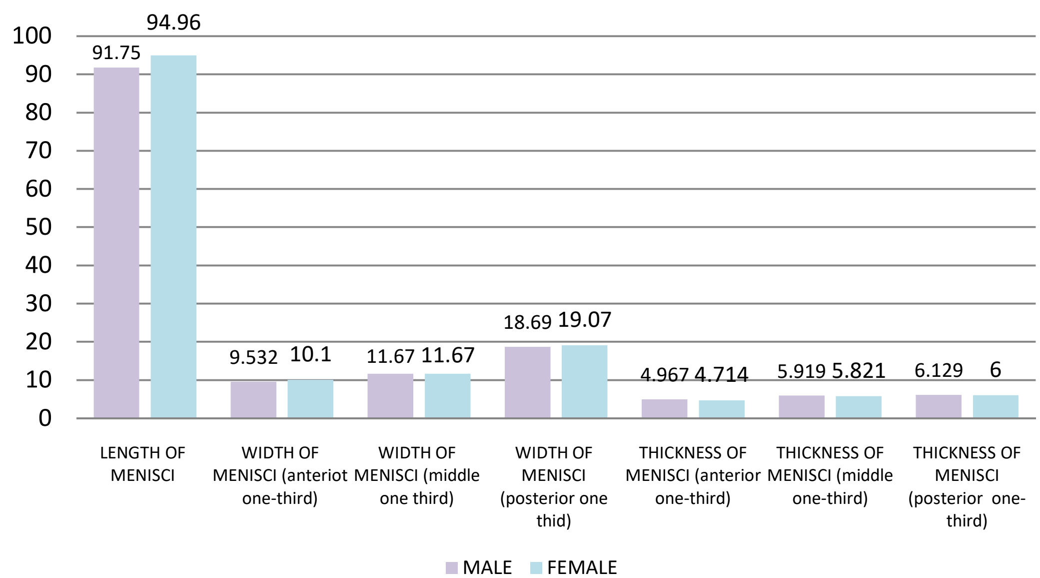
4.5.1. Morphometric results of the medial menisci of knee Joint:

Menisci encompass half to two-thirds of the articular surface of the comparable tibial plateau in the current study, with the lateral meniscus spanning more area than the medial meniscus. The results showed that the medial menisci had a longer outside circumference than the lateral menisci, which is statistically significant for both right and left sides. The anterior portion of the medial meniscus is found to be narrower, whereas the posterior third is the widest in terms of medial meniscus width. The width of anterior, middle, and posterior thirds and thickness of the anterior, middle, and posterior thirds of medial meniscus were observed statistically insignificant for symmetrical and gender dimorphism. The results of findings are shown in the table 4.5.1 and 4.5.2. The findings are demonstrated in the graph below.

MEASUREMENTS (in mm)		RIGHT SIDED (N= 45)			LEFT SIDED (N= 45)				
		Mean	SD	SEM	Mean	SD	SEM	t- value	P-value
Length of medial menisci		90.64	0.720	0.107	94.86	0.559	0.083	3.106	<0.001
Width of menisci	Anterior one-third	9.644	0.216	0.032	9.777	0.242	0.036	0.275	0.391
	Middle one-third	11.17	0.205	0.030	12.02	0.171	0.025	2.115	0.018
	Posterior one-third	18.64	0.216	0.032	18.97	0.186	0.027	0.782	0.218
Thickness of menisci	Anterior one-third	4.770	0.114	0.017	5.000	0.110	0.016	0.935	0.176
	Middle one-third	5.488	0.135	0.020	6.288	0.123	0.018	2.921	0.002
	Posterior one-third	6.044	0.122	0.018	6.133	0.119	0.017	0.348	0.364

TABLE- 4.5.1: STATISTICS FOR MEASUREMENTS OF MEDIAL MENISCUS IN RIGHT SIDED ANDLEFT SIDED OF KNEE

Graph 4.5.1: Morphometric measurements of medial menisci of knee in males and females



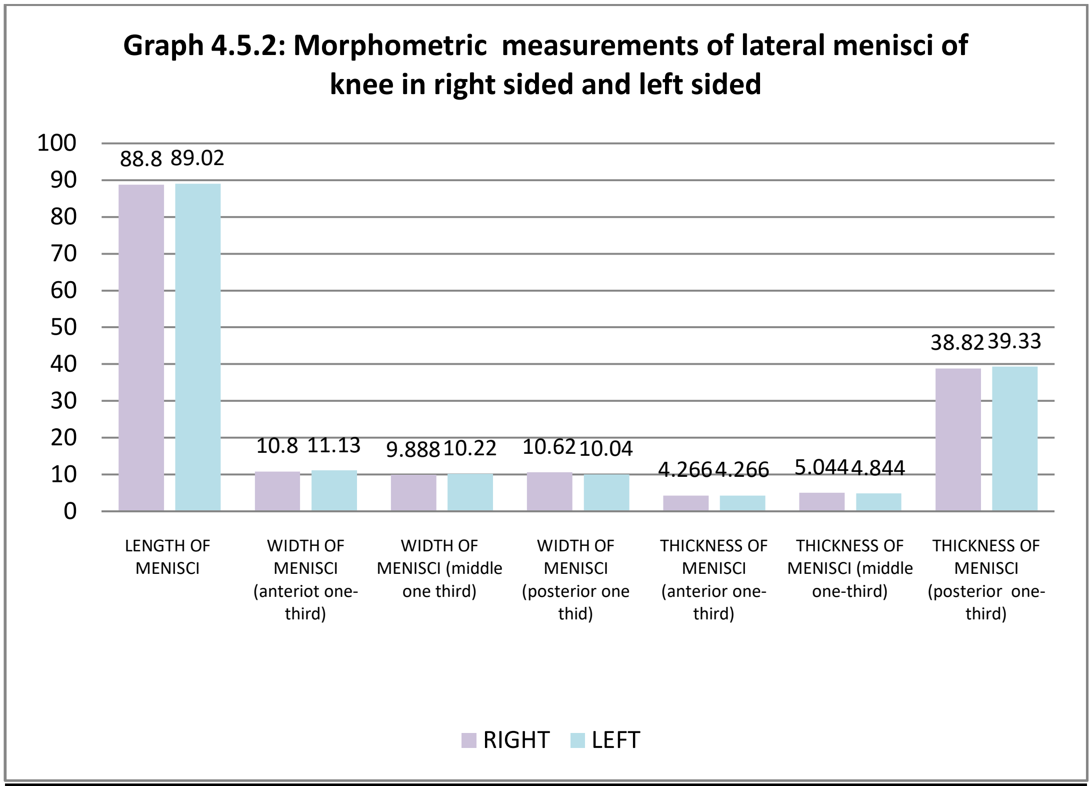
MEASUREMENTS (in mm)		MALE (N= 62)			FEMALE (N= 28)				
		Mean	SD	SEM	Mean	SD	SEM	t- value	p-value
Length of menisci		91.75	0.667	0.084	94.96	0.651	0.123	2.126	0.181
Width Of menisci	Anterior one-third	9.532	0.220	0.028	10.10	0.243	0.046	1.106	0.135
	Middle one-third	11.67	0.198	0.025	11.67	0.179	0.033	0.258	0.398
	Posterior one-third	18.69	0.208	0.026	19.07	0.183	0.034	0.821	0.206
Thickness of menisci	Anterior one-third	4.967	0.117	0.014	4.714	0.101	0.019	0.988	0.162
	Middle one-third	5.919	0.135	0.017	5.821	0.136	0.025	0.316	0.376
	Posterior one-third	6.129	0.124	0.015	6.000	0.112	0.021	0.468	0.320

TABLE- 4.5.2: STATISTICS FOR MEASUREMENTS OF MEDIAL MENISCI IN MALES AND FEMALES

4.5.2. Morphometric Results of lateral menisci of knee Joint:

MEASUREMENTS (in mm)		MALE (N= 62)			FEMALE (N= 28)				
		Mean	SD	SEM	Mean	SD	SEM	t- value	p-value
Length of menisci		88.80	0.474	0.070	89.02	0.482	0.071	0.220	0.413
Width Of menisci	Anterior one-third	10.80	0.180	0.027	11.13	0.199	0.029	0.828	0.204
	Middle one-third	9.888	0.190	0.028	10.22	0.197	0.029	0.813	0.208
	Posterior one-third	10.62	0.194	0.029	10.04	0.190	0.028	1.422	0.079
Thickness of menisci	Anterior one-third	4.266	1.232	0.183	4.266	1.388	0.206	0.000	0.500
	Middle one-third	5.044	0.975	0.145	4.844	1.086	0.161	0.918	0.180
	Posterior one-third	38.82	1.319	0.196	39.33	1.175	0.175	0.421	0.337

TABLE- 4.5.2.1: STATISTICS FOR MEASUREMENTS OF LATERAL MENISCI IN RIGHT SIDED AND LEFT SIDED OF KNEE



MEASUREMENTS (in mm)		**MALE (N= 62)**			**FEMALE (N= 28)**				
		Mean	**SD**	**SEM**	**Mean**	**SD**	**SEM**	**t- value**	**p-value**
Length of menisci		90.50	0.460	0.058	85.39	0.283	0.053	5.410	0.000
Width of menisci	Anterior one-third	11.09	0.187	0.023	10.67	0.196	0.037	0.963	0.168
	Middle one-third	10.30	0.180	0.022	9.500	0.213	0.040	1.851	0.033
	Posterior one-third	10.37	0.175	0.022	10.25	0.231	0.043	0.272	0.392
Thickness of menisci	Anterior one-third	4.951	0.894	0.113	2.750	0.585	0.110	11.89	0.000
	Middle one-third	5.322	0.882	0.112	4.071	0.766	0.144	0.918	0.180
	Posterior one-third	4.193	1.921	0.163	3.000	0.816	0.154	4.494	0.000

TABLE- 4.5.2.2: STATISTICS MEASUREMENTS OF LATERAL MENISCI OF KNEE IN RIGHT SIDED AND LEFT SIDED

C. MORPHOMETRIC RESULTS AND ANATOMICAL VARIATIONS OBSERVED IN THE VARIOUS LIGAMENTS OF KNEE JOINT;

The morphometric knowledge of patella, patellar ligament and their interrelationship can help to orthopedic surgeons for knee arthroplasty procedure. Patellar ligament morphometric knowledge can be of great significant to the surgeons, as patellar tendon graft is choice of graft in anterior and posterior cruciate ligament reconstruction procedure using “Bone-patellar tendon-bone” auto graft harvest. Therefore based on its clinical importance, an attempt was carried out to find out the, morphometric linear measurements including the length, mid-width, thickness in proximal and distal part of patellar ligament of knee. The morphometric analysis of patellar ligament in human cadaveric knee can be well understood by the dissection. Further, focus on the variables such as, side of the limb and gender of the cadaver was considered to evaluate bilateral and sexual dimorphism in cadavers. The results of the study are shown in the table 4.6 and represented in the graph 4.6.1.

4.6 Results of patellar ligament of the knee joint:

MEASUREMENTS (in mm)		RIGHT SIDED (N= 45)			LEFT SIDED (N= 45)				
		Mean	SD	SEM	Mean	SD	SEM	t- value	p-value
Patellar ligament Length		59.82	0.712	0.106	61.93	0.638	0.095	0.196	0.422
Patellar ligament Width		28.33	0.535	0.079	28.95	0.436	0.065	0.647	0.259
Thickness of patellar ligament	Proximal Part	4.044	0.928	0.138	4.400	0.687	0.102	2.064	0.020
	Distal Part	4.222	1.412	0.210	3.977	1.177	0.175	0.891	0.187

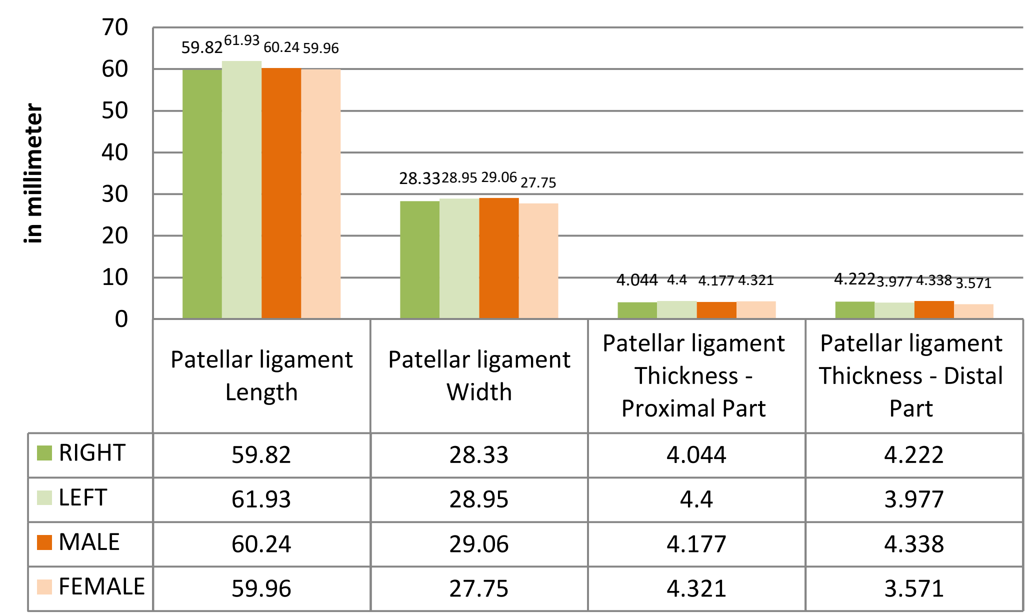
TABLE- 4.6.1: STATISTICS FOR MEASUREMENTS OF PATELLAR LIGAMENT IN RIGHT SIDED AND LEFT SIDED OF KNEE

MEASUREMENTS (in mm)		MALE (N= 62)			FEMALE (N= 28)				
		Mean	SD	SEM	Mean	SD	SEM	t-value	p-value
Length of patellar ligament		60.24	0.625	0.079	59.96	0.614	0.116	0.196	0.422
Width of patellar ligament		29.06	0.455	0.057	27.75	0.549	0.103	1.186	0.119
Thickness of patellar ligament	Proximal Part	4.177	0.820	0.104	4.321	0.862	0.163	0.758	0.225
	Distal Part	4.338	1.447	0.183	3.571	0.634	0.119	2.683	0.04

TABLE- 4.6.2: STATISTICS FOR MEASUREMENTS OF PATELLAR LIGAMENT OF KNEE IN MALES AND FEMALES

The results of morphometric linear measurements of patellar ligament of knee in right sided and left sided, in males and in females were observed as shown in table 4.6.1and 4.6.2 above and the mean values represented below in graph 4.6.1. The difference in means in the variables, right sided, left sided, in males and in females for all the metric parameters was observed to be statistically insignificant.

Graph 4.6: Morphometric linear measurements of patellar ligament of knee in right sided, left sided, in males and females.



4.7 Results of anterior cruciate ligament (ACL) and posterior cruciate ligament(PCL) of the knee Joint:

The cruciate ligaments are responsible for keeping the knee joint stable. Injuries to the cruciate ligaments are common among athletes. Clinically the ACL of knee is the most commonly injured ligament, representing often involved in all knee injuries. Therefore, surgical reconstruction of ACL is essential in injured cases. For reconstruction surgery, it is fundamental to know the thorough anatomy and morphometric measurements of ACL and weather to use it as single bundle or double bundle reconstruction. Henceforth detailed morphometric anatomical knowledge of cruciate ligaments is necessary for the surgical repair of cruciate ligaments which will guide them in determining the appropriate size of the allograft to be utilized in the surgical reconstruction procedure. Therefore, present study aimed to focus on the detailed anatomical knowledge on cruciate ligaments of the knee including the length of ACL and PCL and mid-width of ACL and PCL. Further, focus on the variables such as, side of the limb and gender of the cadaver was considered to evaluate bilateral and sexual dimorphism in cadavers. The results of the study are shown in the table 4.7.1 and 4.7.2 and represented in the graph.

MEASUREMENTS (in mm)	RIGHT SIDED (N= 45)			LEFT SIDED (N= 45)				
	Mean	SD	SEM	Mean	SD	SEM	t- value	p-value
Length of ACL	28.97	0.160	0.023	28.66	0.204	0.030	0.803	0.211
Width of ACL (middle one third)	10.66	0.136	0.020	10.53	0.134	0.020	0.467	0.320
Length of PCL	37.73	0.167	0.024	38.04	0.165	0.024	0.888	0.188
Width of PCL (middle one third)	12.62	0.100	0.015	12.71	0.092	0.013	0.437	0.331

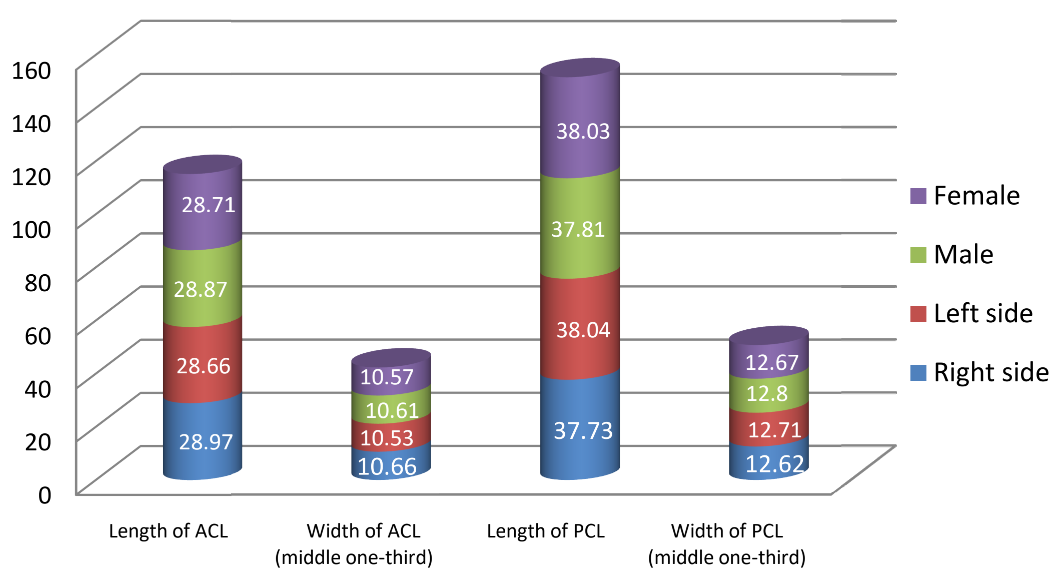
TABLE- 4.7.1: STATISTICS FOR MEASUREMENTS OF ACL & PCL IN RIGHT SIDED AND LEFT SIDED OF KNEE

MEASUREMENTS (in mm)	MALE (N= 62)			FEMALE (N= 28)				
	Mean	SD	SEM	Mean	SD	SEM	t- Value	p-value
Length of ACL	28.87	0.175	0.022	28.71	0.203	0.308	0.373	0.354
Width of ACL (middle one third)	10.61	0.128	0.016	10.57	0.150	0.028	0.134	0.446
Length of PCL	37.81	0.177	0.022	38.03	0.142	0.026	0.565	0.286
Width of PCL (middle one third)	12.80	0.093	0.011	12.67	0.102	0.019	0.078	0.468

TABLE- 4.7.2: STATISTICS FORMEASUREMENTS OF ACL & PCL IN MALES AND FEMALES OF KNEE

The present study included morphometric measurements of the ligament as a whole unit extending from tibial to femoral attachment. The measurements were done in various angle of position of knee flexion and the maximum linear measurements were considered for the result. Any morphometric measurements in the present study were not observed to be statistically significant for the bilateral symmetrical pattern or sexual dimorphism.

Graph 4.7: Morphoetric linear measurements of cruciate ligament of knee in right sided,left sided, in males and females.



4.8 Results on Collateral ligaments of the knee joint:

The architecture of the human knee's medial and lateral aspects exhibits complicated configurations of the joint's static and dynamic stabilizers. The collateral ligaments of the knee are crucial ligaments maintaining the side to side knee joint stability. Both the medial collateral and lateral collateral ligament shows diverse structural characteristics. Clinically, injury to the TCL can be alone or most frequently accompanies to the ACL and medial meniscus with it. While, injury to the FCL is often accompanies injury to the PCL.

4.8.1 Results on Medial collateral ligaments of the knee joint:

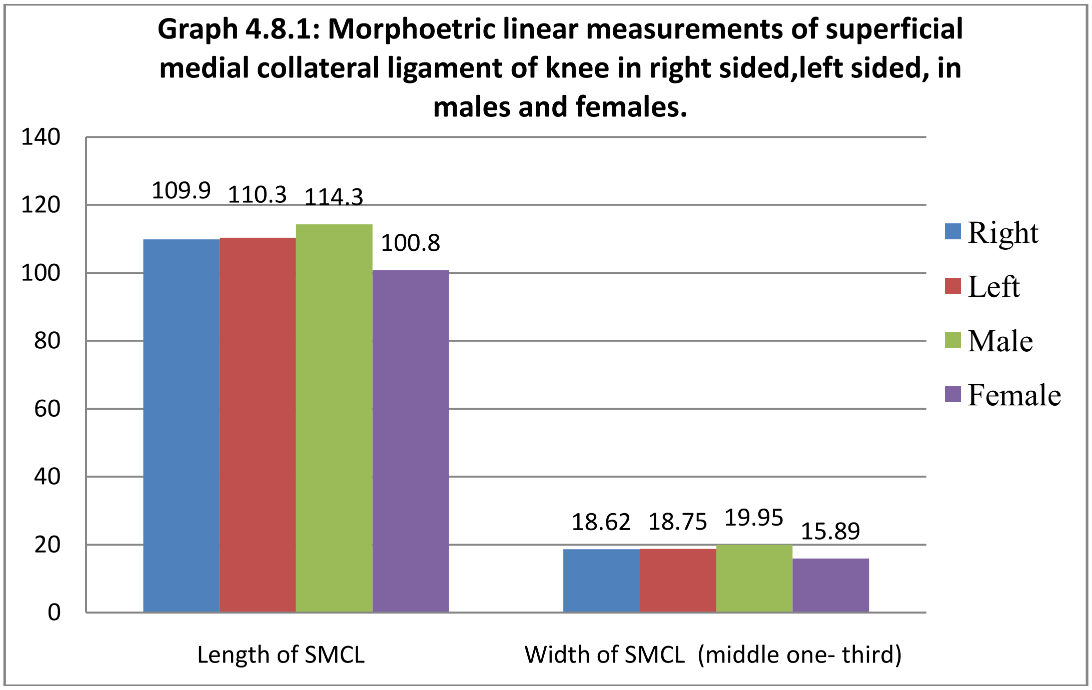
The superficial MCL (SMCL) and the deep MCL (DMCL) are the two parts of the medial collateral ligament (DMCL). Its primary role is to act as a static stabilizer against knee valgus rotation. The MCL must always be partially released during total knee arthroplasty to achieve correct knee alignment. As a result, morphometric understanding of the MCL anatomy is crucial for improving surgical techniques involving the MCL complex. In the present an attempt was made to the record the gross morphometric features of the ligament with emphasis on superficial and deep part including measuring its length from the femoral attachment to the distal tibial attachment and width at width. We observed broad, flat SMCL firmly attached to the medial meniscus in all the specimens. The DMCL consist of the proximal meniscofemoral (MFL) & distal meniscotibial ligament (MTL). Meniscofemoral ligament is longer attaches distal & deep to TCL origin. Meniscotibial ligament is shorter & thicker & attaches distal to tibial cartilage. The data has been listed in the table and graph below. Further, herein an attempt is also made to observe the morphological features and variations in the ligament. We observed the gross morphological variations in one of the specimen and description is considered necessary as it provides a background to understanding the issues to be discussed in the subsequent parts.

MEASUREMENTS (in mm)	Right Sided (N= 45)			Left Sided (N= 45)				
	Mean	SD	SEM	Mean	SD	SEM	t- value	p-value
Length of SMCL	109.9	0.866	0.129	110.3	0.883	0.131	0.240	0.405
Width of SMCL (proximal part)	11.3	0.737	0.219	11.0	0.691	0.701	0.190	0.212
Width of SMCL(middle part)	18.62	3.304	0.492	18.75	2.603	0.388	0.212	0.416
Width of SMCL (distal part)	10.8	0.690	0.699	10.9	0.690	0.700	0.170	0.202
Length of MFL	26.13	2.809	0.418	25.44	1.139	0.169	1.524	0.654
Width of MFL	13.88	2.432	0.362	14.35	2.432	0.362	0.909	0.182
Length of MTL	9.666	2.449	0.365	9.755	2.267	0.338	0.178	0.429
Width of MTL	23.47	3.110	0.321	21.67	2.621	0.554	0.311	0.369

TABLE- 4.8.1.1: STATASTICS FOR MEASUREMENTS OF MEDIAL COLLATERAL LIGAMENTS IN RIGHT SIDED AND LEFT SIDED OF KNEE

MEASUREMENTS (in mm)	Male (N= 62)			Female (N= 28)				
	Mean	SD	SEM	Mean	SD	SEM	t- value	p-value
Length of SMCL	114.3	0.684	0.086	100.8	0.393	0.074	9.658	<0.0001
Width of SMCL (anterior one-third)	11.3	0.737	0.219	9.702	0.420	0.068	8.537	<0.0001
Width of SMCL (middle one-third)	19.95	2.465	0.313	15.89	1.832	0.346	7.783	<0.0001
Width of SMCL (posterior one-third)	11.7	0.793	0.254	10.02	0.425	0.432	8.321	<0.0001
Length of MFL	25.93	2.501	0.317	25.46	1.035	0.195	0.957	0.170
Width of MFL	15.11	2.382	0.302	12.42	1.317	0.248	5.578	<0.0001
Length of MTL	10.37	2.334	0.296	8.321	1.678	0.317	4.177	<0.0001
Width of MTL	20.67	3.124	0.396	14.78	2.587	0.488	8.712	<0.0001

TABLE- 4.8.1.2: STATASTICS FOR MEASUREMENTS OF MEDIAL COLLATERAL LIGAMENTS OF KNEE IN MALES AND FEMALES



The deep medial collateral ligament, according to our findings, is made up of a thickening of the medial joint capsule that is deep and firmly attached to, but separate from, the superficial medial collateral ligament, and has distinct meniscofemoral and meniscotibial components. The distal and deep portions of the meniscofemoral ligament attach to the SMCL's femoral attachment. The meniscotibial component of the superficial medial collateral ligament, which was much shorter and thicker than the meniscofemoral ligament portion, joined only distal to the margin of the medial tibial plateau's articular cartilage. Meniscofemoral and meniscotibial sections of the deep medial collateral ligament have also been reported in other studies. We observed no significant difference between data received from the right and left sides of the knee. But, we observed the strong positive statistical difference between males and females ($p<0.0001$) for the morphometric analysis of MCL. We strongly believe such data will highly useful to the surgeons.

4.8.2 Results on Lateral collateral ligaments of the knee joint:

In our research, we determined that the deep medial collateral ligament is made up of a thickening of the medial joint capsule that is deep and securely attached. The lateral portion of the knee anatomy is complicated, including both static and dynamic stabilizing elements. The anatomic association of the head of fibula, the popliteal tendon, and the biceps femoris muscle has evolved over time, resulting in the intricacy of that architecture. Even though ligaments have a complicated function, their primary duty is to prevent aberrant mobility. In terms of function, the LCL prevents main varus rotation in all positions of knee flexion and ensures side-to-side knee stability.

Lateral collateral ligament injuries are uncommon because the knee is not often subjected to varus force. A varus force damages the ligament, causing the tibia to adduct on the femur. A chunk of bone is commonly used to avulse the ligament from the head of the fibula. As a result, morphometric understanding of the LCL is required, as is the capacity to demonstrate its anatomical diversity using a cadaveric approach. Furthermore, a search for symmetrical variability and gender dispersion has been undertaken. The findings of this investigation are presented in the table below and in the image.

In the present study we observed all fibular collateral ligaments originate from the lateral epicondyle of femur to the head of fibula. The obtained data has been tabulated and graphed below in detail. Furthermore, no any morphological variability in terms of bifurcated, trifurcated ligament or double fibular collateral ligament is observed in any specimen of the present study. In addition, we observe the statistically significant difference between males and females for the length of lateral collateral ligament.

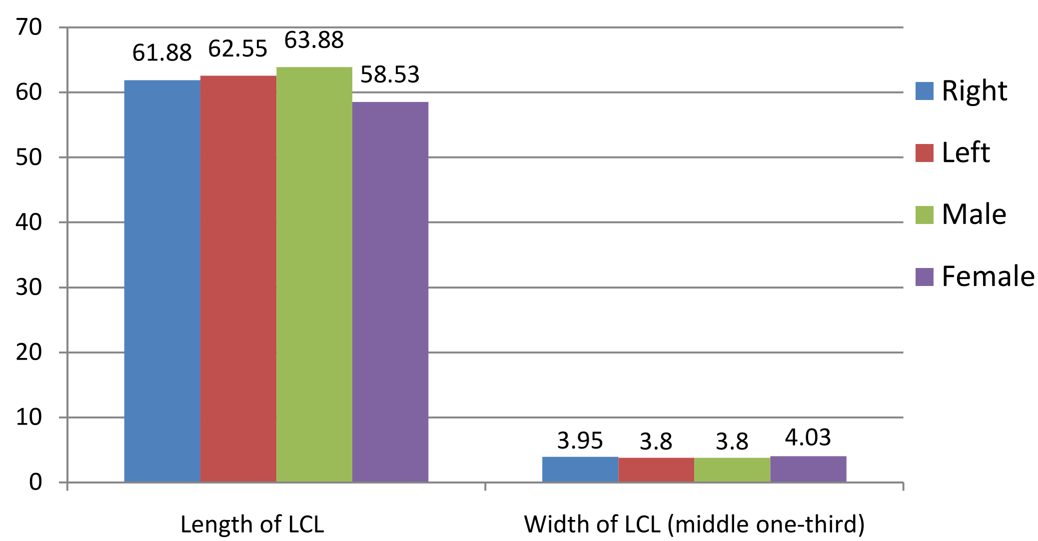
MEASUREMENTS (in mm)	Right Sided (N= 45)			Left Sided (N= 45)				
	Mean	SD	SEM	Mean	SD	SEM	t- value	P -value
Length of LCL	61.88	6.109	0.910	62.55	4.970	0.740	0.567	0.285
Width of LCL (middle one third)	3.950	0.104	0.015	3.800	0.091	0.013	0.750	0.227

TABLE- 4.8.2.1: STATASTICS FOR MEASUREMENTS OF LATERAL COLLATERAL LIGAMENTS OF KNEE IN RIGHT SIDED AND LEFT SIDED OF KNEE

MEASUREMENTS (in mm)	Male (N= 62)			Female (N= 28)				
	Mean	SD	SEM	Mean	SD	SEM	t- value	p-value
Length of LCL	63.88	5.625	0.714	58.53	3.084	0.583	4.714	<0.0001
Width of LCL (middle one third)	3.800	0.088	0.011	4.030	0.117	0.022	1.026	0.153

TABLE- 4.8.2.2: STATASTICS FOR MEASUREMENTS OF LATERAL COLLATERAL LIGAMENTS OF KNEE IN MALES AND FEMALES

Graph 4.8.2: Morphoetric linear measurements of lateral collateral ligament of knee in right sided,left sided, in males and females.



4.9 Results on Transverse ligament of the knee joint:

The transverse or [anterior] meniscomeniscal ligament joins the lateral meniscus's anterior convex border to the medial meniscus's anterior end in the knee joint. The transverse intermeniscal ligament is also known as the transverse geniculate ligament. The transverse ligament is an intracapsular knee ligament that looks like a varied band. It is an anatomical structure that inserts into the menisci's anterior horns. It's placed behind Hoffa's fat pad and can sometimes be seen on lateral plain radiographs of the knee. During the early stages of knee flexion, the ligament limits the medial meniscus's antero-posterior excursion. The anterior horn of the medial meniscus can be torn due to increased tension of this ligament during knee flexion and rotation. During operations such as debridement for tibial tunnel preparation during ACL replacement, the anterior intermeniscal ligament may be jeopardized.

The present study has emphasis on the anatomical study of transverse ligament. An attempt has been made to provide the data listed below in the table and shown in figure; which can be useful to the surgeon.

TRANSVERSE LIGAMENT	Right Sided (N=45)	Left Sided (N=45)	Male (N=62)	Female (N=28)	Total prevalence (N=90)
Presence of transverse ligament	5 (11.11%)	8 (17.77%)	10 (16.12%)	3 (10.71%)	77 (85.55%)
Absence of transverse ligament	40 (88.88%)	37 (82.22%)	52 (83.87%)	25 (89.28%)	13 (14.44%)

TABLE - 4.9.1: SHOWING PREVALENCE OF PRESENCE OF TRANSVERSE (INTER-MENISCAL) LIGAMENT OF KNEE IN RIGHT SIDED, LEFT SIDED, IN MALES AND IN FEMALES

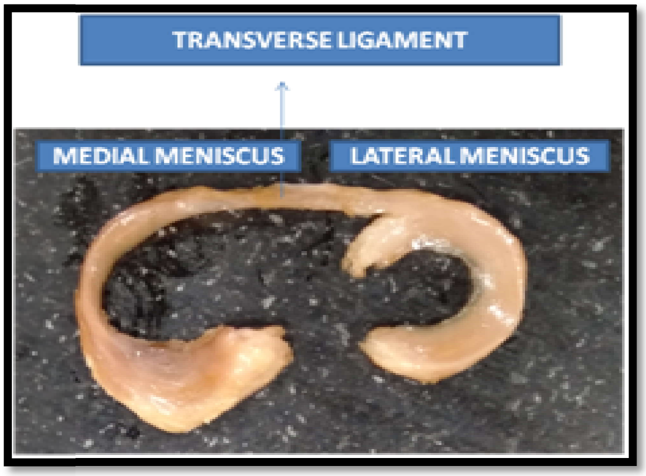
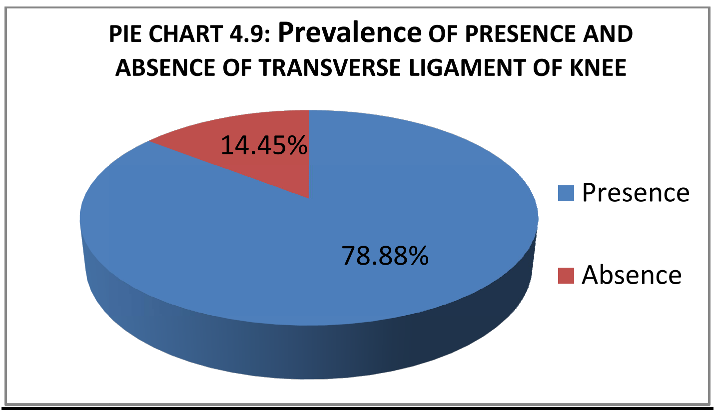


Figure 4.4: Showing transverse ligament of knee joint.



TRANSVERSE LIGAMENT	LENGTH (in mm)		WIDTH (in mm)	
	Right Sided	Left Sided	Right sided	Left sided
Maximum	46.00	43.00	7.000	7.000
Minimum	22.00	24.00	2.000	2.000
Mean	34.25	33.64	4.2.00	3.722
Mode	26.00	39.00	2.000	2.000
SD	7.417	5.648	1.800	1.578
SEM	1.172	0.928	0.284	0.263
t-value	0.397		1.222	
p-value	0.345		0.112	

TABLE- 4.9.2: SHOWING MORPHOMETRIC MEASUREMENTS AND STATISTICAL ANALYSIS OF TRANSVERSE LIGAMENT OF KNEE

4.10 Results on Oblique popliteal ligament of the knee joint:

The oblique popliteal ligament (OPL) is one of the semimembranosus muscle's five insertions and is part of the knee's posterior architecture. This ligament runs from medial to lateral across the popliteal fossa and is thought to be the primary limiting genu recurvatum, preventing hyperextension of the knee. Hyperextension can affect gait and make walking on uneven surfaces harder. Despite the importance of the posterior structures of the knee, including the OPL, few researches have focused on them in the literature because there are no techniques available for their appropriate anatomical and surgical description, as well as reconstruction.

One of the five insertions of the popliteal ligament is the oblique popliteal ligament (OPL). The OPL is a structure that begins from the semimembranosus muscle's tendon and inserts in the posterior capsule of the knee with the lateral condyle, according to the findings of the current study. The OPL is a thick semimembranosus ligament. Below table shows the data observed for the mean length and mean width of oblique popliteal ligament. We further aim to study the ligament in future.

VARIABLES	OBLIQUE POPLITEAL LIGAMENT	
	LENGTH (in mm)	WIDTH (in mm)
Right	36.5	16
Left	35.9	18
Male	37.5	21
Female	33.4	17

TABLE 4.10: SHOWING MORPHOMETRIC ANALYSIS OF OBLIQUE POPLITEAL LIGAMENT

Results on variations observed in relations to the knee Joint:

4.11. Variations related to the Os fabella of knee:

The location of the fabella, under the proximal part of the gastrocnemius muscle tendon, the arcuate ligament, and the oblique popliteal and fabellofibular ligaments, as well as confluent biomechanics forces and treatment options, make the posterolateral corner of the knee a region with complex anatomy. The fabella is a tiny sesamoid bone of the knee that is found on the posterolateral side of the knee. It forms in the lateral head of the gastrocnemius muscle's tendon. The fabella is a cartilaginous or osseous structure. It articulates with the lateral femoral condyle and may aid in knee joint stability. It accounts for 10–30% of the population, and its magnitude can be estimated.

The fabella is commonly observed in everyday life and is considered a natural anatomical variation in humans. Several mammals, including dogs, cats, and rabbits, have it in their gastrocnemius muscles. In evolutionary terms, the fabella appears to disappear during the transition from quadripedal to bipedal posture, because standing demands more stability and less rotation. As a result, the fabella is missing in humans and is characterized as a phylogenetically retrogressive anatomical feature that lost its function with the human upright posture.

Furthermore, the sesamoid bones have the ability to vary pressure, reduce friction, and therefore protect tendons, change the direction of muscle pull, and help muscular motions. The prevalence of the fabella in different ethnic groups was assessed using radiography, MRI, or cadaver dissection, and the results showed a lot of variation. As a result, we investigated the prevalence, symmetry pattern, and gender differences in the current study's cadaveric sample.

The followings are the variations we observed in relation to the fabella bone in the present study:

- Total prevalence of presence of os fabella was observed in the 24(26.66%) specimens of cadaveric knee.
- The total prevalence of presence of os fabella was observed in the 14(15.55%) specimens on right sided and in 10 (11.11%) specimens on left sided out of respectively forty-five cadaveric knees.
- In males total prevalence of presence of os fabella was measured in the 17 (18.88%) specimens out of sixty-two cadaveric knee. In females total prevalence of presence of fabella was observed in 7 (7.77%) specimens out of twenty eight cadaveric knees.
- The total prevalence of absence of os fabella was observed in 66(73.34%) specimens of cadaveric knee.
- The total prevalence of absence of os fabella was observed in the 31(34.43%) specimens on right sided and in 35 (38.88%) specimens on left sided out of respectively forty-five cadaveric knees.
- In males total prevalence of absence of os fabella was measured in the 45 (45.99%) specimens out of sixty-two cadaveric knee. In females total prevalence of presence of fabella was observed in 21 (23.34%) specimens out of twenty eight cadaveric knees.
- The total number of prevalence of os fabella for symmetrical pattern was observed unilaterally in 8(8.88%) specimen and bilaterally in 16(17.77%) specimens. In addition, the unilateral: bilateral ratio for prevalence of 0s fabella was observed 1:2.
- The morphometric measurement of os fabella has a wide scope in the study as very few literatures are available as per our record. We observed total mean length of Os fabella was measured 19.22mm, on right sided measured 18.66mm and 22.46mm on and left sided respectively.
- The total mean width of os fabella was measured 12.95mm, on right sided measured 11.80mm and 11.20mm on left sided respectively.

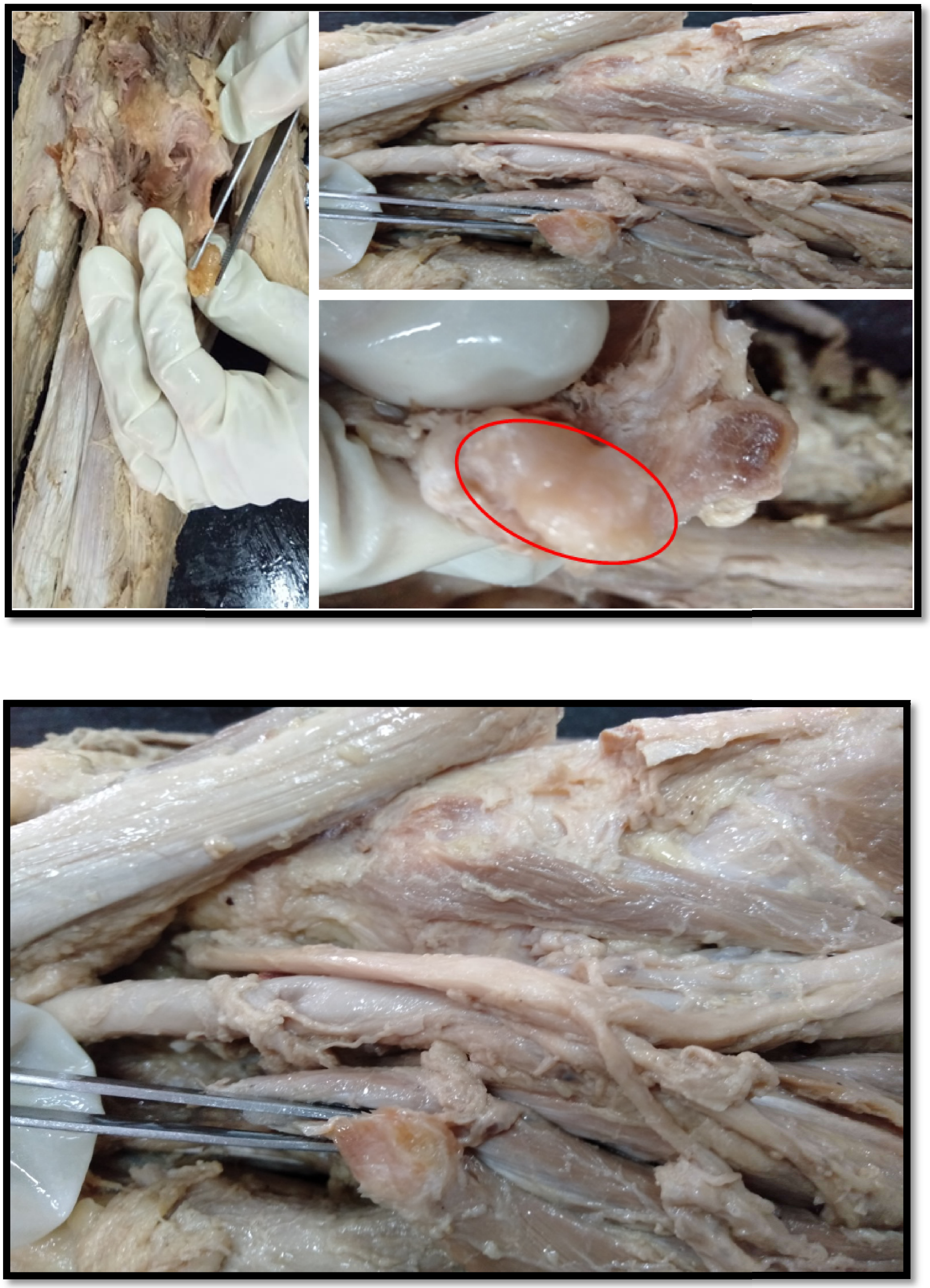


Figure 4.5: Showing various os fabella in present study.

4.12 Variations related to the plantaris muscle:

The plantaris muscle belongs to the flexor group of lower leg muscles. It arises from the oblique popliteal ligament and the lower half of the lateral supracondylar line. The muscular belly is fusiform in shape, and it finishes in a long, slender tendon that runs obliquely between the gastrocnemius and soleus muscles, fusing or inserting with them. The flexor retinaculum and the superficial fascia of the leg have also been documented to fuse with the muscle. The muscle's fusiform belly features a long, narrow tendon that can be mistaken for a nerve. The plantaris muscle tendon frequently unites superficially with the fascia of the leg, making it prone to damage. Prior knowledge of superficial position of the tendon and its resemblance to a nerve should be well known to the surgeon operating on the back of leg.

The present study observed variations in relations to the plantaris muscle and the following are the results:

- Plantaris muscle was present in all the cadaveric specimens.(The plantaris muscle is absent in 10% of limbs).
- It is a vestigial muscle. The muscle belly was observed small and fusiform in the shape and it was ending as a long slender tendon in all the specimens.
- No case with absence of plantaris was observed.
- The muscle arises from the lower part of lateral supracondylar line of femur and oblique popliteal ligament, tendon runs obliquely inferomedially between gastrocnemius and soleus, and inserts in a calcaneus medial to the tendocalcaneus in all the specimen.
- The plantaris muscle was innervated by the tibial nerve in all the specimens.

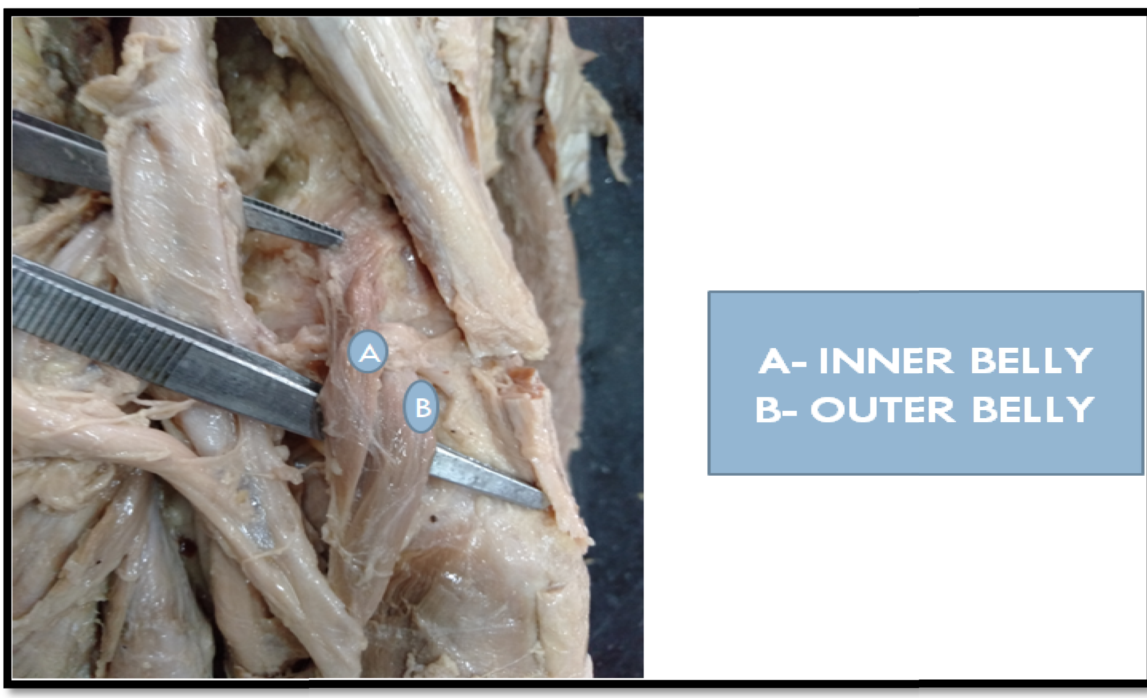


Figure 4.6: Showing rare variation of unilateral double headed plantaris muscle in present study.

- The mean length of belly of plantaris muscle was measured 8.3cm ranges from 5.5cm-8.6cm.
- The mean width of belly of plantaris muscle was measured 1.8cm ranges from 1.3cm - 1.9cm.
- The mean length of tendon of plantaris muscle was measured 24.46cm ranges from 22.2cm-27.4cm.
- The plantaris muscle tendon ratio was observed 1:3.3.
- The mean width of tendon of plantaris muscle was measured 0.6cm ranges from 0.3cm-0.8cm.
- A rare anatomical variation of unilateral double headed plantaris muscle was observed in cadavers in one of right sided of knee joint and showed prevalence of 1.11% in present study.
- Unilateral double headed plantaris muscle was found in one of right sided of knee joint. (1.11%). It has reported to be present with inner belly (A) and outer belly (B) of plantaris muscle.
- The inner belly of plantaris muscle (A) arises from the lower part of lateral supracondylar ridge of the femur and measured in the length and the width 6.6cm and 1.6cm. The outer belly of the plantaris muscle (B) was arises from the lower part of lateral supracondylar ridge above the origin of lateral head of gastrocnemius muscle and measured in length and width 8.1cm and 1.3cm respectively. The tendon is attached independently on superior surface of the calcaneus on the medial to the tendocalcaneus. The tendon was measured 29.46cm in length and 0.9cm in width.
- There are several tendons that can be used as tendon grafts in secondary flexor tendon injury restoration, including the extensor digitorum longus tendon, Palmaris longus tendon, and the plantaris tendon, which has been used effectively for over sixty years. Because of its length, shape, and size, as well as the bone stock adequate for robust phalanx anchoring, the tendo-osseous plantaris graft is a potential option for secondary flexor tendon repair.

4.13 Variations related to the Pes anserinus of knee:

Pes anserinus (PA) includes conjoined tendinous insertion of Sartorius, Gracilis, and Semitendinosus muscle. Each tendon can have individual insertions attached nearly in a linear arrangement. Presence of accessory tendons, bands and structures constituting in forming PA shows high variability and have reported clinical importance in harvesting PA graft and tendon reconstruction procedures. While doing the dissection in the knee region, the author observed different variations in the insertion pattern of tendons on the anteromedial aspect of the knee including Sartorius (S), Gracilis (G), and semitendinosus (ST). Upon dissection, Pes anserinus tendons were exposed carefully and dissected to identify for any anatomical and morphological variations. Therefore, in the present study the insertion site was macroscopically observed. The data was analyzed for several variations in the disposition of the tendons. The tendon of muscles, ligaments and accessory band taking participation in the constitution of each pes anserinus were analyzed.

The followings are the variations we observed in relation to the fabella bone in the present study:

I. **Anatomical and morphological analysis for the structures constituting in the insertion of the Pes anserinus**

The commonest and most frequent constituency is observed with S/G/ST. The other variant in pes anserinus formation was observed as participation from the semimembranosus muscle, Tibial collateral ligament, accessory band of sartorius and various accessory bands of semitendinosus muscle. The participation of accessory band of semitendinosus as S/G/ST/aST pattern is observed as a most frequent variation. The other pattern which is observed are S/G/ST/SM pattern, S/G/ST/SM/MCL, S/G/ST/aST pattern, S/G/ST/aS, S/G/ST/aS/aST and S/G/ST/aST/abST. In addition, an accessory band of Gracilis was not observed in any of specimen of cadaver in the present study. The detailed contribution is depicted in table:

Pes anserinus formed by	Pattern present in total no. of Specimens	Percentage (%)
Monotendinous- Sartorius, Gracilis, Semitendinosus (S/G/ST pattern)	67	74.44%
Monotendinous- Sartorius, Gracilis, Semitendinosus, Semimembranosus (S/G/ST/SM pattern)	5	5.55%
Sartorius, Gracilis, Semitendinosus, Semimembranosus, medial collateral ligament (S/G/ST/SM/MCL pattern)	2	2.22%
S/G/ST/aST	12	13.33%
S/G/ST/ aS	2	2.22%
S/G/ST/ aS/ aST	1	1.11%
S/G/ST/ aST/ abST	1	1.11%

TABLE- 4.13.1: SHOWING TOTAL NO. OF SPECIMENS AND PERCENTAGE OF INDIVIDUAL PATTERN INVOLVED IN CONSTITUENT OF INSERTION OF PES ANSERINUS

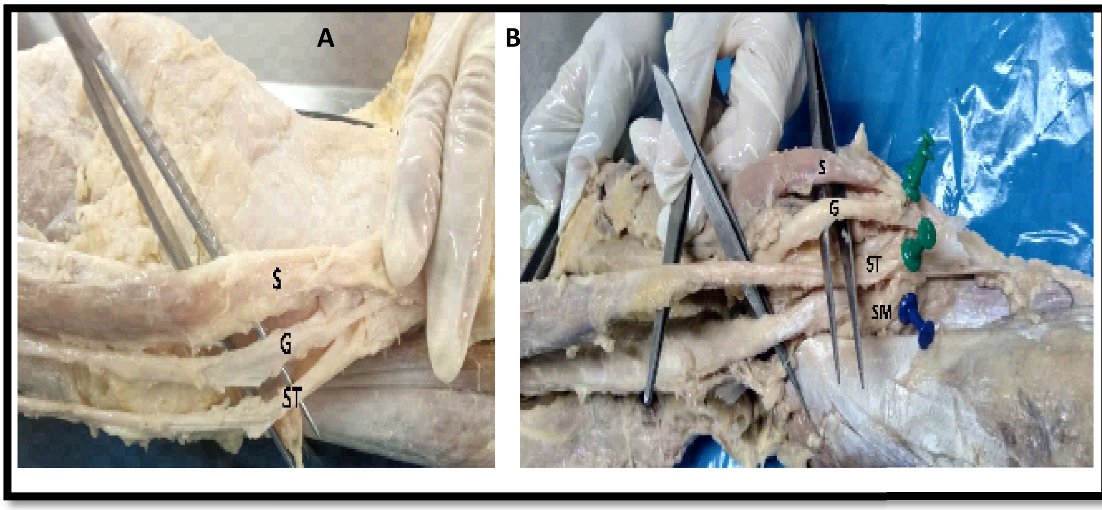


Figure 4.7: A. Showing most frequent constituent of pes anserinus with mono-tendinous tendons of Sartorius(S), Gracilis (G), and Semitendinosus (ST), muscle forming (S/G/ST) pattern. B. Showing tendon of Semimembranosus muscle (SM) taking participation in the constituent of pes anserinus forming S/G/ST/SM pattern.

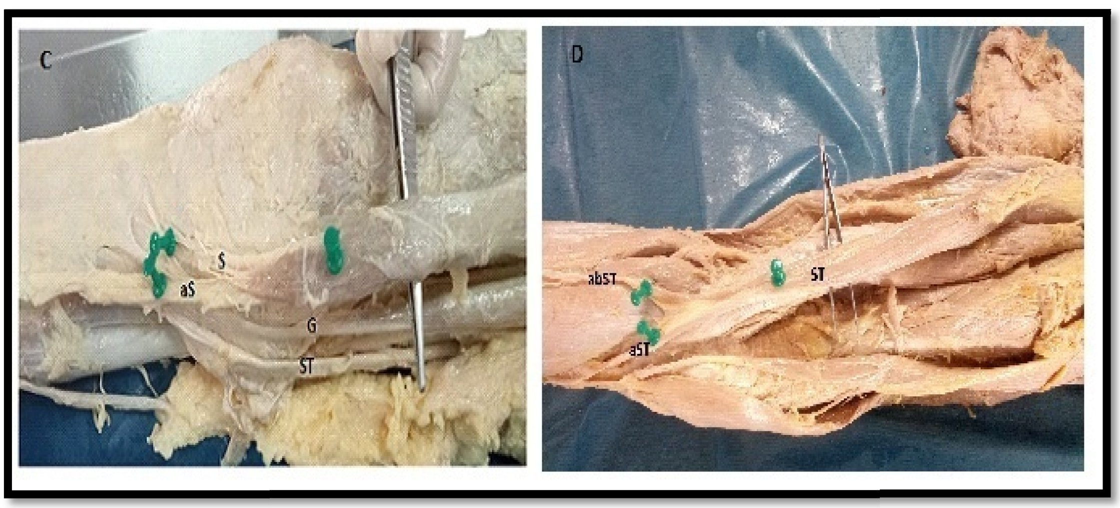
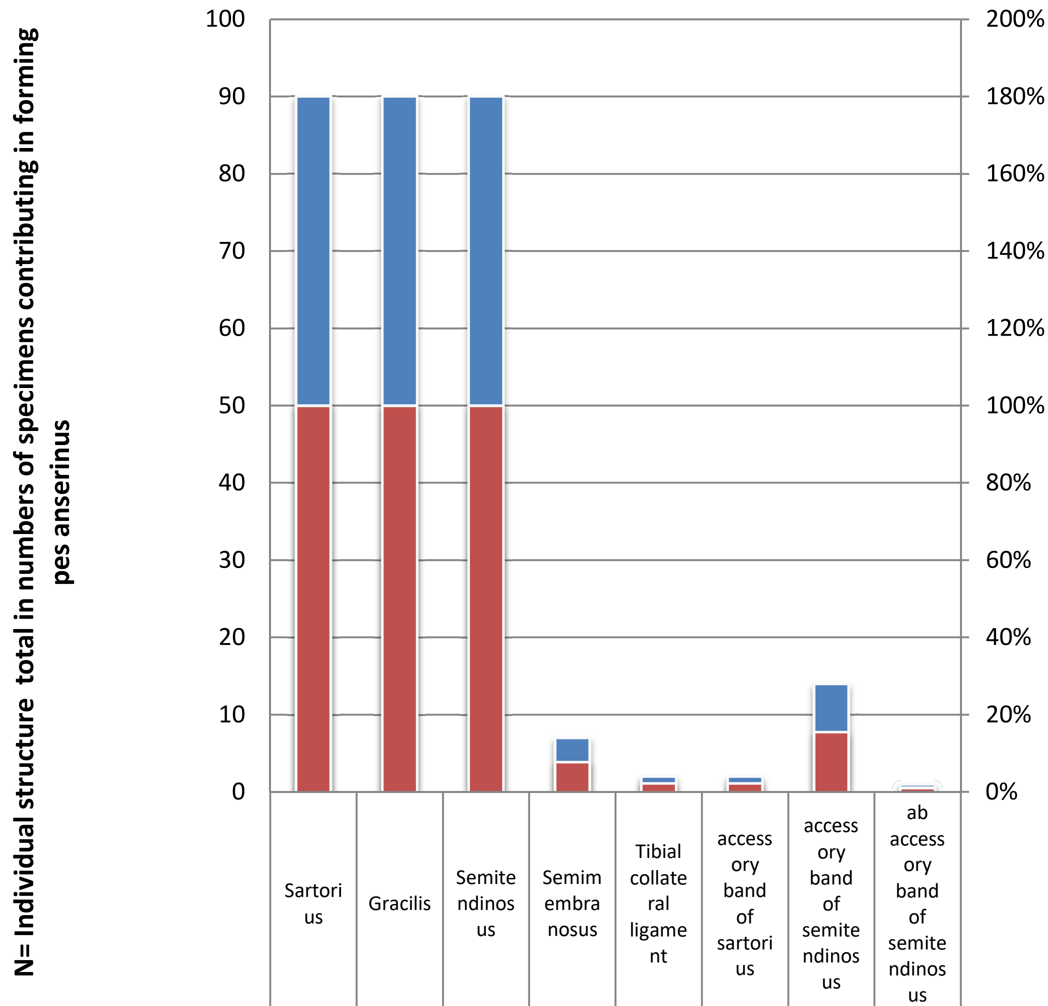


Figure 4.8: C. Showing accessory band of sartorius tendon taking participation in the constituent of pes anserinus forming S/G/ST/Sa pattern. D. Showing accessory bands of semitendinosus taking participation in the constituent of pes anserinus forming S/G/ST/aST/abST pattern.

Graph 4.13: Showing various individual structures in numbers and percentag e contributing in forming pes anserinus



	Sartorius	Gracilis	Semitendinosus	Semimembranosus	Tibial collateral ligament	accessory band of sartorius	accessory band of semitendinosus	ab accessory band of semitendinosus
N= number of specimens	90	90	90	7	2	2	14	1
Percentage(%)	100%	100%	100%	7.77%	2.22%	2.22%	15.55%	1.11%

II. Anatomical and morphological analysis for the Convergence pattern of Pes anserinus

A. Early convergent: When the tendons unite to form the pes anserinus, which is located above the medial tibial condyle.

B. Late convergent: When the tendons unite to form the pes anserinus, which is located below to the medial tibial condyle (most frequent).

C. Non-convergent/ Divergent: Each constituting tendon attached as separate unit on the tibia. When it has side-by-side termination pattern.

Convergent pattern of Pes anserinus	Pattern present in total no. of Specimens	Percentage (%)
Late Convergent	73	81.11%
Early convergent	10	11.11%
Non convergent(divergent)	**7**	8.64%

TABLE- 4.13.2: SHOWING TOTAL NO. OF SPECIMENS AND PERCENTAGE OF VARIOUS CONVERGENT PATTERN OF PES ANSERINUS

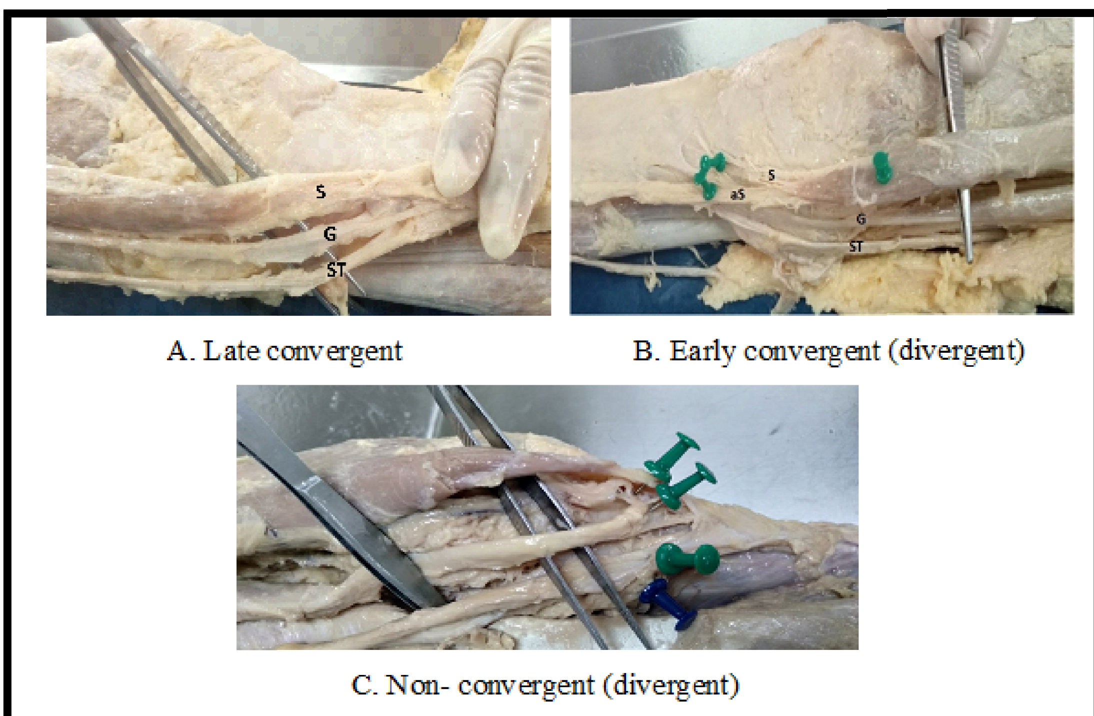


Figure 4.9: Showing various convergent patterns of Pes anserinus

III. The frequency of site of insertion of the pes anserinus:

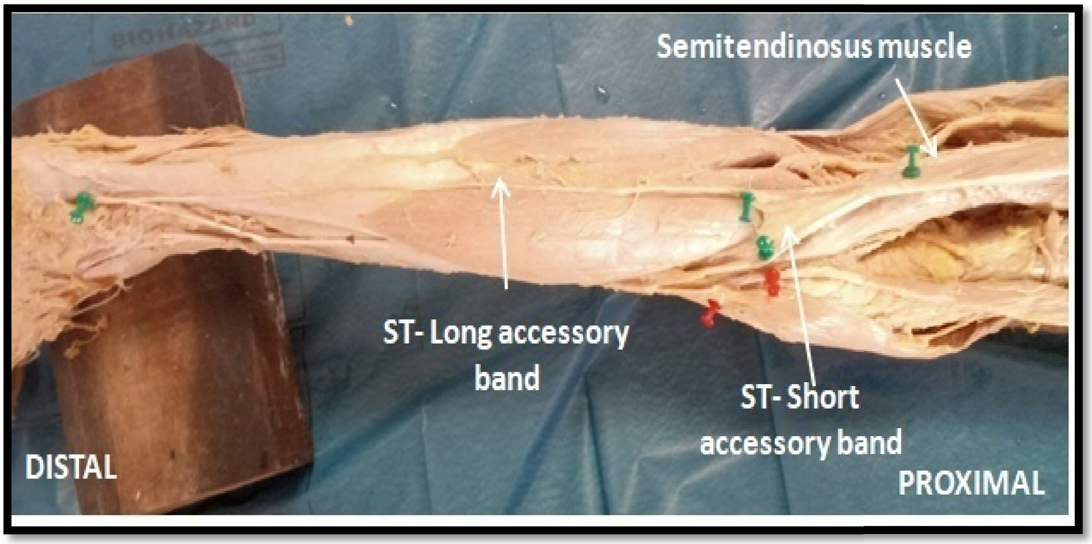
The attachment of the pes anserinus is observed to be on both the superior anteromedial tibia and medial border of tibia. In occasions pes anserinus it is attached to the trio; superior anteromedial tibia + medial border of tibia + fascia cruris. It may be attached to the medial collateral ligament and ligamentum patellae. In the present study we observed the relation of pes anserinus to plantar aponeurosis. This description is considered necessary as it provides a background to understanding the issues to be discussed in the succeeding parts. In most of the specimen we observed the superomedial aspect of the tibia. Nevertheless, did not attach to the superior anteromedial tibia only we observed many variations and the frequency of site of insertion of pes anserinus is attached in the present has been shown in the below table.

Convergent pattern of Pes anserinus	Pattern present in total no. of Specimens	Percentage (%)
Superomedial aspect of tibia	75	83.33%
Fascia cruris	8	8.88%
Both tibia and Fascia cruris	5	5.55%
Medial collateral ligament	1	1.11%
Ligamentum Patellae	0	0.00%
Plantar aponeurosis	1	1.11%

TABLE- 4.13.3: SHOWING FREQUENCY OF SITE OF INSERTION OF PES ANSERINUS

4.14 Variation related to the semitendinosus muscle of the knee:

- Semitendinosus is a hamstring muscle located on the posteromedial side of the thigh. It arises from the inferomedial aspect of the ischial tuberosity and the long head of the biceps femoris tendon, and has a long tendinous insertion at the anteromedial part of the tibia, posterior to the Gracilis muscle. In anterior cruciate ligament restoration surgery, the Semitendinosus and Gracilis tendons are routinely used for grafting. The goal of this study was to demonstrate a rare occurrence of an unique accessory band and aberrant semitendinosus muscle insertion in a human corpse.
- A rare case of an unusual accessory band and anomalous insertion of semitendinosus muscle in the human cadaver. The data was analyzed, photographed and recorded. The length and width were measured using digital vernier caliper and measuring tape.
- An unusual accessory bands of semitendinosus muscle in cadaver. The first long accessory band was observed in back of leg, and the short second accessory band arises from common muscle belly of ST shown in below image.
- The long accessory band was measured 46.6cm in length from the common muscular insertion and the width was measured as 0.4mm. The short accessory band measured with length of 19.2cm and width 8.0mm.
- The long accessory band was inserted into the tendocalcaneus along with plantaris muscle.
- The short accessory band was observed to be inserted into the crura of leg.



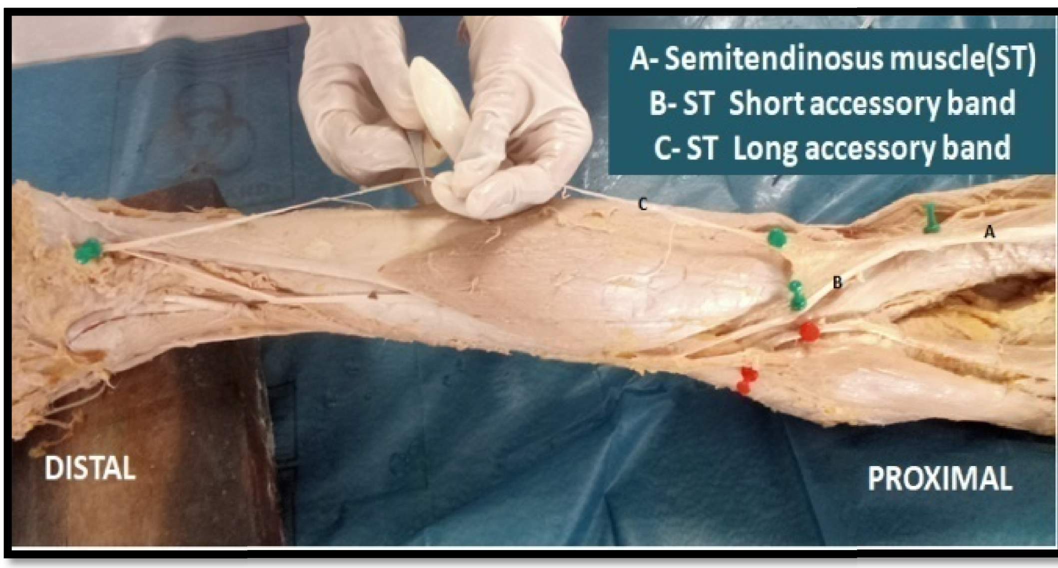


Figure 4.10: Showing rare variation semitendinosus muscle inserting in planter aponeurosis.

The current study focuses on how operating surgeons can use knowledge of uncommon anatomical variations of the semitendinosus muscle to avoid complications during operations such as transplant surgeries and graft harvesting during reconstructive surgeries to conduct efficient surgical procedures. Furthermore, orthopedic and plastic surgeons can benefit from this knowledge because the gracilis and semitendinosus tendons are regularly removed for anterior cruciate ligament (ACL) tendon restoration procedures.