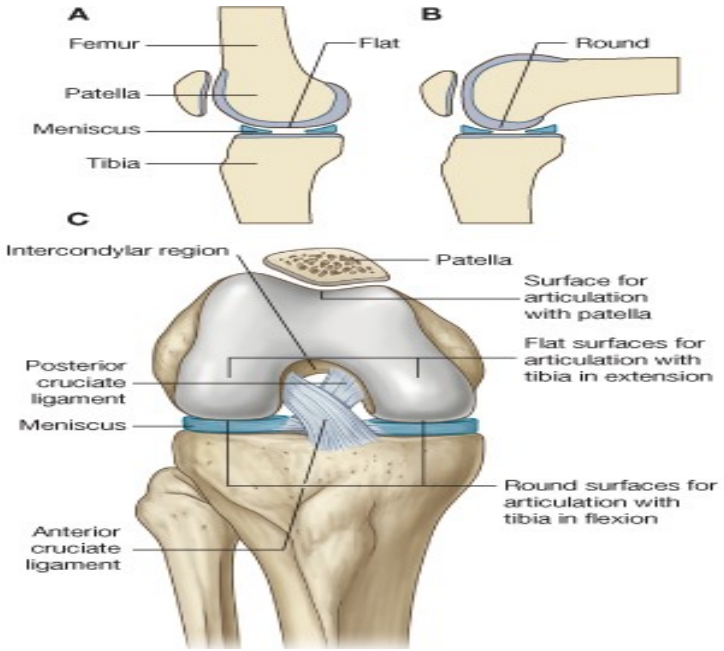
STUDY TITLE: "A CADAVERIC EVALUATION AND MORPHOMETRIC ANALYSIS OF KNEE JOINT WITH ITS CLINICAL IMPLICATIONS"

1. INTRODUCTION:

Walking on the two limbs for locomotion in the search of food have places centre of mass over the foot. In the need of developing an erect posture and maintaining our upright torso, which have caused relative changes in musculature of limb. It has offer a fulcrum for the powerful extensor and flexor muscles that act on the joint during propulsion. Many numbers of stabilizing factors counter the biomechanical demands which are imposed upon the joint; inclusive major demands on knee joint. Furthermore the presence of complex arrangement of intra capsular and extra capsular ligaments and dynamic muscular stabilizers have necessitates the interest in understanding of anatomy of the knee joint significantly.

The knee is the largest & most complex synovial joint in the body. It is consists of three distinct joints which includes patella-femoral joint, medial tibio-femoral joint & lateral tibio-femoral joint. The joint is partially separated by compartments which collectively forms functionally a complex 'hinge' joint & structurally compound, complex & condylar variety of synovial joint. The tibial condyles are very small and shallow to accommodate and hold the large, convex, femoral condyles in place. While, the patellofemoral articulation has shallow articular surfaces and because of the outward angulations between the long axis of the thigh and of the leg it is also quite insecure.

The stability of the joint is provided by the menisci, joint stability is heavily dependent and maintained by a number of factors:
(1) The factors strengthening the capsule of knee joint.
(2) The tibiofemoral articulation of the human knee joint is stabilized from either side by medial and lateral collateral ligaments.
(3) The cruciate ligaments maintain antero-posterior stability.



1.1 FUNCTIONS OF KNEE JOINT

Anatomy of the knee joint is variable and the only constant is it's the complex function. Functional complexity has results in the anatomical play among the bony structure as patella, femur, tibia, fibula along with joint, muscles, ligaments, tendons and other structures present in surrounding to it.

There are only few anatomical structures that are solely responsible for one specific function. Generally, each function of the knee is the result of a complex team work of several anatomical structures together. The knee joint in human body functions as:

- The knee carries a large portion of our body weight, in our daily activities.
- The knee allows a wide range of motion for flexion–extension and internal rotation – external rotation.

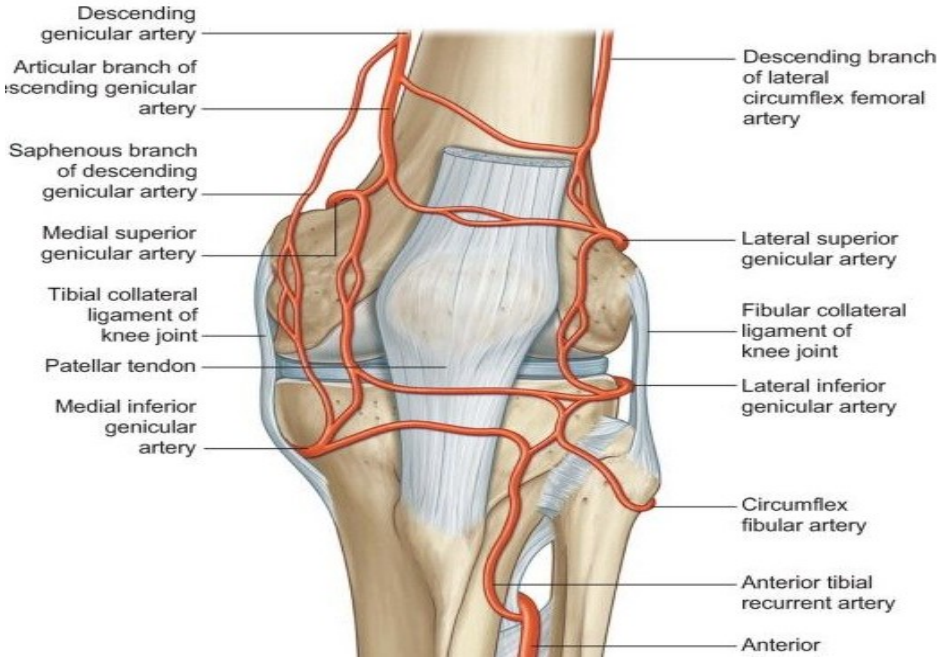
During the evolution of mankind, the knee has been optimally adapted to the forces and loads acting at and through the knee joint.

1.2 STRUCTURE OF KNEE JOINT

1.2.1 SKIN AND SOFT TISSUE

SKIN

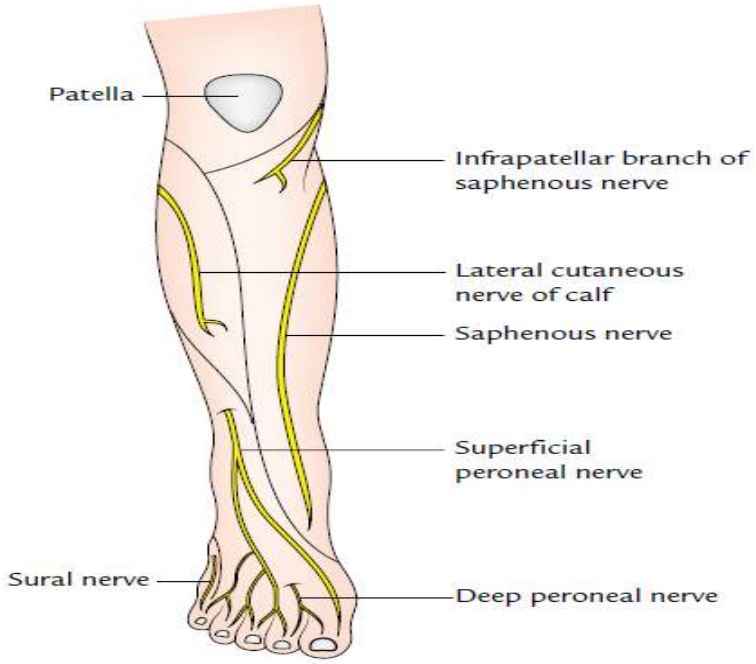
Cutaneous vascular supply:
The arterial supply of the skin covering the knee is from the cutaneous branches from the neighboring large vessels which include genicular branches of the popliteal artery, the descending genicular branch of the femoral artery, and the anterior recurrent branch of the anterior tibial artery and small contributions is from the arteries to vastus medialis and the hamstrings.



Cutaneous veins are tributaries of the vessels that correspond to the named arteries.

Cutaneous lymphatic drainage of knee:
Cutaneous lymphatic drainage is initially to the superficial inguinal nodes, and possibly also to the popliteal nodes and thence to the deep inguinal group of lymph nodes.

Cutaneous innervations:
Skin over the knee is supplied by Infrapatellar branch of the saphenous nerve. It reaches the anterior aspect of the knee from the medial side.



Peripatellar plexus:
Over and around the patella lies subcutaneous network of communicating nerve fibres known as peripatellar plexus. Proximal to the knee, the infrapatellar branch of the saphenous nerve connects with branches of the medial and intermediate femoral cutaneous nerves, and lateral femoral cutaneous nerve. Distal to the knee it connects with other branches of the saphenous nerve.

SOFT TISSUE
Soft tissues around knee plays very important & key role in stabilizing the joint which includes superficial fascia, deep fascia, surrounding ligaments & muscles. These structures are components of popliteal fossa as well.

LIGAMENTS RELATED TO KNEE JOINT:

Ligaments of the knee joint are-
1. Capsular ligament with synovial membrane.
2. Ligamentum patellae
3. Tibial and Fibular collateral ligament
4. Anterior and posterior cruciate ligament
5. Medial & lateral menisci
6. Oblique popliteal ligament
7. Transverse ligament, coronary ligament, menisco-femoral ligament
8. Arcuate popliteal ligament

Ligaments of the knee surrounding to it maintains static stability of the joint & plays important role in the biomechanics of knee joint. These ligaments are:

JOINT CAPSULE

Given the incongruence of the knee joint, even with the improvements provided by the menisci, joint stability is heavily dependent on the surrounding joint structures. The delicate balance between stability and mobility varies as the knee is flexed from full extension toward increased flexion. Bony congruence and overall ligament tautness are maximal in full extension, representing the close-packed position of the knee joint. In knee flexion, the periarticular passive structures tend to be lax, and the relative bony incongruence of the joint permits greater anterior and posterior translations, as well as rotation of the tibia beneath the femur.

LIGAMENTUM PATELLAE

It is the tendinous insertion of quadriceps femoris, which extends from the apex of the patella to the upper part of the tibial tuberosity. It is approximately 7.5 cm long and 2.5 cm broad. It is attached above to the margins and rough posterior surface of the apex of patella, and below it is attached to the smooth upper part of tibial tuberosity. It is related to the subcutaneous and deep infrapatellar bursae, and infrapatellar pad of fat.

ANTERIOR & POSTERIOR CRUCIATE LUGAMENT

The anterior cruciate ligament (ACL) and posterior cruciate ligament are one of the major knee structures. ACL consists of anteromedial bundle (AMB) and posterolateral bundle (PLB). The cruciate ligaments are intracapsular but extrasynovial. Cruciate ligaments are two thick, strong fibrous bands, which act as direct bonds of union between the femur and tibia. The ligaments cross each other like the letter “X” hence the name cruciate. They represent the collateral ligaments of the primitive femorotibial joints. It maintains anteroposterior stability of the knee joint & named anterior and posterior according to its site of attachment to the tibia.

MENISCI

The menisci of the knee joint are crescent shaped fibro-cartilaginous discs, important functional units to improve joint congruence and load distribution, thereby reducing the stress on the knee joint, its function is considered primordial to protect the articular cartilage and to prevent osteoarthritis.

COLLATERAL LIGAMENT

The collateral ligaments are strong and cord like structure; it provides side to side stability to the knee joint. We aim to characterize the role of anatomical knowledge of morphometric and morphological analysis of knee joint and its clinical significance for various approaches in the surgeries of knee.

2. AIMS & OBJECTIVES OF STUDY:

The Knee joint have always been a subject of interest to the medical professional & to the research scientist as it is one of the most commonly involved joint in many common pathological & degenerative disorders affecting to the population of world wide. The current scenario of medical, surgical and rehabilitation management of knee joint have laid the interest in studying the knee joint in cadavers. Present cadaveric study of the knee joint will significantly aids and opens up the more information to the current available literature and will certainly help this knowledge to the orthopedic surgeon, General surgeon, plastic surgeon, Radiologists Anatomist, physical therapist & to the research aspirants. Awareness might help to the surgeons, sports physicians & physiotherapists in identifying and treating injuries of knee joint.

The morphometric data of ligaments will play crucial role in selecting the quantity of graft for surgical repair of damaged ligaments during its reconstruction. Hence, the purpose of this study is to establish the anatomical knowledge of knee joint which may help in important clinical implications.

Primary objectives of the present work are:

1. To measure the morphometry of articular surfaces of the bones contributing in forming knee joint in cadavers.
2. To measure the morphometry of ligaments of cadaveric knee joint.
3. To evaluate any morphological variations in bones or any structures related to the knee joint.
4. To evaluate the anatomical variations in any structure related & surroundings to the knee joint.

3. RESEARCH METHODOLOGY:

3.1. DATA COLLECTION PROCEDURE:

This was an observational study carried out after obtaining approval from ethics committee Medical College Baroda, Gujarat. Ninety properly embalmed and formalin fixed lower limb of adult cadavers (62 males and 28 females) were selected for the study. All the available specimens, did not have any visible external abnormalities in their lower limb were included. Any cadavers with previously operated in lower limb knee region, established osteoarthritic changes to knee, signs of patellofemoral disease, physical signs of deformity of patella which may prevent the morphometric analysis were excluded from the study. Dissection was done under the guidance and supervision and observations were made after dissecting the cadavers.

3.2 DATA COLLECTION METHODOLOGY:

Initially the skin and soft tissue surrounding the joint was removed carefully, for freeing the muscles, fat was cleaned properly. The patella and patellar tendon was exposed meticulously. The patellar and patellar ligament morphometric linear measurements were taken and recorded. Soft tissues surrounding the joint were cleaned properly to expose ligaments and capsule of the knee joint. The patella was pulled down along with its ligament, collateral ligaments was identified, cleaned properly and studied well. Cut made on one side for better view of the cruciate ligaments. The capsule was removed from the posterior aspect of knee, ACL and PCL was identified and morphometric analysis was done. The femoral and tibial attachment of cruciate ligaments needs to be cut very close to the bone with the help of a scalpel. Menisci were identified and measured for the maximum length, thickness and width (at anterior1/3rd, middle 1/3rd, Posterior1/3rd). Menisco femoral ligaments and menisco-tibial ligaments were dissected and exposed. All their attachments, length and mid width measurements was noted. Other measurements of knee joints, including articular surfaces on lower end of femur, upper end of tibia, and patellar articular surfaces was recorded with the help of digital vernier caliper and thread. Any morphological and morphometric variations related to any soft tissue, muscles, ligaments and bones related to knee joint were observed and recorded. All the collected data was statistically analyzed by using Statistical product and Service Solution (SPSS).

3.3 DATA ANALYSIS:-

The data was measured by using digital vernier caliper in millimeters (mm). It shows mean, SD (SD), t-value and p-value of all parameters of both male and female sexes and right and left side. Data was statistically analyzed by Statistical product and Service Solution (SPSS). Data entry is done and analyzed in Microsoft Excel.

3.4 EXPECTED OUTCOME:-

- Morphological variation of the articular surfaces of knee joint.

-Morphological variation of ligaments and structures surroundings to knee joint.

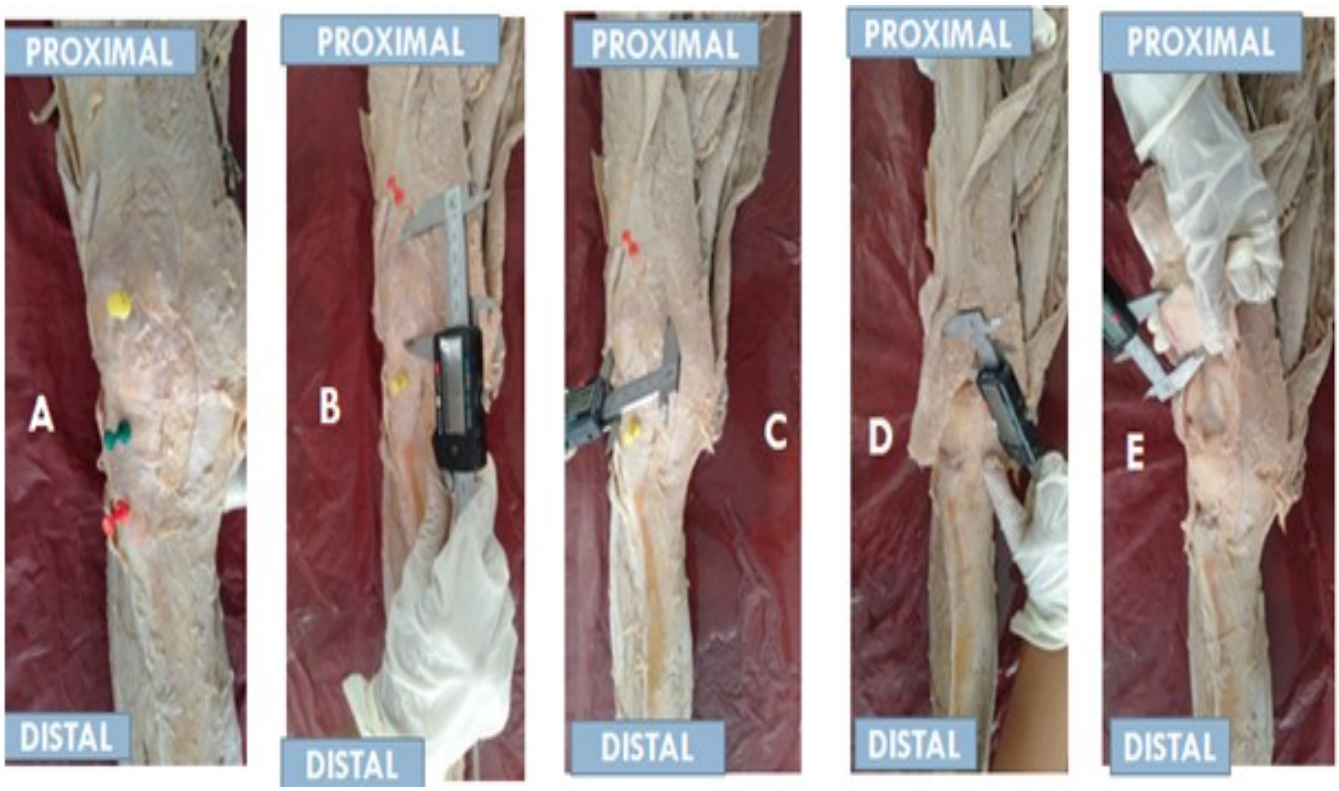
4. RESULTS:

Total ninety cadaveric knee joints were dissected (Right = 45, Left = 45) with known gender. All measurements were taken in the Department of Anatomy from various colleges, and data was measured by digital vernier calipers. Data is enlisted in the below tables in detail.

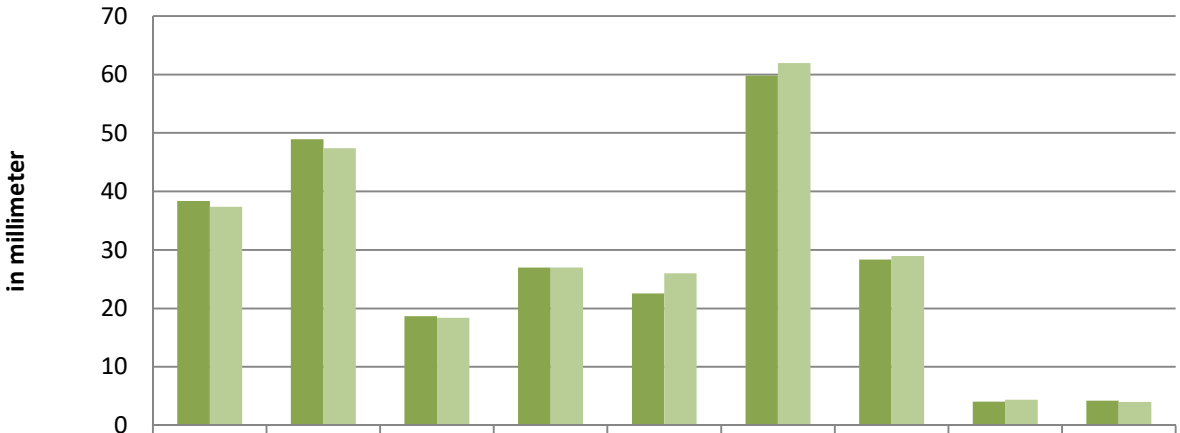
4.1RESULTS ON ARTICULAR SUFACE OF PATELLA:

An attempt has been made to identify the cadaveric analysis and morphometric evaluations of knee Joint, described in with review of literature, to find out any morphological variations related to knee and to correlate its surgical significance.

- In the present study, mean length, width, thickness, width of medial articular facet, width of lateral articular facet of patella was studied 38.37, 48.86, 18.37, 22.57, and 27.00 respectively on the right side and on the left side measured 37.40, 47.40, 18.76, 26.00, and 27.00 respectively. In males was measured 39.54, 48.00, 18.62, 16.69, 22.69respectively. In females was measured 33.82, 48.22, 18.35, 16.96, and 23.32 respectively.

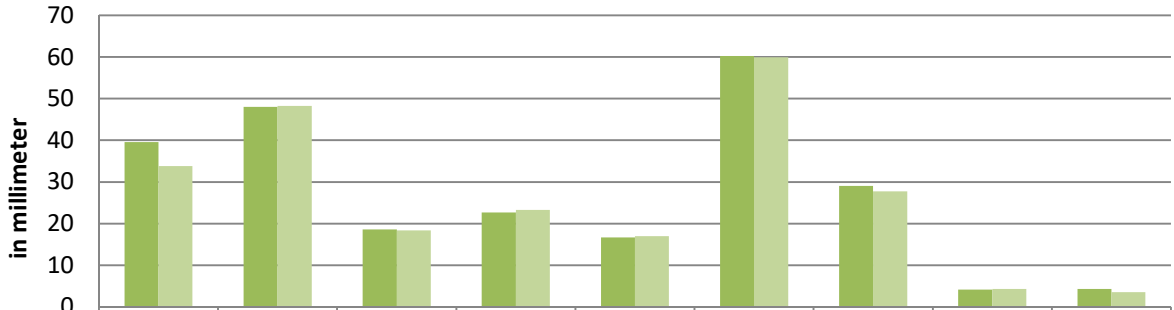


Graph 1: Morphometric linear measurements of patella & patellar ligament of knee right sided and left sided.



	Length of patella	Width of patella	Thickness of patella	Width of lateral articular facet	Width of medial articular facet	patellar ligament length	patellar ligament width	Thickness of patellar ligament (proximal part)	Thickness of patellar ligament (Distal part)
RIGHT	38.37	48.95	18.68	27	22.57	59.82	28.33	4.044	4.222
LEFT	37.4	47.4	18.4	27	26	61.93	28.95	4.4	3.977

Graph 2: Morphometric linear measurements of patella & patellar ligament of knee in males and females.

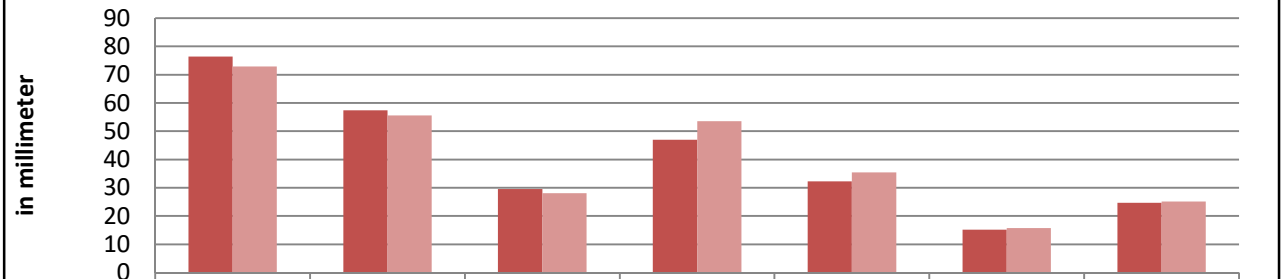


	LENGTH OF PATELLA	WIDTH OF PATELLA	THICKNESS OF PATELLA	WIDTH OF LATERAL ARTICULAR FACET	WIDTH OF MEDIAL ARTICULAR FACET	LENGTH OF PATELLAR LIGAMENT	WIDTH OF PATELLAR LIGAMENT	THICKNESS OF PATELLAR LIGAMENT (PROXIMAL PART)	THICKNESS OF PATELLAR LIGAMENT (DISTAL PART)
MALE	39.54	48	18.62	22.69	16.69	60.24	29.06	4.177	4.338
FEMALE	33.82	48.22	18.35	23.32	16.96	59.96	27.75	4.321	3.571

4.2 RESULTS ON ARTICULAR SUFACE OF FEMUR:

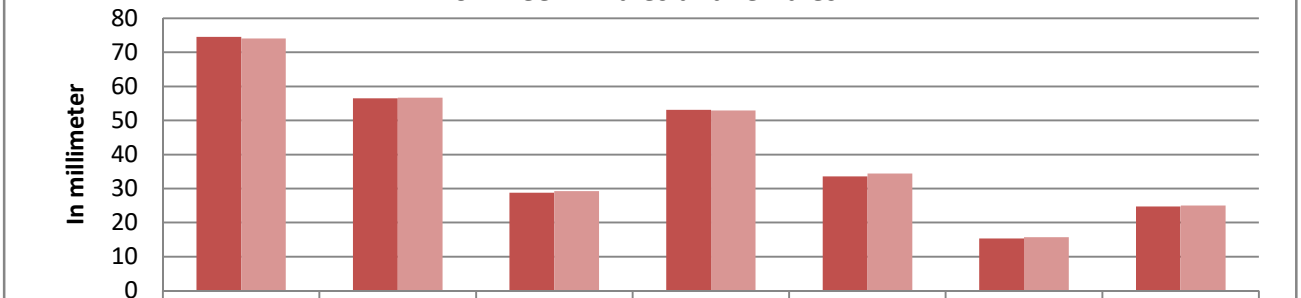
- The mean Bicondylar width of femur, Medial femoral condyle antero-posterior diameter, Medial femoral condyle transverse diameter, Lateral femoral condyle antero-posterior diameter, Lateral femoral condyle transverse diameter, Intercondylar notch width of femur, Intercondylar notch length of femur was studied 76.46, 57.37, 29.56, 47.00, 32.22, 15.20, 24.64 on the right side respectively and on the left side measured 72.88, 55.55, 28.13, 53.71, 35.44, 15.73, 25.13 respectively. In males was measured 74.51, 56.50, 28.79, 53.16, 33.58, 15.33 and 24.75 respectively. In females was measured 74.03, 56.67, 29.28, 52.89, 34.39, 15.75 and 25.00 respectively.

Graph 3: Morphometric linear measurements of Femur of knee right sided and left sided.



	BICONDYLAR WIDTH OF FEMUR	MEDIAL FEMORAL CONDYLE AP DIAMETER	MEDIAL FEMORAL CONDYLE TRANSVERSE DIAMETER	LATERAL FEMORAL CONDYLE AP DIAMETER	LATERAL FEMORAL CONDYLE TRANSVERSE DIAMETER	INTERCONDYLAR NOTCH WIDTH OF FEMUR	INTERCONDYLAR NOTCH LENGTH OF FEMUR
RIGHT	76.46	57.37	29.56	47	32.22	15.2	24.64
LEFT	72.88	55.55	28.13	53.51	35.44	15.73	25.13

Graph 4: Morphometric linear measurements of patella & patellar ligament of knee in males and females.

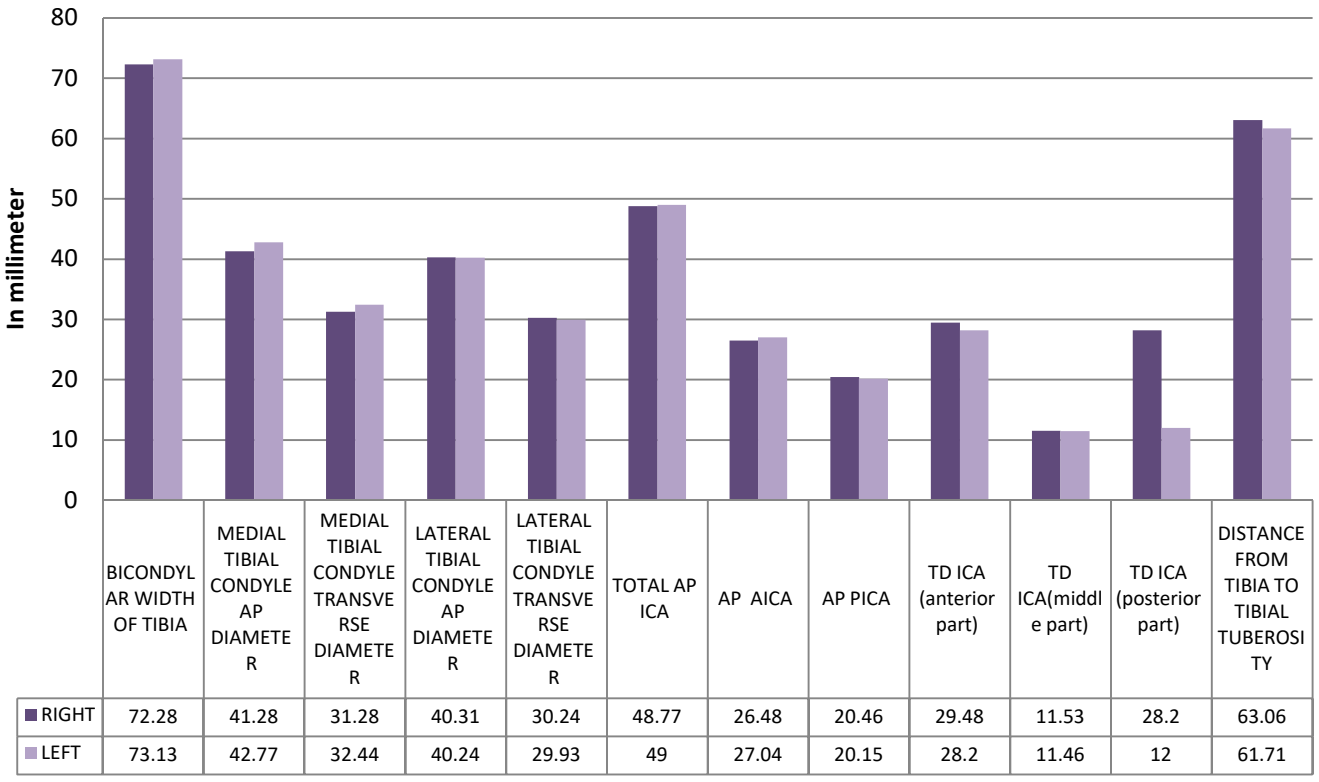


	BICONDYLAR WIDTH OF FEMUR	MEDIAL FEMORAL CONDYLE AP DIAMETER	MEDIAL FEMORAL CONDYLE TRANSVERSE DIAMETER	LATERAL FEMORAL CONDYLE AP DIAMETER	LATERAL FEMORAL CONDYLE TRANSVERSE DIAMETER	INTERCONDYLAR NOTCH WIDTH OF FEMUR	INTERCONDYLAR NOTCH LENGTH OF FEMUR
MALE	74.51	56.5	28.79	53.16	33.58	15.33	24.75
FEMALE	74.03	56.67	29.28	52.89	34.39	15.75	25

4.3 RESULTS ON ARTICULAR SUFACE OF TIBIA:

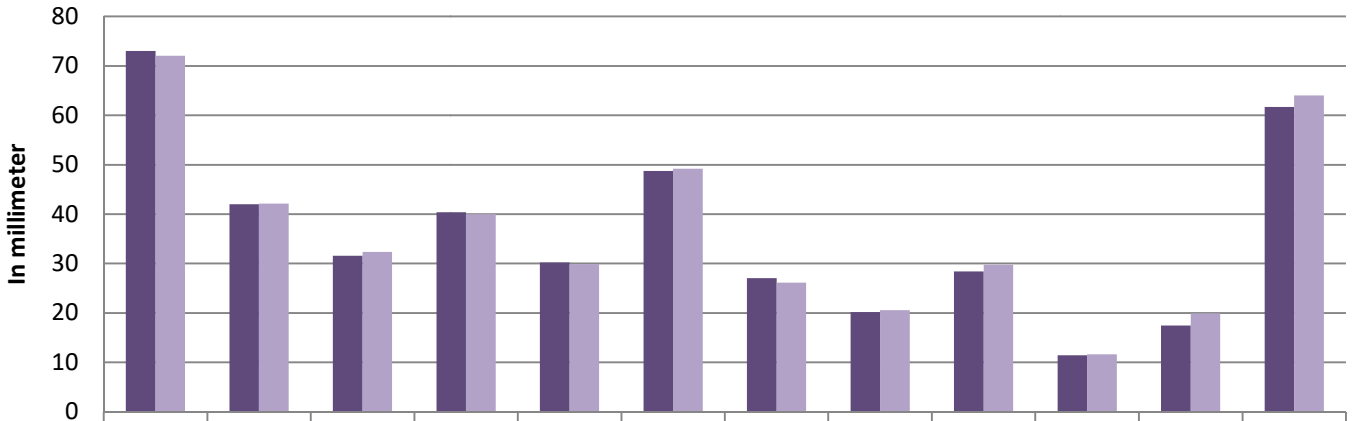
- The mean Bicondylar width of tibia, Medial tibial condyle antero-posterior diameter, Medial tibial condyle transverse diameter, Lateral tibial condyle antero-posterior diameter, Lateral tibial condyle transverse diameter, Total antero-posterior intercondylar area, Antero-posterior diameter of anterior intercondylar area, Antero-posterior diameter of posterior intercondylar area, Transverse diameter of intercondylar area anterior part, Transverse diameter of intercondylar area middle part, Transverse diameter of intercondylar area posterior part and Distance from tibial to tibial tuberosity was studied 72.28, 41.28, 31.28, 40.31, 30.24, 48.77, 26.48, 20.46, 29.48, 11.53, 28.20, 63.06 on the right side respectively and on the left side measured 73.13, 42.77, 32.44, 40.24, 29.93, 49.00, 27.04, 20.15, 28.20, 11.46, 12.00, 61.71 respectively. In males was measured 73.00, 42.00, 31.61, 40.38, 30.22, 48.74, 27.03, 20.19, 28.41, 11.43, 17.48 and 61.66 respectively. In females was measured 72.07, 42.14, 32.35, 40.03, 29.89, 49.21, 26.17, 20.57, 29.78, 11.64, 19.92 and 64.00 respectively.

Graph 5: Morphometric linear measurements of tibia of knee right sided and left sided.



	BICONDYLAR WIDTH OF TIBIA	MEDIAL TIBIAL CONDYLE AP DIAMETER	MEDIAL TIBIAL CONDYLE TRANSVERSE DIAMETER	LATERAL TIBIAL CONDYLE AP DIAMETER	LATERAL TIBIAL CONDYLE TRANSVERSE DIAMETER	TOTAL AP ICA	AP AICA	AP PICA	TD ICA (anterior part)	TD ICA(middle part)	TD ICA (posterior part)	DISTANCE FROM TIBIA TO TIBIAL TUBEROSITY
RIGHT	72.28	41.28	31.28	40.31	30.24	48.77	26.48	20.46	29.48	11.53	28.2	63.06
LEFT	73.13	42.77	32.44	40.24	29.93	49	27.04	20.15	28.2	11.46	12	61.71

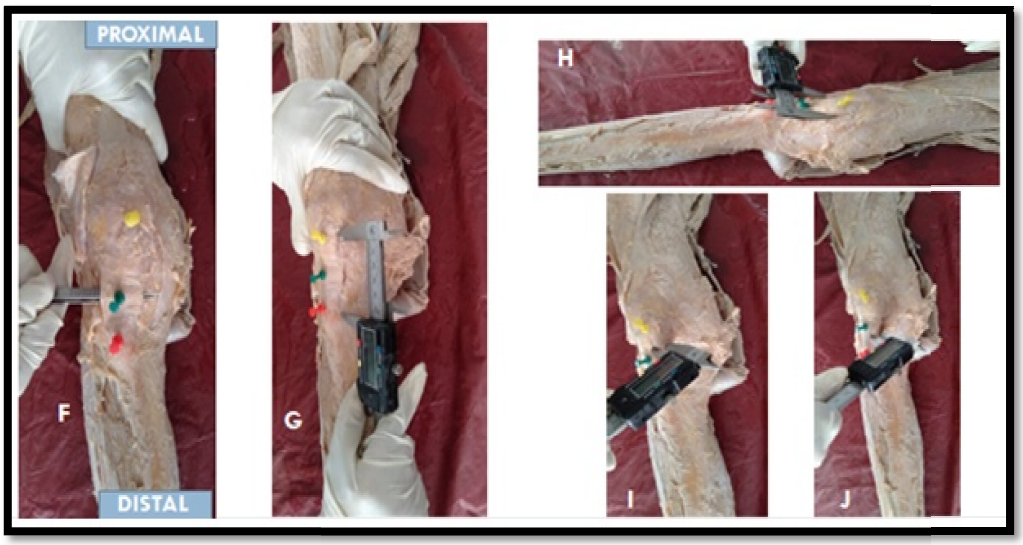
Graph 6: Morphometric linear measurements of tibia of knee right sided and left sided.



	BICONDYLAR WIDTH OF TIBIA	MEDIAL TIBIAL CONDYLE AP DIAMETER	MEDIAL TIBIAL CONDYLE TRANSVERSE DIAMETER	LATERAL TIBIAL CONDYLE AP DIAMETER	LATERAL TIBIAL CONDYLE TRANSVERSE DIAMETER	TOTAL AP ICA	AP AICA	AP PICA	TD ICA (anterior part)	TD ICA(middle part)	TD ICA (posterior part)	DISTANCE FROM TIBIA TO TIBIAL TUBEROSITY
MALE	73	42	31.61	40.38	30.22	48.74	27.03	20.19	28.41	11.43	17.48	61.66
FEMALE	72.07	42.14	32.35	40.03	29.89	49.21	26.17	20.57	29.78	11.64	19.92	64

4.4 RESULTS ON VARIOUS LIGAMENTS OF KNEE JOINT:

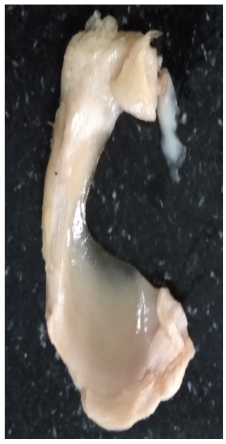
4.4.1. Results on patellar ligament of knee joint



- The mean Length, width, thickness of patellar ligament in proximal part and distal part was studied 59.82, 28.33, 4.044, and 4.222 on the right side respectively and on the left side measured 61.93, 28.95, 4.400 and 3.977 respectively. In males was measured 60.24, 29.06, 4.177 and 4.338 respectively. In females was measured 59.96, 27.75, 4.321 and 3.571 respectively.

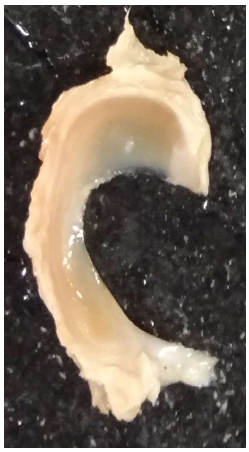
4.4.2. Results on morphological variations of menisci of knee joint

- Incidence of different shapes of Medial meniscus was found crescent shaped, Sickle shaped, C-shaped, Sided U shape and Sided V shape was found in total 66(73.33%), 17(18.88%), 4 (4.33%), 3(3.33%) and nil (0.00%) respectively.

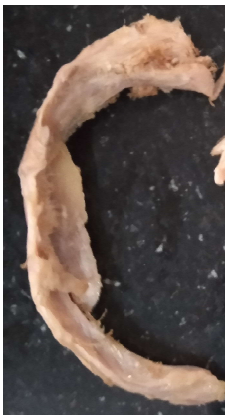


CRESCENT SHAPED

SICKLE SHAPED

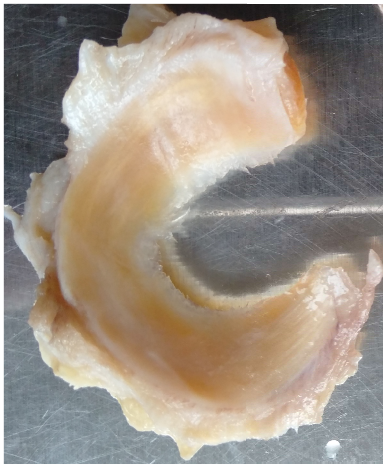


C SHAPED



SIDED U SHAPED

- Incidence of different shapes of Lateral meniscus was found C-shaped, Discoid (circular) shaped and V shaped was found in total 86(95.55%), 4(4.44%) and nil (0.00%) respectively.



C SHAPED

INCOMPETE DISCOID SHAPED

4.4.3 Results on menisci of knee Joint

- The medial meniscus mean length, width in anterior third, middle third, posterior third, thickness in anterior third, middle third and posterior third was found 90.64, 9.644, 11.17, 18.64, 4.770, 5.488 and 6.044 on right sided respectively. On left sided was found 94.86, 9.777, 12.02, 18.97, 5.000, 6.288 and 6.133 respectively. In males was found 91.75, 9.532, 11.67, 18.69, 4.967, and 5.919 respectively. In females was found 94.96, 10.10, 11.67, 19.07, 4.714 and 5.821 respectively.

Measurements		Right Sided (N= 45)			Left Sided (N= 45)				
		Mean	SD	SEM	Mean	SD	SEM	t- value	P-value
Length of medial menisci (in mm)		90.64	0.720	0.107	94.86	0.559	0.083	3.106	0.001
Width of menisci (in mm)	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 (in mm)	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 1 : STATASTICS FOR MEASUREMENTS OF MEDIAL MENISCUS ON RIGHT VS LEFT SIDED.

- The Lateral meniscus mean length, width in anterior third, middle third, posterior third, thickness in anterior third, middle third and posterior third was found 88.80, 10.80, 9.888, 10.62, 4.266, 5.044 and 38.82 on right sided respectively. On left sided was found 89.02, 11.13, 10.22, 10.04, 4.266, 4.844 and 39.33 respectively. In males was found 90.50, 11.09, 10.30, 10.37, 4.951, 5.322 and 4.193 respectively. In females was found 85.39, 10.67, 9.500, 10.25, 2.750, 4.071 and 3.000 respectively.

Measurements		Right Sided (N= 45)			Left Sided (N= 45)				
		Mean	SD	SEM	Mean	SD	SEM	t- value	p-value
Length of menisci (in mm)		88.80	0.474	0.070	89.02	0.482	0.071	0.220	0.413
Width of menisci (in mm)	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 (in mm)	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 2: STATASTICS FOR MEASUREMENTS OF LATERAL MENISCUS RIGHT VS LEFT SIDED.

4.4.4 Results on Anterior cruciate and posterior cruciate ligament of knee Joint

- The mean length and Width of Anterior Cruciate Ligament on right sided was found 28.97 and 10.66 respectively. On left sided was found 28.66 and 10.53 respectively. In males was found 28.87 and 10.61 respectively. In females was found 28.71 and 10.57 respectively.
- The mean length and width of Posterior Cruciate Ligament on right sided was found 37.73 and 12.62 respectively. On left sided was found 38.04 and 12.71 respectively. . In males was found 37.81 and 12.80 respectively. In females was found 38.03 and 12.67 respectively.

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 3: STATASTICS FOR MEASUREMENTS OF ACL & PCL 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: STATASTICS FOR MEASUREMENTS OF ACL & PCL OF KNEE.

4.4.5. Results on Collateral ligament of knee joint

- The superficial medial collateral ligament mean length, width in middle one third was measured 109.9, 18.62mm respectively on right sided and 110.3, 18.75mm on left sided respectively. In males were measured 114.3, 19.95 respectively. In females were measured 100.8, 15.89 respectively.
- The fibular collateral ligament mean length, width in middle one third was measured 61.88, 3.950 mm respectively on right sided and 62.55, 3.800 mm on left sided respectively. In males were measured 63.88, 3.800 respectively. In females were measured 58.53, 4.030 respectively.

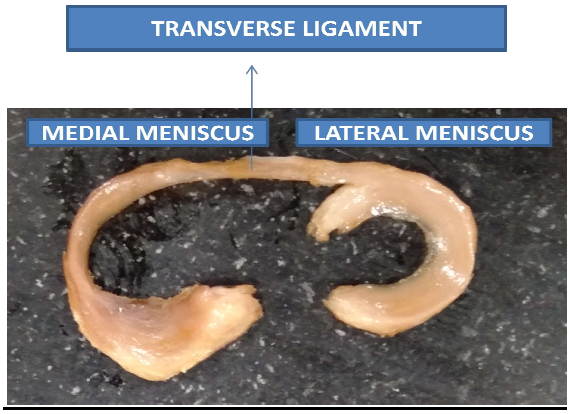
Measurements	Right Sided (N= 45)			Left Sided (N= 45)				
	Mean	**SD**	**SEM**	**Mean**	**SD**	**SEM**	**t- value**	**p-value**
Length of SMCL (cm)	109.9	0.866	0.129	110.3	0.883	0.131	0.240	0.405
Width of SMCL(middle one third) (cm)	18.62	3.304	0.492	18.75	2.603	0.388	0.212	0.416
Length of LCL (cm)	61.88	6.109	0.910	62.55	4.970	0.740	0.567	0.285
Width of LCL (middle one third) (cm)	3.950	0.104	0.015	3.800	0.091	0.013	0.750	0.227

TABLE 5: STATASTICS FOR MEASUREMENTS OF COLLATERAL LIGAMENTS OF KNEE.

Measurements	Male (N= 62)			Female (N= 28)				
	Mean	**SD**	**SEM**	**Mean**	**SD**	**SEM**	**t- value**	**p-value**
Length of SMCL (cm)	114.3	0.684	0.086	100.8	0.393	0.074	9.658	<0.0001
Width of SMCL(middle one third) (cm)	19.95	2.465	0.313	15.89	1.832	0.346	7.783	<0.0001
Length of LCL (cm)	63.88	5.625	0.714	58.53	3.084	0.583	4.714	<0.0001
Width of LCL (middle one third) (cm)	3.800	0.088	0.011	4.030	0.117	0.022	1.026	0.153

TABLE 6: STATASTICS FOR MEASUREMENTS OF COLLATERAL LIGAMENTS OF KNEE.

4.4.6. Results on Transverse ligament of knee joint



- Total incidence of presence of transverse ligament was found in total 77(85.55%) specimens.
- Incidence of presence of transverse ligament was found on right sided in 5(11.11%) and 8 (17.77%) on left sided out of 45cadaveric knee. In males was found in 10 (16.12%) out of 62 cadaveric knee. In females was found in 3 (10.71%) out of 28 cadaveric knees.
- Total incidence of absence of transverse ligament was found in 13(14.44%) specimens.
- Incidence of transverse ligament absence was found in 40 (88.88%) and 37 (82.22%) on left sided out of 45 Specimens. In males absence was found in 52 (83.87%) out of 62 specimens. In females absence was found in 25 (89.28%) out of 28 specimens.
- The mean length of transverse ligament was found 34.25 on right sided and 33.64 on left sided. The mean width of transverse ligament was found 42.00 on right sided and 37.22 on left sided.

4.4.6. Results on variations related to knee joint

- Incidence of presence of os fabella was found on right sided in 14(15.55%) and 10 (11.11%) on left sided out of 45cadaveric knee. In males was found in 17 (18.88%) out of 62 cadaveric knee. In females was found in 7 (7.77%) out of 28 cadaveric knees. Total incidence of presence of was found in 24(26.66%) specimens.
- The total mean length of os fabella was found 19.22mm, on right sided 18.66mm and 22.46mm on and left respectively.
- The total mean width of os fabella was found 12.95mm, on right sided 11.80mm and 11.20mm on left sided respectively.
- Unilateral double headed plantaris muscle was found in one of right sided of knee joint. (1.11%).Outer belly was measured in length and width measured 8.1cm and 1.3cm respectively. Inner belly was measured in length and width measured 6.6cm and 1.6cm. Tendon was measured 29.46cm and 0.9cm in length and width respectively.
- An unusual unilateral trifurcation of sciatic nerve was observed.
- There was no specimen found with the any absence of muscles of lower limb.

5. CONCLUSION:

After the study work of ninety human cadaveric lower limbs the different morphometric analysis and anatomical variations in the articular surfaces of patella, femur, tibia and ligaments of knee joint were came across. Following general conclusion can be derived:

- The morphometric knowledge of patella, patellar ligament and their interrelationship in different population group and gender is often utilized for the functionality of implant design. A disproportional patellofemoral joint implant would result in an ineffective lever support, limitation of range of motion, excessive wear of the patella with associated knee pain. Furthermore, knowledge is crucial in various other surgical procedures of knee such as the harvesting technique of patellar ligament grafts during the reconstruction of the anterior cruciate ligament and posterior cruciate ligament.
- Morphometric data of the lower end of the femur and upper end of tibia by direct observation in cadaver can aid knowledge in selection of correct prosthesis according to measurements for the Indian population. The morphometric data of this study can be of importance to the orthopedicians in the prevention and management of knee injuries. We have also provided data for gender wise and on right and left sides which will improve the longitivity of prosthesis, will increase mobility and improve lifestyle of patient after knee replacement surgery.
- Morphometric Anatomical knowledge of menisci is useful for various therapeutic and diagnostic procedures of knee. Variations in morphology of menisci is important to Orthopedic surgeon , General Surgeons, Radiologists and physical therapist and for Performing advanced orthopedic surgeries, arthroscopic surgeries, knee-transplant surgery, meniscectomy, meniscal reconstruction surgery, meniscal transplant surgery. Furthermore, knowledge of anatomical variations of menisci can help and utilized for facilitating the rehabilitation process.
- The fabella is usually founded in routine practices and accepted as a normal anatomical variant in humans. It is variably absent in humans and classified as a phylogenetically retrogressive anatomical structure that lost its function with the upright posture of the human. In evolutionary terms, the fabella seemingly starts to disappear during the transition from the quadripedal posture to the bipedal, because the standing position requires more stability and less rotation. Functionally, it is believed to have a role similar to the patella in redirecting extension forces of the knee joint from one point to another whereas the fabella redirects forces on the flexor side.
- The clinical significance of plantaris muscle is of great importance as it is the choice of graft in reconstruction surgery of anterior talofibular and calcaneofibular ligament, tendon transfer for flexor tendon in hand and in atrioventricular repair.
- An anatomical knowledge of variations related to knee joint is significantly important to the orthopedic surgeon, General surgeon, Plastic surgeon, Radiologist, Physical therapist, rehabilitation therapist for the various surgical procedures of knee for the better outcome of surgery and early rehabilitation and post surgical recovery of patient.

6. UNIQUENESS OF PRESENT STUDY:-

Geometry and anatomy of the knee is variable. So, the study have found the various parameters of the knee joint, which can establish its importance in the various procedures and surgeries like Total knee arthroplasty and uni-compartmental knee arthroplasty (UKA) and ligament reconstruction procedures, which are frequently done procedures for the treatment of various forms of arthritis and knee injuries.

Present study data was recorded from cadaveric study by direct observation. Morphometric study on Patella, Femur, Tibia and ligaments of knee was usually done by dry bone study, CT-scan study or intra-operative study as per the author's record. Results of this study will give a detailed new knowledge of the morphometric pattern of the knee joint and will establish an essential key be helpful to the orthopedic surgeon, plastic surgeons, anatomists, physical therapist, anthropologists, and in co-relating and utilizing its knowledge in various clinical applications.

7. FUTURE RESEARCH SCOPE:

The scope of present study is that it finds out the various measurements, parameters and attachment landmarks of individual anatomical structure of the knee joint and the morphometric data of knee ligaments will aids the knowledge in selecting the graft for surgical repair of damaged ligaments during its reconstruction. The present study will provide proper understanding and fundamental knowledge which is the prime in complex diagnostic procedures, joint replacement procedures and in various other surgeries of knee joint. Knowledge The data can significantly help in orthopedic surgery, Forensic evaluation, anthropology, comparative anatomy, and evolutionary biology of humans.

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