ORIGINAL ARTICLE

MEASUREMENTS OF CRUCIATE LIGAMENTS OF KNEE JOINT

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ABSTRACT: AIM OF STUDY: To measure length and width of Cruciate Ligaments and to observe for any variations in the parameters. **PERIOD OF STUDY:** 2008-2011. **MATERIALS AND METHODS**: 100 disarticulated limbs were collected from department of anatomy, Kakatiya Medical College, Warangal. Telangana. Which were preserved in 10% formalin, 50 MRIs of Knee joint were studied and measurements were taken from Vijaya Diagnostic center, Hanamkonda, Warangal, Telangana. To expose cruciate ligament a systematic dissection procedure has been adopted. The cruciate ligaments were exposing and their attachments were defined on to the femur and tibia. **OBSERVATIONS:** Average of parameters for anterior and posterior cruciate ligaments were calculated for all 100 limbs and 50 knee joint MRI scans. The observations were similar to the previous studies. **CONCLUSION:** The parameters which were measure are help full in selection and preparation of the graft and in re construction of ligaments. The aim of re-construction is not just to substitute a torn ligament, but to restore the morphology inherent in the ligament.

KEYWORDS: Tibia, Fibula, Intercondylar notch, Femoral condyles.

INTRODUCTION: "Ligament" most commonly refers to a band of tough, fibrous dense regular connective tissue comprising attenuated fibres. Ligaments connect bones to other bones to form a joint. Some Ligaments limit the mobility of articulations, or prevent certain movements altogether.

They have got certain amount of elastic stretch but can weaken if too much tension is put on to it. (What are the cruciate ligaments (2008) - KNEE guru- information hub, July 27, 2008). (What are the cruciate ligaments (2008)- KNEEguru- information hub, July 27, 2008).(1)

The cruciate Ligaments are the strong bands of tissue that connect the femur and tibia. The word cruciate mean crossed. The cruciate ligament also called because they cross over another as they link the two bones together. Not only do the ends of the ligament splay out gain a wide contact surface, but the ligament itself has a twist in it allowing a complex mechanical action which allows some ligament fibers to take the strain in flexion and others to take the strain in extinction. (What are the cruciate ligaments (2008)- KNEEguru- information hub, July 27, 2008). (What are the cruciate ligaments (2008)- KNEEguru- information hub, July 27, 2008).(1)

The anterior cruciate ligament is attached to the antero intercondylar aria of tibia just anterior and slightly lateral to the medical tibial eminence, partly blending with the anterior horn of the lateral meniscus. It ascends postero laterally twisting on itself and fanning out to attach high on the postero medial aspect of lateral femoral condyle. (Susan Standing et al (2008)- Fortieth edition – Gray's Anatomy-page 1401).(2)

It is primary restraint to anterior tibial translation (90%); secondary restraint to tibial rotation; Minor secondary restraint to varus-valgus angulation at full extension.

The most common courses of ACL rapture can be divided into three major classifications:

1. Environmental.
2. Anatomical.
3. Hormonal.

ENVIRONMENTAL CAUSES: Sports which include running and jumping pose the most potential injury to the athlete. The risk for rupture of the anterior cruciate ligament does not increase in contact sports (As opposed to non-contact sports). However many would dispute that the sport of football does produce more anterior cruciate ligament injuries. At the very least it produces the most horrific cruciate ligament Injuries. This is seen when one player collides low, directly into another player's knee while tackling or blocking.

ANATOMICAL VAUSES: ACL injuries are especially common in female athletes, due to many possible contributing factors. The most prevalent explanation relates to female athletes tending to land more straight legged than men removing the quadriceps muscle's shock absorbing action on the knee. Often the knee on a straight leg can't withstand this and bends sideways.

HORMONAL CAUSES: High levels of specific hormones have been associated with an increased risk of ACL rupture. Estrogen is one of these hormones. Some anatomical and hormonal causes (such as high levels of estrogen) may put women at a higher risk for injury.

MAIN REASON FOR FEMALE ACL TEARS: There are several reasons for the higher prevalence of ACL injuries in female athletes. One potential cause is women's preferential use of the quadriceps femoris muscle for jumping as compared to the hamstrings in men, which provides an opposing force that decreases the strain on ACL. Additionally, as a result of the increased angle formed by a woman's hips and her knees, the ligaments are generally under more stress than those of a man.

LIGAMENT AND QUADRICEPS DOMINANCE: Women's bodies tend to work in a way that uses the ligaments more than it uses muscles. When ligaments are compensating for muscles it makes the ligaments weak and more susceptible for damage. Male athletes are more likely to use their hamstrings instead of their ligaments for stability. Instead of using their hamstrings, women tend to use their quadriceps, which compress the joint and pulls the tibia forward. Doing this can damage or cause stress on the anterior cruciate ligament.

ADOLESCENTS: Young girls are not as likely to tear their ACLs as young women, because their hips have not widened more than a boy's of same age. When puberty occurs, this changes the risk of women tearing their ACL from 2 times to 4 times more than men.

BIOMECHANICS: Women's bodies are shaped in such a way that when they are jumping, pivoting and landing, their knees are likely to bend inward. Doing so distributes the weight unevenly throughout the woman's body. The femoral notch -the space at the bottom of the femur where the ACL runs is narrower in women than in men. Since the woman's femoral notch

is smaller the femur grinds the ACL and can make it weaker. The quadriceps femoris angle, also known as the Q angle is larger in woman bodies than men, because of their larger pelvises. The female's ACL is shaped slightly different and it is slightly smaller when compared to males.

Several diagnostic manoeuvres help clinicians diagnose an injured ACL. They are anterior drawer test, Lachman test and pivot shift test. The diagnosis is usually confirmed by MRI.

Treatment for an ACL injury can either be surgical or non-surgical depending on the extent of the injury.

The aim of reconstruction is not just to substitute a torn ligament but to restore the morphology and function inherent in the ligament. Hence ACL replacement depends on the structure of the material used and shape of attachment on each side.

DRAFT SELECTION: The grafts can be auto grafts, allografts, artificial ligaments or a combination of these.

AUTOGRAFTS: Patellar tendon, semitendinosus tendon, gracilis tendon and iliotibial band are used as auto grafts.

Allograft and artificial ligaments have certain disadvantages compared to auto graft.

POSTERIOR CRUCIATE LIGAMENT: The posterior cruciate ligament is thicker and stronger than the anterior cruciate ligament. It is attached to the lateral surface of the medial femoral condyle and extends up on to the anterior part of the roof of the intercondylar notch, where its attachment is extensive in the anteroposterior direction. Its fibres are adjacent to the articular surface. They pass distally and posteriorly to a fairly compact attachment in the intercondylar region and in a depression on the adjacent posterior tibia. This gives a fan like structure in which fibre orientation is variable. (Susan Standing et al (2008)- Fortieth edition – Gray's Anatomy-page 1401).[(2)]

PCL is responsible for 95% of total restraint to posterior translation of the tibia. Secondary restraint to tibial external rotation.

An injury to posterior cruciate ligament requires a powerful force. A common cause of injury is a bent knee hitting a dashboard in a car accident or a football player falling on a knee that is bent.

Several grafts and several fixation techniques have been introduced for PCL reconstruction over the past years. To date auto graft, and allograft tissues are recommended for PCL reconstruction, whilst synthetic grafts should be avoided. Auto graft tissues include patellar tendon graft, the hamstrings and the quadriceps tendon. Allograft tissues are increasingly being used for primary PCL reconstruction. Besides the previous mentioned graft types allograft tissues include Achilles and tibialis anterior/posterior tendons. (Jurgen Hoher et al (2003)- Graft choice and graft fixation in PCL reconstruction- Knee surgery, Sport Traumatology, Arthroscopy-2003).[(3)]

In the present study, normal parameters of cruciate ligaments are measured are measured because they are helpful in selection and preparation of the graft and in reconstruction of ligaments.

MATERIALS AND METHODS: The following are the materials used for present study.

100 disarticulated limbs were collected from the department of anatomy, Kakatiya Medical College, Warangal, Andhra Pradesh which were preserved in 10% Formalin (Photograph 2).

50 MRIs of knee joint were studied and measurement was taken from Vijaya Diagnostic Center, Hanamkonda, Warangal, Andhra Pradesh.

CHEMICAL REQUIRED: 10% formalin for preservation.

INSTRUMENTS:

(Photograph 1)	QUANTITY
1. SCALPEL with detachable Blades	2
2. FORECEPS small pointed	2
Large grooved	2
3. SCISSORS	1
4. DIVIDER from Geometry Box	1
5. MEASURING SCALE (made of plastic-15Cms)	1
6. PAIR OF GLOVES	1
7. CARDS WITH NUMBERS	100

METHODS: 100 Disarticulated limbs (48 Right, 52 Left) from the department of anatomy, Kakatiya Medical College, Warangal, Andhra Pradesh.

To expose the cruciate ligaments a systematic dissection procedure has been adapted (Cunningham's Manual of practical Anatomy-Fifteenth edition volume 1-Upper and lower limbs.129, 217-19).[4]

1. A vertical incision is given thought the skin along the medial aspect of high.
2. Skin is reflected from the superficial fascia and turned laterally.
3. Superficial fascia is stripped downwards from the front and lateral side of thigh by blunt dissection.
4. Exposure of the deep fascia of the front and lateral side of the thigh is completed.
5. Structures surrounding the knee joint were removed.
6. Quadriceps tendon is cut immediately proximal to the patella. Ends of this incision are carried downwards to the tibial condyle, passing 2 to 3cms on either side of the ligamentous patella.
7. Patella is turned downwards and cavity of the knee joint exposed. Tendon of the quadriceps is lifted and it is noted that the cavity of the joint extended upwards deep to it to from the supra patellar bursa.
8. Lower part of the quadriceps is spilt longitudinally and extent of the bursa is examined.
9. Infra patellar synovial fold and pad of fat removed. Deep Infra patellar bursa is opened. Posterior part of the fibrous capsule is removed. Middle genicula artery is followed through it to the cruciate ligaments. Posterior parts of these ligaments were defined; Synovial membrane and connective tissue were removed from their anterior surfaces.

Thus cruciate ligaments were exposed and their attachment was defined on to the femur and tibia.

The following parameters were observed:

LENGTH: Length of cruciate ligaments is measured from the tibial attachment to femoral attachment.

WIDTH: Width of cruciate ligaments is taken at three levels.

1. Proximal
2. Middle
3. Distal

INSERTION: Insertion points on femur and tibia were noted.

PROCEDURE FOR TAKING MRI SCAN OF KNEE JOINT: The patient is asked first to wear hospital gown o clothing without metal fasteners (such as sweatpants and a t-shirt). Certain types of metal can cause inaccurate images.

This patient will lie on his back on a narrow table, which sides into the middle of the MRI machine. Small devices, called coils may be placed around the patient's knee. These devices help to send and receive the radio waves, and improve the quality of these images.

Some exams require a special dye (contrast). The dye is usually given before the best through a vein in the patients hand a forearm. The dye helps the radiologists to see certain areas more clearly.

During the MRI, the person who operates the machine will watch the patient from another room. Several sets of images are usually needed each taking 2-15 minutes. The exam may be one hour or longer.

PREPARATION OF THE PATIENT FOR THE TEST: The patient may be asked not to eat or drink anything for four hours to six hours before the scan.

Before the test, the patient has to tell the radiologist if he is currently receiving dialysis as this may effect whether the patient may have IV contrast. If the patient fear confined spaces (have claustrophobia), he has to on form it to the doctor before the exam. The patient may be a given a medicine to help him feel sleepy and less anxious or the doctor may recommended an "open" MRI in which the machine is not as close to the body.

The strong magnetic fields created during MRI can interface with certain implants, particularly pace marks. Persons with cardiac pace makers cannot have ab MRI and should not enter MRI area. The patient may not be able to enter an MRI area if he has any of the following metallic objects in his body.

- Brain aneurysm clips.
- Certain artificial valves.
- Inner ear (cochlear) implants.
- Recently placed artificial joints.
- Some older types of vascular stents.

Patient has to tell the health care provider if he has one of these devices when scheduling the test, so that the exact type of metal can be determined.

Before MRI, sheet metal workers or any person that may have been exposed to small metal fragments should receive a skull x-ray to check for metal in the eyes.

Because the MRI contains a magnet, metal containing objects such as pens, pocket knives, and eye glasses may fly across the room. This can be dangerous, so they are not allowed into the scanner area.

Other metallic objects are also not allowed into the room such as jewellery, watches, credit cards and hearing aids. They can be damaged. Pins, Hair pins, metal zippers and similar metallic items can distort the images. Removable dental work should be taken out just before the scan.

An MRI exam causes no pain; some people become anxious, they may be given a mild sedative. Excessive movement can blur MRI images and cause errors.

They table may be hot or cold but the patient may request a blanket or pillow. The machine produces loud thumping and humming noises when turned on the patient can wear ear plugs to help reduce the noise. An intercom in the room allows the patient to speak to the person operating the scanner at any time. Some MRIs have television and special head phones so that the patient can pass the time.

There is no recovery time, unless patient needs sedation. After an MRI scan the patient can resume his normal diet and medication.

Indications for the test include anterior cruciate ligament injury, arthritis of the knee, bursitis of the knee, baker's cyst, infection of the knee joint, knee locking when the patient walks or moving, signs of knee fractures, signs of damage to the knee muscle, cartilage or ligaments, unexplained knee pain that does not get better with treatment.

Results are considered normal if the knee joint and surrounding structures look normal in size and shape and are in the proper position. Results depend on the nature of the problem. Different types of tissue send back different MRI signals. For example healthy tissue sends back a slightly different signal than cancerous tissue.

Abnormal results may be due to:

- Anterior Cruciate ligament injury.
- Arthritis of the knee.
- Avascular necrosis.
- Bone tumour or cancer.
- Broken bone.
- Bursitis.
- Buildup of joint fluid behind the knee.
- Fluid collecting in the knee joint.
- Infection in the knee joint (Osteomyelitis).
- Inflammation.
- Knee cartilage tear.
- Medial or Lateral collateral ligament injury.
- Muscle damage.
- Osteochondral dissecans of the knee.
- Posterior cruciate ligament injury.

MRI contains no ionizing radiation. The most common type of contrast used is gadolinium. It is very safe. Allergic substances rarely occur. The person operation the machine will monitor the patient the heart beat and breathing as needed.

Same parameters which were observed in cadaveric were also observed in MRI scans of knee joint (Fig. 1, 2, 5)

OBSERVATIONS: Normal parameters of both anterior and posterior cruciate ligaments i.e. length and width (which taken at 3 levels i.e. proximal, middle, distal) were measured in 100 disarticulated limbs and in 50 knee joint MRI scans. The insertion sides of both the ligaments were also observed.

Out of 100 disarticulated limbs, 487 were right and 52 were left (the sex of which is not known) out of 50 MRI scans 25 were male and 25 were female patients scans.

In MRI scans of 25 male patients, 11 were of right knee joint scans and 14 were of left knee joint scans.

In MRI scans of 25 female patients, 10 were of right knee joint scans and 15 were of left knee joint scans.

In dissection method every specimen was systematically dissected to expose the cruciate ligaments and observed the parameters.

In MRI method the measurement were taken in the MRI machine at the diagnostic center.

Average of parameters for anterior and posterior cruciate ligaments was calculated for all 100 limbs and 50 knee joint MRI scans.

DISSECTION METHOD – RIGHT LIMB: In dissection method, the length of ACL in right limbs ranged between 28-40mm with a mean value of 35.14mm (SD-3.36). Its proximal width ranged between 7-13mm with a mean value of 10.16mm (SD-1.56). Its middle width ranged between 7-13mm with a mean value of 10.02mm (SD-1.68). It's distal ranged between 7-13mm with a mean value of 10.41mm (SD-1.66). The ACL got insertion on to the posteromedial aspect of lateral femoral condyle proximally and anterior intercondylar area just anterior and slightly lateral to the medial tibial eminence blending with the anterior horn of the lateral meniscus distally (Table 1 & 2).

The length of PCL ranged between 34-40mm with a mean value of 37mm (SD-1.5). Its proximal width ranged between 12-14mm with a mean value of 12.58mm (SD-0.53). Its distal width ranged between 11-14mm with a mean value of 12.95mm (SD-0.77). The PCL got inserted proximally on to the lateral surface of the medial femoral condylar extending up on to the anterior part of the roof of the intercondylar notch and posteriorly in the intercondylar region and in a depression on the adjacent posterior tibia distally (Tables 1 & 3).

Sl. No.	Anterior Cruciate Ligament						Posterior Cruciate Ligament					
	Length	PW	MW	DW	Insertion sites		Length	PW	MW	DW	Insertion sites	
					Femur	Tibia					Femur	Tibia
					Posteromedial aspect of Lateral Femoral condyle	Anterior Intercondylar area just anterior and slightly lateral to the medial tibial eminence partly blending with the anterior hom of the lateral meniscus					Lateral surface of the medial femoral condyle extending up on to the anterior part of the roof of the intercondylar notch	Posteriorly in the intercondylar region and in a depression on the adjacent posterior tibia
1	40	13	12	12	-do-	-do-	40	14	13	13	-do-	-do-
2	33	9	9	10	-do-	-do-	36	12	12	11	-do-	-do-
3	30	8	7	7	-do-	-do-	35	12	12	13	-do-	-do-
4	34	10	9	9	-do-	-do-	35	13	12	12	-do-	-do-
5	28	7	7	8	-do-	-do-	34	12	11	12	-do-	-do-
6	31	9	8	8	-do-	-do-	36	13	12	12	-do-	-do-
7	32	8	8	9	-do-	-do-	36	13	12	13	-do-	-do-
8	35	11	10	10	-do-	-do-	38	14	13	13	-do-	-do-
9	34	9	9	10	-do-	-do-	38	14	13	13	-do-	-do-
10	40	12	12	13	-do-	-do-	40	14	13	14	-do-	-do-
11	30	8	7	7	-do-	-do-	35	13	12	12	-do-	-do-
12	32	9	8	8	-do-	-do-	36	13	12	13	-do-	-do-
13	29	8	7	7	-do-	-do-	35	12	12	13	-do-	-do-
14	35	11	10	10	-do-	-do-	37	12	12	13	-do-	-do-
15	37	10	10	11	-do-	-do-	38	14	13	14	-do-	-do-
16	32	9	9	9	-do-	-do-	36	12	12	13	-do-	-do-
17	29	7	7	8	-do-	-do-	35	13	12	12	-do-	-do-
18	40	12	12	13	-do-	-do-	40	14	13	14	-do-	-do-
19	33	10	9	9	-do-	-do-	36	13	12	12	-do-	-do-
20	34	9	9	10	-do-	-do-	38	14	13	13	-do-	-do-
21	38	12	11	11	-do-	-do-	38	14	13	13	-do-	-do-
22	34	10	10	11	-do-	-do-	37	13	12	12	-do-	-do-
23	33	10	10	10	-do-	-do-	36	13	12	12	-do-	-do-
24	31	8	8	9	-do-	-do-	36	13	12	12	-do-	-do-
25	38	11	11	10	-do-	-do-	38	14	13	13	-do-	-do-
26	32	9	9	10	-do-	-do-	36	13	12	12	-do-	-do-

27	35	10	10	11	-do-	-do-	38	14	13	13	-do-	-do-
28	40	12	12	13	-do-	-do-	40	14	13	13	-do-	-do-
29	38	11	11	12	-do-	-do-	38	14	13	13	-do-	-do-
30	31	9	9	9	-do-	-do-	36	13	12	12	-do-	-do-
31	39	13	13	13	-do-	-do-	39	14	13	12	-do-	-do-
32	33	9	9	10	-do-	-do-	36	12	12	13	-do-	-do-
33	35	11	11	11	-do-	-do-	38	14	13	13	-do-	-do-
34	36	10	10	11	-do-	-do-	38	14	13	13	-do-	-do-
35	39	13	13	13	-do-	-do-	38	14	13	13	-do-	-do-
36	37	10	10	11	-do-	-do-	38	14	13	14	-do-	-do-
37	36	11	11	11	-do-	-do-	38	14	13	14	-do-	-do-
38	39	12	12	11	-do-	-do-	39	14	13	14	-do-	-do-
39	36	10	10	11	-do-	-do-	38	14	13	14	-do-	-do-
40	38	10	11	11	-do-	-do-	38	14	13	14	-do-	-do-
41	37	12	12	12	-do-	-do-	38	14	13	14	-do-	-do-
42	38	11	11	12	-do-	-do-	38	14	13	14	-do-	-do-
43	37	11	11	12	-do-	-do-	38	13	13	13	-do-	-do-
44	39	13	13	13	-do-	-do-	39	13	13	13	-do-	-do-
45	36	11	11	11	-do-	-do-	38	13	13	14	-do-	-do-
46	37	10	11	11	-do-	-do-	38	13	13	13	-do-	-do-
47	38	10	11	11	-do-	-do-	38	14	13	13	-do-	-do-
48	39	10	11	11	-do-	-do-	39	13	13	14	-do-	-do-

Table 1: Showing measurements and insertion sites of anterior and posterior ligaments of right limbs (Dissection method)

All lengths recorded in mm.

Sl. No.	Parameter	Mean Values	Standard Deviation
1	Length	35.1mm	3.36
2	Proximal Width	10.16mm	1.56
3	Middle width	10.02mm	1.68
4	Distal width	10.41mm	1.66

Table 2: Showing mean value and standard deviation of various parameters of anterior cruciate ligament of right limb (Dissection Method)

Sl. No.	Parameter	Mean Values	Standard Deviation
1	Length	37mm	1.5
2	Proximal Width	13.35mm	0.75
3	Middle width	12.58mm	0.53
4	Distal width	12.95mm	0.77

Table 3: Showing mean value and standard deviation of various parameters of posterior cruciate ligament of right limb (Dissection Method)

DISSECTION METHOD – LEFT LIMB: In dissection method the length of ACL in left limbs ranged between 27-41 mm with a mean value of 34.5mm (SD-3.32). Its proximal width ranged between 7-13mm with a mean value of 10.23mm (SD-1.60). Its middle width ranged between 7-12mm with a mean value of 9.78mm (SD-1.56). It's distal ranged between 7-12mm with a mean value of 10.06mm (SD-1.48). The ACL got insertion on to the posteromedial aspect of lateral femoral condyle proximally and anterior intercondylar area just anterior and slightly lateral to the medial tibial eminence partly blending with the anterior horn of the lateral meniscus distally (Table 4 & 5).

The length of PCL in left ranged between 34-41mm with a mean value of 37.04mm (SD-1.54). Its proximal width ranged between 11-14mm with a mean value of 12.59mm (SD-0.63). Its middle width ranged between 11-13mm with a mean value of 12.38mm (SD-0.59). Its distal width ranged between 11-13mm with a mean value of 12.38mm (SD-0.82).

The PCL got inserted proximally on to the lateral surface of the medial femoral condylar extending up on to the anterior part of the roof of the inter condylar notch and posteriorly in the intercondylar region and in a depression on the adjacent posterior tibia distally (Tables 4 & 6).

Sl. No.	Anterior Cruciate Ligament						Posterior Cruciate Ligament					
	Length	PW	MW	DW	Insertion sites		Length	PW	MW	DW	Insertion sites	
					Femur	Tibia					Femur	Tibia
					Postromedial aspect of Lateral Femoral candyle	Anterior Intercondylar area just anterior and slightly lateral to the medial tibial eminence partly blending with the anterior hom of the lateral meniscus					Leteral surface of the medial femoral condyle extending up on to the anterior part of the roof of the intercondylar notch	Posteriorly in the intercondylar region and in a depression on the adjacent posterior tibia
49	38	10	11	11	-do-	-do-	38	12	12	14	-do-	-do-
50	30	8	7	7	-do-	-do-	35	12	12	12	-do-	-do-
51	37	12	11	11	-do-	-do-	38	13	13	14	-do-	-do-

52	27	8	7	7	-do-	-do-	34	11	11	12	-do-	-do-
53	36	11	10	10	-do-	-do-	38	13	13	14	-do-	-do-
54	32	9	9	10	-do-	-do-	36	12	12	13	-do-	-do-
55	38	11	11	10	-do-	-do-	38	13	13	14	-do-	-do-
56	34	10	9	9	-do-	-do-	37	12	12	13	-do-	-do-
57	40	12	12	12	-do-	-do-	40	13	13	14	-do-	-do-
58	30	8	8	9	-do-	-do-	35	13	12	12	-do-	-do-
59	37	12	11	11	-do-	-do-	38	13	13	34	-do-	-do-
60	28	8	7	7	-do-	-do-	34	11	11	12	-do-	-do-
61	36	12	10	10	-do-	-do-	38	13	13	14	-do-	-do-
62	40	8	12	12	-do-	-do-	40	13	13	14	-do-	-do-
63	35	11	10	10	-do-	-do-	37	12	12	13	-do-	-do-
64	34	13	10	11	-do-	-do-	37	13	12	12	-do-	-do-
65	36	10	10	11	-do-	-do-	38	13	13	14	-do-	-do-
66	28	7	7	8	-do-	-do-	34	11	11	12	-do-	-do-
67	32	9	9	8	-do-	-do-	36	12	12	13	-do-	-do-
68	37	12	11	11	-do-	-do-	38	13	13	13	-do-	-do-
69	29	8	7	7	-do-	-do-	35	12	12	12	-do-	-do-
70	41	13	12	12	-do-	-do-	41	13	13	14	-do-	-do-
71	38	12	11	11	-do-	-do-	38	13	13	14	-do-	-do-
72	33	10	9	9	-do-	-do-	36	12	12	13	-do-	-do-
73	29	8	7	7	-do-	-do-	35	13	12	12	-do-	-do-
74	36	11	10	10	-do-	-do-	38	13	13	12	-do-	-do-
75	34	10	10	11	-do-	-do-	37	12	12	13	-do-	-do-
76	33	10	9	9	-do-	-do-	36	12	12	13	-do-	-do-
77	36	12	11	11	-do-	-do-	38	13	13	14	-do-	-do-
78	31	9	8	8	-do-	-do-	36	12	12	13	-do-	-do-
79	33	9	9	10	-do-	-do-	36	13	12	12	-do-	-do-
80	30	8	8	9	-do-	-do-	35	12	12	13	-do-	-do-
81	35	11	10	10	-do-	-do-	37	12	12	13	-do-	-do-
82	32	10	9	9	-do-	-do-	36	13	12	12	-do-	-do-
83	37	12	11	11	-do-	-do-	38	13	13	12	-do-	-do-
84	39	13	12	12	-do-	-do-	39	13	13	12	-do-	-do-
85	32	10	9	9	-do-	-do-	36	13	12	12	-do-	-do-
86	37	10	11	11	-do-	-do-	38	12	13	13	-do-	-do-
87	31	9	8	8	-do-	-do-	36	12	12	13	-do-	-do-

88	34	11	10	10	-do-	-do-	37	12	12	12	-do-	-do-
89	38	11	11	12	-do-	-do-	38	13	13	12	-do-	-do-
90	35	10	10	11	-do-	-do-	37	13	12	12	-do-	-do-
91	35	10	10	11	-do-	-do-	37	12	12	13	-do-	-do-
92	39	13	12	12	-do-	-do-	39	13	13	12	-do-	-do-
93	31	8	8	9	-do-	-do-	36	12	13	13	-do-	-do-
94	38	11	12	12	-do-	-do-	38	13	12	14	-do-	-do-
95	37	12	11	11	-do-	-do-	38	14	13	13	-do-	-do-
96	33	9	9	10	-do-	-do-	36	13	12	12	-do-	-do-
97	38	11	12	11	-do-	-do-	38	13	13	14	-do-	-do-
98	35	10	10	11	-do-	-do-	37	13	12	12	-do-	-do-
99	39	11	12	12	-do-	-do-	39	13	13	14	-do-	-do-
100	31	9	9	10	-do-	-do-	36	12	12	13	-do-	-do-

Table 4: Showing measurements and insertion sites of anterior and posterior ligaments of right limbs (Dissection method)

All lengths recorded in mm.

Sl. No.	Parameter	Mean Values	Standard Deviation
1	Length	34.5mm	3.32
2	Proximal Width	10.23mm	1.6
3	Middle width	9.78mm	1.56
4	Distal width	10.06mm	1.48

Table 5: Showing mean value and standard deviation of various parameters of anterior cruciate ligament of right limb (Dissection Method)

Sl. No.	Parameter	Mean Values	Standard Deviation
1	Length	37.4mm	1.54
2	Proximal Width	12.59mm	0.63
3	Middle width	12.38mm	0.59
4	Distal width	12.90mm	0.82

Table 6: Showing mean value and standard deviation of various parameters of posterior cruciate ligament of right limb (Dissection Method)

MRI METHOD-MALE PATIENTS:

RIGHT KNEE JOINS: In MRI method, the length of ACL in right limbs of male patients ranged between 28-40mm with a mean value of 33.81mm (SD-4.14). Its proximal width ranged between 7-12mm with a mean value of 9.18mm (SD-1.77). Its middle width ranged between 7-11mm with a mean value of 9mm (SD-1.61). It's distal ranged between 7-12mm with a mean value of 9.36mm (SD-1.74). The ACL got insertion on to the posteromedial aspect of lateral femoral condyle proximally and anterior intercondylar area just anterior and slightly lateral to the medial tibial eminence partly blending with the anterior horn of the lateral meniscus distally (Table 7 & 8). The length of PCL ranged between 34-42mm with a mean value of 37.90mm (SD-2.46). Its proximal width ranged between 11-14mm with a mean value of 12.18mm (SD-1.16). Its middle width ranged between 11.13mm with a mean value of 11.09mm (SD-0.94). Its distal width ranged between 11-14mm with a mean value of 12.18mm (SD-1.16). The PCL got inserted proximally on to the lateral surface of the medial femoral condylar extending up on to the anterior part of the roof of the intercondylar notch and posteriorly in the intercondylar region and in a depression on the adjacent posterior tibia distally (Tables 7 & 9).

Sl. No.	Anterior Cruciate Ligament						Posterior Cruciate Ligament					
	Length	PW	MW	DW	Insertion sites		Length	PW	MW	DW	Insertion sites	
					Femur	Tibia					Femur	Tibia
					Postromedial aspect of Lateral Femoral condyle	Anterior Intercondylar area just anterior and slightly lateral to the medial tibial eminence partly blending with the anterior hom of the lateral meniscus					Lateral surface of the medial femoral condyle extending up on to the anterior part of the roof of the intercondylar notch	Posteriorly in the intercondylar region and in a depression on the adjacent posterior tibia
1	40	12	11	13	-do-	-do-	42	14	13	14	-do-	-do-
2	29	7	7	7	-do-	-do-	35	11	11	11	-do-	-do-
3	39	12	11	12	-do-	-do-	41	14	13	14	-do-	-do-
4	38	10	10	10	-do-	-do-	40	13	13	13	-do-	-do-
5	28	7	7	7	-do-	-do-	34	11	11	11	-do-	-do-
6	34	9	10	10	-do-	-do-	39	12	13	13	-do-	-do-
7	31	8	8	8	-do-	-do-	37	11	11	11	-do-	-do-
8	36	10	10	10	-do-	-do-	38	12	12	12	-do-	-do-
9	30	8	7	8	-do-	-do-	36	11	11	11	-do-	-do-
10	35	10	10	10	-do-	-do-	38	13	13	12	-do-	-do-
11	32	8	8	9	-do-	-do-	37	12	12	12	-do-	-do-

Table 7: Showing measurements and insertion sites of anterior and posterior cruciate ligaments of right knee joint of male patients limbs (MRI method)

Sl. No	Parameter	Mean Values	Standard Deviation
1	Length	33.81mm	4.14
2	Proximal Width	9.18mm	1.77
3	Middle width	9.00mm	1.61
4	Distal width	9.36mm	1.74

Table 8: Showing mean value and standard deviation of anterior cruciate ligament of right knee joint of male patients (MRI method)

Sl. No	Parameter	Mean Values	Standard Deviation
1	Length	37.90mm	2.46
2	Proximal Width	12.18mm	1.16
3	Middle width	11.09mm	0.94
4	Distal width	12.18mm	1.16

Table 9: Showing mean value and standard deviation of various parameters of posterior cruciate ligament of right limb (Dissection Method)

LEFT KNEE JOINTS: In MRI method, the length of ACL in right limbs of male patients ranged between 32-40mm with a mean value of 36.21mm (SD-2.45). Its proximal width ranged between 9-12mm with a mean value of 10.42mm (SD-1.15). Its middle width ranged between 9-12mm with a mean value of 10.14mm (SD-0.86). It's distal ranged between 9-12mm with a mean value of 10.64mm (SD-1.08).

The ACL got insertion on to the posteromedial aspect of lateral femoral condyle proximally and anterior intercondylar area just anterior and slightly lateral to the medial tibial eminence partly blending with the anterior horn of the lateral meniscus distally (Table 10&11).

The length of PCL left limbs ranged between 38-41mm with a mean value of 38.85mm (SD-1.29). Its proximal width ranged between 12-14mm with a mean value of 13.07mm (SD-0.47). Its middle width ranged between 12-13mm with a mean value of 12.5mm (SD-0.51). Its distal width ranged between 12-14mm with a mean value of 12.92mm (SD-0.73).

The PCL got inserted proximally on to the lateral surface of the medial femoral condylar extending up on to the anterior part of the roof of the intercondylar notch and posteriorly in the intercondylar region and in a depression on the adjacent posterior tibia distally (Tables 10&12).

Sl. No	Anterior Cruciate Ligament						Posterior Cruciate Ligament					
	Length	PW	MW	DW	Insertion sites		Length	PW	MW	DW	Insertion sites	
					Femur	Tibia					Femur	Tibia
					Posteromedial aspect of Lateral Femoral condyle	Anterior Intercondylar area just anterior and slightly lateral to the medial tibial eminence partly blending with the anterior hom of the lateral meniscus					Lateral surface of the medial femoral condyle extending up on to the anterior part of the roof of the intercondylar notch	Posteriorly in the intercondylar region and in a depression on the adjacent posterior tibia
12	37	10	10	10	-do-	-do-	38	13	12	13	-do-	-do-
13	33	9	9	10	-do-	-do-	38	13	12	13	-do-	-do-
14	37	10	10	10	-do-	-do-	39	13	13	13	-do-	-do-
15	35	10	10	10	-do-	-do-	38	13	12	13	-do-	-do-
16	33	9	9	10	-do-	-do-	38	13	12	12	-do-	-do-
17	40	12	12	12	-do-	-do-	42	14	13	14	-do-	-do-
18	38	12	11	12	-do-	-do-	39	13	13	13	-do-	-do-
19	32	9	9	9	-do-	-do-	38	13	12	12	-do-	-do-
20	34	10	10	10	-do-	-do-	38	13	13	12	-do-	-do-
21	38	12	10	12	-do-	-do-	39	13	13	13	-do-	-do-
22	37	10	10	10	-do-	-do-	38	13	12	13	-do-	-do-
23	36	10	10	10	-do-	-do-	38	13	12	12	-do-	-do-
24	38	12	11	12	-do-	-do-	40	12	13	14	-do-	-do-
25	39	11	11	12	-do-	-do-	41	14	13	14	-do-	-do-

Table 10: Showing measurements and insertion sites of anterior and posterior cruciate ligaments of right knee joint of male patients limbs (MRI method)

Sl. No	Parameter	Mean Values	Standard Deviation
1	Length	36.21mm	2.45
2	Proximal Width	10.12mm	1.15
3	Middle width	10.14mm	0.86
4	Distal width	10.64mm	1.08

Table 11: Showing mean value and standard deviation of anterior cruciate ligament of right knee joint of male patients (MRI method)

Sl. No	Parameter	Mean Values	Standard Deviation
1	Length	38.85mm	1.29
2	Proximal Width	13.07mm	0.47
3	Middle width	12.05mm	0.51
4	Distal width	12.92mm	0.73

Table 12: Showing mean value and standard deviation of various parameters of posterior cruciate ligament of right limb (MRI method)

FEMALE PATIENTS:

RIGHT KNEE JOINTS: In MRI method, the length of ACL in right limbs of female patients ranged between 31-39mm with a mean value of 35.5mm (SD-2.67). Its proximal width ranged between 8-11mm with a mean value of 9.8mm (SD-1.31). Its middle width ranged between 8-11mm with a mean value of 9.3mm (SD-0.9). It's distal ranged between 8-11mm with a mean value of 9.9mm (SD-1.09).

The ACL got insertion on to the posteromedial aspect of lateral femoral condyle proximally and anterior intercondylar area just anterior and slightly lateral to the medial tibial eminence partly blending with the anterior horn of the lateral meniscus distally (Table 13 & 14).

The length of PCL ranged between 37-41mm with a mean value of 38.1mm (SD-1.44). Its proximal width ranged between 11-13mm with a mean value of 12.1mm (SD-0.56). Its middle width ranged between 11-13mm with a mean value of 11.9mm (SD-0.87). Its distal width ranged between 11-13mm with a mean value of 11.9mm (SD-0.87).

The PCL got inserted proximally on to the lateral surface of the medial femoral condylar extending up on to the anterior part of the roof of the intercondylar notch and posteriorly in the intercondylar region and in a depression on the adjacent posterior tibia distally (Tables 13 & 15).

Sl. No	Anterior Cruciate Ligament						Posterior Cruciate Ligament					
	Length	PW	MW	DW	Insertion sites		Length	PW	MW	DW	Insertion sites	
					Femur	Tibia					Femur	Tibia
					Posteromedial aspect of Lateral Femoral condyle	Anterior Intercondylar area just anterior and slightly lateral to the medial tibial eminence partly blending with the anterior hom of the lateral meniscus					Lateral surface of the medial femoral condyle extending up on to the anterior part of the roof of the intercondylar notch	Posteriorly in the intercondylar region and in a depression on the adjacent posterior tibia
26	38	11	10	11	-do-	-do-	40	13	12	13	-do-	-do-

27	37	11	10	11	-do-	-do-	39	11	12	13	-do-	-do-
28	35	9	9	9	-do-	-do-	37	12	11	11	-do-	-do-
29	36	9	9	9	-do-	-do-	37	12	11	12	-do-	-do-
30	37	11	9	11	-do-	-do-	38	12	12	12	-do-	-do-
31	33	9	9	9	-do-	-do-	37	12	12	11	-do-	-do-
32	31	8	8	8	-do-	-do-	37	12	11	11	-do-	-do-
33	37	11	10	11	-do-	-do-	38	12	12	12	-do-	-do-
34	39	11	11	11	-do-	-do-	41	13	12	13	-do-	-do-
35	32	8	8	9	-do-	-do-	37	12	11	11	-do-	-do-

Table 13: Showing measurements and insertion sites of anterior and posterior cruciate ligaments of right knee joint of female patients limbs (MRI method)

Sl. No	Parameter	Mean Values	Standard Deviation
1	Length	35.5mm	2.67
2	Proximal Width	9.8mm	1.31
3	Middle width	9.3mm	0.94
4	Distal width	9.9mm	1.19

Table 14: Showing mean value and standard deviation of anterior cruciate ligament of right knee joint of female patients (MRI method)

Sl. No	Parameter	Mean Values	Standard Deviation
1	Length	38.1mm	1.44
2	Proximal Width	12.1mm	0.56
3	Middle width	11.6mm	0.51
4	Distal width	11.9mm	0.87

Table 15: Showing mean value and standard deviation of various parameters of posterior cruciate ligament of female patients (MRI method)

LEFT KNEE JOINTS: In MRI method, the length of ACL in right limbs of female patients ranged between 27-39mm with a mean value of 33.46mm (SD-3.60). Its proximal width ranged between 6-11mm with a mean value of 8.33mm (SD-1.54). Its middle width ranged between 6-10mm with a mean value of 8.2mm (SD-1.42). It's distal ranged between 6-11mm with a mean value of 8.53mm (SD-1.50).

The ACL got insertion on to the posteromedial aspect of lateral femoral condyle proximally and anterior intercondylar area just anterior and slightly lateral to the medial tibial eminence partly blending with the anterior horn of the lateral meniscus distally (Table 16 & 17).

The length of PCL in left limbs ranged between 33-41mm with a mean value of 37.13mm (SD-2.29). Its proximal width ranged between 10-13mm with a mean value of 11.46mm (SD-1.12). Its middle width ranged between 10-12mm with a mean value of 11.09mm (SD-0.88). Its distal width ranged between 10-13mm with a mean value of 11.53mm (SD-1.12).

The PCL got inserted proximally on to the lateral surface of the medial femoral condylar extending up on to the anterior part of the roof of the intercondylar notch and posteriorly in the intercondylar region and in a depression on the adjacent posterior tibia distally (Tables 16 & 18).

Sl. No	Anterior Cruciate Ligament						Posterior Cruciate Ligament					
	Length	PW	MW	DW	Insertion sites		Length	PW	MW	DW	Insertion sites	
					Femur	Tibia					Femur	Tibia
					Posteromedial aspect of Lateral Femoral condyle	Anterior Intercondylar area just anterior and slightly lateral to the medial tibial eminence partly blending with the anterior hom of the lateral meniscus					Lateral surface of the medial femoral condyle extending up on to the anterior part of the roof of the intercondylar notch	Posteriorly in the intercondylar region and in a depression on the adjacent posterior tibia
36	34	9	9	9	-do-	-do-	37	12	11	12	-do-	-do-
37	36	9	9	9	-do-	-do-	38	12	12	12	-do-	-do-
38	32	8	8	9	-do-	-do-	37	12	11	12	-do-	-do-
39	36	9	9	9	-do-	-do-	37	12	11	12	-do-	-do-
40	32	7	7	8	-do-	-do-	36	11	10	11	-do-	-do-
41	35	9	9	9	-do-	-do-	35	10	10	10	-do-	-do-
42	30	7	6	7	-do-	-do-	37	11	11	11	-do-	-do-
43	35	9	9	9	-do-	-do-	38	11	12	12	-do-	-do-
44	30	7	7	7	-do-	-do-	33	10	10	10	-do-	-do-
45	33	8	9	9	-do-	-do-	39	12	12	12	-do-	-do-
46	27	6	6	6	-do-	-do-	40	13	12	13	-do-	-do-
47	37	9	9	9	-do-	-do-	34	10	10	10	-do-	-do-
48	38	11	10	11	-do-	-do-	41	13	12	13	-do-	-do-
49	28	6	6	6	-do-	-do-	35	10	10	10	-do-	-do-
50	39	11	10	11	-do-	-do-	40	13	12	13	-do-	-do-

Table 16: Showing measurements and insertion sites of anterior and posterior cruciate ligaments of left knee joint of female patients (MRI method)

Sl. No	Parameter	Mean Values	Standard Deviation
1	Length	33.46mm	3.60
2	Proximal Width	8.33mm	1.54
3	Middle width	8.2mm	1.42
4	Distal width	8.53mm	1.50

Table 17: Showing mean value and standard deviation of anterior cruciate ligament of left knee joint of female patients (MRI method)

Sl. No	Parameter	Mean Values	Standard Deviation
1	Length	37.13mm	2.29
2	Proximal Width	11.46mm	1.12
3	Middle width	11.06mm	0.88
4	Distal width	11.53mm	1.12

Table 18: Showing mean value and standard deviation of various parameters of posterior cruciate ligament of left knee joints of female patients (MRI method)

DISCUSSION: Parameters of both anterior and posterior cruciate ligaments were obtained from 100 limbs by cadaveric dissection and in fifty knee joint MRI scans.

Mean of all parameters i.e. length, proximal width, middle width, distal width were calculated, insertion sites on femur and tibia were noted and compared with that of available previous studies.

LENGTH OF ANTERIOR CRUCIATE LIGAMENT: According to Odensten. Metal, Girgis et al, Duthon V Betal K.Antony Shaju-Anterior Cruciate Ligament-Injuries and Surgery,[(5)] M. Odensten et l(1993)- Reconstruction of the posterior cruciate ligament using a new drill-guide-Knee Surgery, sport Tramatology, Arthoscopy (1993) 1: 39-43,[(6)] Duthon VB et al (2006)-Anatomy of the anterior cruciate ligament-Knee Surgery, Sport Traumatology, Arthroscopy (2006) Mar; 14(3): 204-13.Epub 2005 Oct. 19)[(7)] the length of anterior cruciate ligament was found to be 3.5 to 4cms, 31±3 mm, 31 to 38 mm, 32mm respectively.

In the present study the length of anterior cruciate ligament by dissection method in rights limbs ranged between 28-40mm, with a mean value of 35.14mm (SD-3.36). In left limbs it ranged between 27-41mm, with a mean value of 34.5mm (SD-3.52).

In MRI method, in male patients it ranged between 28-40mm, with a mean value of 35.16mm (SD-3.44), in female patients it ranged from 27-39mm, with a mean value of34.28mm (SD-3.36).

In right knee joint of male patients it ranged between 28-40mm, with a mean value of 33.81mm (SD-4014), in left knee joints it ranged between 32-40mm, with a mean value of 36.21mm (SD-2.45).

In right knee joints of female patients ranged between 31-39mm, with a mean value of 35.5mm (SD-2.67), in left knee joints it range between 27-39 mm with a mean value of 33.46mm (SD-3.60).

Sl. NO	Studied by	Method	Mean Length and Standard Deviation
1	K. ANTONY SHAJU(K. Antony Shaju-Anterior Cruciate Ligament-Injuries and Surgery)	-	3.5-4cm
2	ODENSTEN.M ET AL[6](M.Odensten et l(1993)- Reconstruction of the posterior cruciate ligament using a new drill-guide-Knee Surgery, sport Tramatology, Arthoscopy(1993) 1: 39-43)	Dissection method	31±3mm
3	GIRGIS ET AL	-	31-38mm
4	DUTHON VB ET AL[7](Duthon VB et al(2006)-Anatomy of the anterior cruciate ligament-Knee Surgery, Sport Traumatology, Arthroscopy (2006) Mar; 14(3): 204-13.Epub 2005 oct 19)	-	32mm
5	PRESENT STUDY	Dissection Method	
		Tight limb	35.1mm±3.36
		Left limb	34.5mm±3.52
		MRI Method	
		Male Female	35.16mm±3.44 34.28mm±3.36
		Male	
		Right	33.81mm±4.14
		Left	36.21mm±2.45
		Female	
		Right	.5.5mm±2.67
		Left	33.46mm±.60

Table 19: Showing the comparative values of length of acl between various authors

According to Naveen chandrashekar et al, the anterior cruciate ligament in women was smaller in length, when compared to that of men (Naveen Chandrashekhar et al (2005 - Sex-Based Differences in the Anthropometric charachteristics of the Anterior Cruciate Ligament and its Relation to Intercondylar Notch Geometry – A cadaveric study – The American of Sport Medicine-October 2005, Vol-33, no.10, 1492-98).[(8)] In the present study the length of female ACL in right knee joints is greater than in males. Except this one the ACL lengths are smaller in females.

The smaller ligament size in women may contribute their having a higher rate of ligament injuries.

PROXIMAL WIDTH OF ANTERIOR CRUCIATE LIGAMENT: According to Lazar Stizak et al the male femoral ACL insertion (12mm) was significantly greater than female ACL femoral insertion (10mm)(Lazar Stizak et al (2009)–Correlation between the morphometric parameters of the anterior cruciate ligament and the intercondylar width: gender and age differences – knee surgery, sport Traumatology, Arthoscopy-2009 jul; 17(7): 812-7.Epub 2009 May 7).[9]

According to TakehikoIwahashi, the proximal width of ACL was 8.0±0.5mm. (Takehiko I wahashi et al (2010) – Direct Anterior Cruciate Ligament Insertion to the Femur Assessed by Histology and 3-Dimensional Volume Rendered Computed Tomography-The Journal of Arthroscopic and Related surgery Volume 26, Issue 9, supplement, pages s_{13}-s_{20}, September 2010).[10]

In the present study, the proximal width of anterior cruciate ligament by dissection method in right limbs ranged between7-13mm, with a mean value of 10.16mm (SD-1.56), in left limbs it ranged between 7-13mm, with a mean value of 10.23mm (SD-1.60).

In MRI method, in male patients, it ranged between 7-12mm with a mean value of 9.88mm (SD-1.56), in female patients it ranged between 6-11mm, with a mean value of 8.92mm (SD-1.60).

In right knee joints of male patients, it ranged between 7-12mm with a mean value was 9.18mm (SD-1.77), in left knee joints it ranged between9-12m with a mean value of 10.42mm (SD-1.15).

In right knee joints of female patients it ranged between8-11mm with a mean value was 9.8mm (SD-1.31), in left knee joints it ranged between 6-11mm with a mean value of 8.33mm (SD-1.54).

Sl. No.	Studied by	Method	Mean proximal width and Standard Deviation
1	LAZAR STIZAK Lazar Stizak et al (2009) – Correlation between the morphometric parameters of the anterior cruciate ligament and the intercondylar width: gender and age differences – knee surgery, sport Traumatology, Arthoscopy-2009 Jul; 17(7): 812-7.Epub 2009 May 7)[10]	Dissection method	
		Male	12mm
		Female	10mm
2	TAKEHIKO IWAHASHI(Takehiko I wahashi et al (2010) – Direct Anterior Cruciate Ligament Insertion to the Femur Assessed by Histology and 3-Dimensional Volume Rendered Computed Tomography-The Journal of Arthroscopic and Related surgery Volume 26, Issue 9, supplement, pages s_{13}-s_{20}, September 2010)[10]	3d volume rendered computed tomography	8.0±0.5mm

3	PRESENT STUDY	Dissection method	
		Tight limb	10.16±1.56mm
		Left limb	10.23±1.6mm
		MRI Method	
		Male	9.88±1.56mm
		Female	8.92±1.6mm
		Male	
		Right	9.18±1.77mm
		Left	10.42±1.15mm
		Female	
		Right	9.8±1.31mm
		Left	8.33±1.54mm

Table 20: Showing the comparative values of the proximal width of ACL between various authors

MIDDLE WIDTH OF ACL: According to Girgis et al, Duthon V B et al, Wheeless text book of orthopaedics, K Antony Shaju, the width of ACL were 11mm, 7-12mm, 1cm respectively.

In present study, the middle width of anterior cruciate ligament by dissection method in right limbs ranged between 7-13mm with a mean value of 10.02mm (SD-1.68), in left limbs it ranged between 7-12mm, with a mean value of 9.78mm (SD-1.56).

In MRI method, in male patients it ranged between 7-12mm with a mean value of 9.65mm (SD-1.35), in female patients it ranged between 6-11mm, with a mean value of 8.64mm (SD-1.35).

In right knee joints of male patients, it ranged between 7-11mm, with amean value of 9mm (SD-1.61). In left knee joints it ranged between 9-12mm, with a mean value of 10.14mm (SD-0.86).

In right knee joints of female patients it ranged between 8-11mm, with a mean value of 9.3mm (SD-0.94), in left knee joints it ranged between 6-10mm, with a mean value of 8.2mm (SD-1.42).

Sl. NO	Studied by	Method	Mean middle width and Standard Deviation
1	GRGIS ET AL	-	11mm
2	DUTHON VB — Anatomy of the anterior cruciate ligament-Knee Surgery, Sports Traumatology, Arthroscopy (2006) Mar; 14(3): 204-13.Epub 2005 oct 19)[7]	-	7-12mm

3	Wheeless Text book of Orthopedics	-	7-12mm
4	K. ANTONY SHAJU (K. Antony Shaju- Anterior Cruciate Ligament-Injuries and Surgery)	-	1cm
3	PRESENT STUDY	Dissection method	
		Tight limb	10.02±1.68mm
		Left limb	9.78±1.56mm
		MRI Method	
		Male	9.64±1.35mm
		Female	8.64±1.35mm
		Male	
		Right	9.0±1.61mm
		Left	10.14±0.86mm
		Female	
		Right	9.3±0.94mm
		Left	8.2±1.42mm

Table 21: Showing the comparative values of middle width of ACL between various authors

DISTAL WIDTH OF ACL: According to wheeless text book of orthopedics, the tibial attachment of ACL was 11mm.

In the present study, distal width of anterior cruciate ligament by dissection method in right limbs ranged between 7-13mm, with a mean value of 10.41mm (SD-1.66), in left limbs it ranged between 7-12mm, with a mean value of 10.06mm (SD-1.48).

In MRI method, in female patients it ranged between 7-12mm, with a mean value of 10.08mm (SD-1.52), in female patients it ranged between 6-11mm with a mean value of 9.08mm (SD-1.52).

In right knee joints of male patients, it ranged between 7-12mm with a mean value of 9.36mm (SD-1.74), in left knee joints it ranged between 9-12mm, with a mean value of 1.64mm (SD-1.08).

In right knee joints of female patients, it ranged between 8-11mm, with a mean value of 9.9mm (SD-1.19), in left knee joints it ranged between 6-11mm, with a mean value of 8.53mm (SD-1.50).

Sl. No.	Studied by	Method	Mean middle width and Standard Deviation
1	Wheeless text bool of orthopedics	-	11mm
2	Present study	Dissection method	
		Tight limb	10.41±1.66mm
		Left limb	10.06±1.48mm
		MRI Method	
		Male	10.08±1.52mm
		Female	9.08±1.52mm
		Male	
		Right	9.36±1.74mm
		Left	10.64±1.08mm
		Female	
		Right	9.9±1.19mm
		Left	8.53±1.50mm

Table 22: Showing the comparative values of distal width of ACL between various authors

INSERTION SITES OF ACL SEEN IN DISSECTION AND MRI METHODS: In the present study, the anterior cruciate ligament is attached to the anterointercondylar area of the tibia just anterior and slightly lateral to the medical tibial eminences partly blending with the anterior horn of the lateral meniscus. On the femur it is attaching to the postero medical aspect of lateral femoral candyle. These observations are similar to the previous studies.

LENGTH OF POSTERIOR CRUCIATE LIGAMENT: According to Girgis et al and M, Odensten et al (M. Odensten et al (1993) - Reconstruction of the posterior cruciate ligament using a new drill- guide-Knee Surgery, Sports Tramatology, Arthoscopy(1993) 1: 39 – 43)[6], the length of PCL were 38mm and 38±4mm respectively.

In the present study, the length of posterior cruciate ligament in dissection method, in right limbs ranged between 34-40mm, with a mean value of 37mm (SD-1.5). In the left limbs it ranged between 34-41mm, with a mean value of 37.04mm (SD-1.54).

In MRI method, in male patients it ranged between 34-42mm, with a mean value of 38.44mm (SD-1.91), in female patients it ranged between 33-41mm with a mean value of 37.52mm (SD-1.52).

In right knee joints of male patients, it ranged between 34-42mm with a mean value of 37.90mm (SD-2.46), in left side knee joints it ranged between 38-42mm, with a mean value of 38.85mm (SD-1.29).

In right knee joints of female patients, it ranged between 37-41mm with a mean value of 38.1mm (SD-1.44), in left knee joints it ranged between 33-41mm, with a mean value of 37.13mm (SD-2.29).

Sl. No.	Studied by	Method	Mean middle width and Standard Deviation
1	Dirgis et al	-	38mm
2	M.ODENSTEIN ET AL[6](M. Odensten et al (1993) - Reconstruction of the posterior cruciate ligament using a new drill-guide-Knee Surgery, Sports Tramatology, Arthoscopy(1993) 1: 39 – 43)	dissection	38±4mm
3	Present Study	Dissection method	
		Right limb	37±1.5mm
		Left limb	37.04±1.54mm
		MRI Method	
		Male	38.44±1.91mm
		Female	37.52±2.02mm
		Male	
		Right	37.90±2.46mm
		Left	38.85±1.29mm
		Female	
		Right	38.1±1.44mm
		Left	37.13±2.29mm

Table 23: Showing the comparative values of distal width of ACL between various authors

PROXIMAL WIDTH OF PCL: In the present study, the proximal width of posterior cruciate ligament in dissection method, in right limbs ranged between 12-14mm, with a mean value of 13.35mm (SD-0.72). In the left limbs it ranged between 11-14mm, with a mean value of 12.59mm (SD-0.63).

In MRI method, in male patients it ranged between 11-14mm, with a mean value of 12.68mm (SD-1.94), in female patients it ranged between 10-13mm with a mean value of 11.72mm (SD-0.97).

In right side of male patients, it ranged between 11-14mm with a mean value of 12.18mm (SD-1.16), in left side knee joints it ranged between 12-14mm, with a mean value of 13.07mm (SD-0.47).

In right side of female patients, it ranged between 11-13mm with a mean value of 12.1mm (SD-0.56), in left knee joints it ranged between 10-13mm, with a mean value of 11.46mm (SD-1.12). No previous literature was available regarding this parameter.

Sl. No.	Studied by	Method	Mean middle width and Standard Deviation
1	Present study	Dissection method	
		Right limb	13.35±0.72mm
		Left limb	12.59±0.63mm
		MRI Method	
		Male	12.68±0.94mm
		Female	11.72±0.97mm
		Male	
		Right	12.18±1.16mm
		Left	13.07±0.47mm
		Female	
		Right	12.1±0.56mm
		Left	11.46±1.12mm

Table 24: Showing values of proximal width of PCL in present study

MIDDLE WIDTH OF PCL: According to the literature available on Internet[4] (www.eORIF.com, Girgis.et.al) the width of PCL was 13mm.

In the present study, middle width of posterior cruciate ligament in dissection method, in right limbs ranged between 11-13mm, with a mean value of 12.58mm (SD-0.53). In the left limbs it ranged between 11-13mm, with a mean value of 12.38mm (SD-0.59).

In MRI method, in male patients it ranged between 11-13mm, with a mean value of 12.24mm (SD-0.77), in female patients it ranged between 10-12mm with a mean value of 11.28mm (SD-0.79).

In right knee joints of male patients, it ranged between 11-13mm with a mean value of 11.09mm (SD-0.94), in left knee joints it ranged between 12-13mm, with a mean value of 12.05mm (SD-0.51).

In right knee joint of female patients, it ranged between 11-12mm with a mean value of 11.6mm (SD-0.51), in left knee joints it ranged between 10-12mm, with a mean value of 11.06mm (SD-0.88).

Sl. No.	Studied by	Method	Mean middle width and Standard Deviation
1	INTERNET (www.eORIF.com, Girgis.et.al)	-	13mm

2	Present Study	Dissection method	
		Right limb	12.58±0.53mm
		Left limb	12.38±0.59mm
		MRI Method	
		Male	12.24±0.77mm
		Female	11.28±0.79mm
		Male	
		Right	11.09±0.94mm
		Left	12.05±0.51mm
		Female	
		Right	11.6±0.51mm
		Left	11.06±0.88mm

Table 25: Showing comparative value of middle width of PCL between various authors

DISTAL WIDTH OF PCL: The distal width of posterior cruciate ligament in dissection method, in right limbs ranged between 11-14mm, with a mean value of 12.95mm (SD-0.77). In the left limbs it ranged between 12-14mm, with a mean value of 12.88mm (SD-0.81).

In MRI method, in male patients it ranged between 11-14mm, with a mean value of 12.6mm (SD-1), in female patients it ranged between 10-13mm with a mean value of 11.68mm (SD-1.02).

In right knee joints of male patients, it ranged between 11-14mm with a mean value of 12.18mm (SD-1.16), in left knee joints it ranged between 12-14mm, with a mean value of 12.92mm (SD-0.73).

In right knee joint of female patients, it ranged between 11-13mm with a mean value of 11.9mm (SD-0.87), in left knee joints it ranged between 10-13mm, with a mean value of 11.53mm (SD-1.12). No previous literature was available regarding this parameter.

Sl. No.	Studied by	Method	Mean middle width and Standard Deviation
1	PRESENT STUDY	Dissection method	
		Right limb	12.95±0.77mm
		Left limb	12.9±0.82mm
		MRI Method	
		Male	12.6±1.00mm
		Female	11.68±1.02mm
		Male	
		Right	12.18±1.16mm
		Left	12.92±0.73mm
		Female	
		Right	11.9±0.87mm
		Left	11.53±1.12mm

Table 26: Showing values of distal width of PCL in present study

INSERTION SITES OF PCL SEEN IN DISSECTION AND MRI METHODS: In the present study the PCL is attached to the lateral surface of the medial femoral condyle and extends up on to the anterior part of the roof of the inter condylar notch. On tibia it is attaching posteriorly in the inter condylar region and in a depression on the adjacent posterior tibia. These observations are similar are similar to previous studies.

SUMMARY AND CONCLUSION: The present study was undertaken to know measurments i.e. length, proximal width, middle width and distal width of anterior and posterior cruciate ligaments includind insertion site.

Hundred disarticulated limbs (48 Right, 52 Left) were collected from Kakatiya Medical College, Warangal, Andhra Pradesh, Fifty MRI scans (25 Male, 25 Female) were collected from Vijaya Diagnostic Center, Hanamkonda, Warangal. In 25 male patient scans 11were of right knee joint scans and 14 were of left knee joint scans. In 25 female patient scans 10 were of right knee joint scans and 15 were of left knee joint scans.

LENGTH: The present study shows that the mean length of ACL in right limbs was 35.1mm (SD-3.36), in left limb it was34.5mm (SD-3.52), and in male MRI scans it was 35.16mm (SD-3.44), (Right-33.81±4.14mm, Left-36.21±2.15mm), in female MRI scans it was 37.52mm (SD-2.02), Right-35.5±2.67 mm, Left -33.46±3.60mm).

The mean length of PCL in right limbs was 37mm (SD-1.5), in left limbs it was 37.04mm (SD-1.74), in male MRI scans it was 38.44mm (SD-1.91)(Right 37.90±2.46 mm, Left 38.85±1.29mm), in female MRI scans it was 37.52mm (SD-2.02), (Right 38.1±1.44mm, Left 37.13±2.29mm).

These result were very close to the available literature.

PROXIMAL WIDTH: The mean proximal width of ACL in right limbs was 10.16mm (SD-1.56), in left limbs it was 10.23mm (SD-1.60), in male MRI scans it was 9.88mm (SD-1.56), (Right 9.18±1.77mm, Left 10.14±0.86mm), in female MRI scans it was 8.92mm (SD-1.60), (Right 9.8±1.31mm, Left 8.33±1.54mm).

The mean Proximal width of PCL in right limbs was 13.35mm (SD-0.72), in left limbs it was 12.59mm (SD-0.63), in male MRI scans it was 12.68mm (SD-0.94), (Right 12.18±1.16 mm, Left 13.07±0.47mm), in female MRI scans it was 11.72mm (SD-0.97), (Right12.1±0.56mm, Left 11.46 ± 1.12mm).

These result were very close to the available literature.

MIDDLE WIDTH: The mean Middle width of ACL in right limbs was 10.02mm (SD-1.68), in left limbs it was 12.38mm (SD-0.59), in male MRI scans it was 9.64mm (SD-1.35), (Right 9±1.61mm, Left 10.14±0.86mm), in female MRI scans it was 12.24mm (SD-0.77), (Right 9.3±0.94mm, Left 8.2±1.42mm).

The mean Middle width of PCL in right limbs was 12.58mm (SD-0.53), in left limbs it was 12.38mm (SD-0.59), in male MRI scans it was 12.24mm (SD-0.77), (Right 11.09±0.94 mm, Left 12.5±0.51mm), in female MRI scans it was 11.28mm (SD-0.79), (Right11.6±0.51mm, Left 11.06 ± 0.88mm).

These result were very close to the available literature.

DISTAL WIDTH: The mean distal width of ACL in right limbs was 10.41mm (SD-1.66), in left limbs it was 10.06mm (SD-1.48), in male MRI scans it was 10.08mm (SD-1.52), (Right 9.36±1.74mm, Left 10.14±1.08mm), in female MRI scans it was 9.08mm (SD-1.52), (Right 9.9±1.19mm, Left 8.53±1.50mm).

The mean distal width of PCL in right limbs was 12.95mm (SD-0.77), in left limbs it was 12.90mm (SD-0.82), in male MRI scans it was 12.6mm (SD-1.0), (Right 12.18±1.16 mm, Left 12.92±0.73mm), in female MRI scans it was 11.68mm (SD-1.02), (Right11.9±0.87mm, Left 11.53 ± 1.12mm).

These result were very close to the available literature.

The parameters which were measured are helpful in selection and preparation of the graft and in reconstruction of ligamnets. The aim of reconstruction is not just to substitute a torn ligament, but to restore the morphology inherent in the ligament.

GRAFT SELECTION: The graft can be auto graft, allograft, artificial ligaments or a combination of these.

Pateller tendon, semitendinosus tendon, Gracillis tendon and iliotibial band are used as grafts for ACL tears.

Pateller tendon graft, the hamstrings and the quadriceps tendon are used as the auto grafts for PCL tears.

Allograft tissues are increasingly being used for primary PCL reconstruction.

Photograph 1: Instruments used in dissection method

Photograph 2: Formalin preserved limbs.

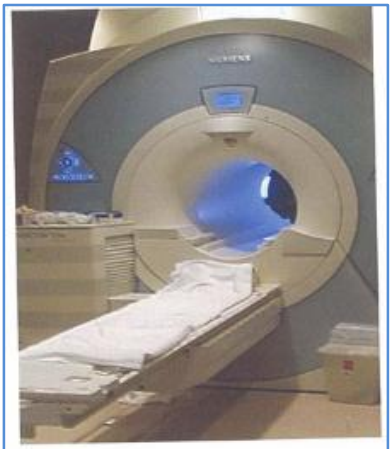


Figure 1: MRI machine

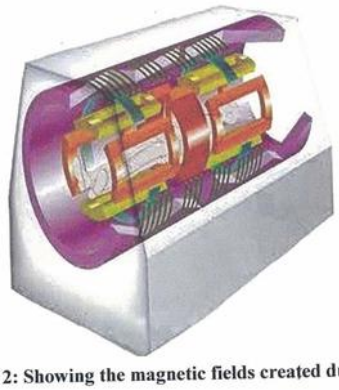
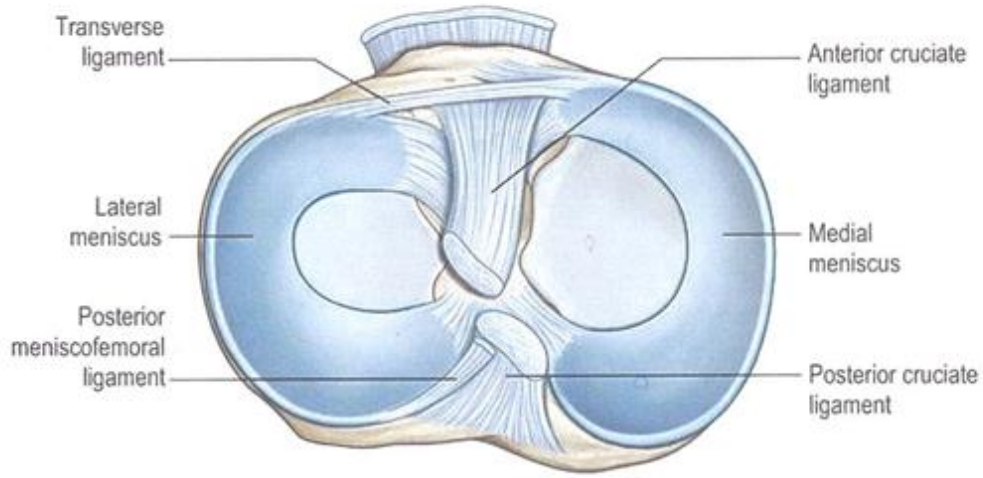


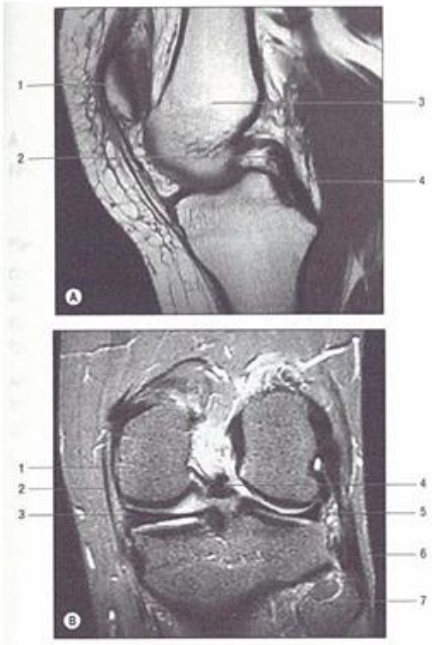
Figure 2: Showing the magnetic fields created during MRI

The left tibial plateau. 1. Tibial tuberosity. 2. Attachment of anterior horn, lateral meniscus. 3. Lateral condyle. 4. Attachment of posterior horn, lateral meniscus. 5. Attachment of anterior horn, medial meniscus. 6. Attachment of anterior cruciate ligament. 7. Medial condyle. 8. Intercondylar eminence. 9. Attachment of posterior horn, medial meniscus. 10. Attachment of posterior cruciate ligament.

Figure 3: Showing attachment areas of anterior and posterior cruciate ligaments on tibia



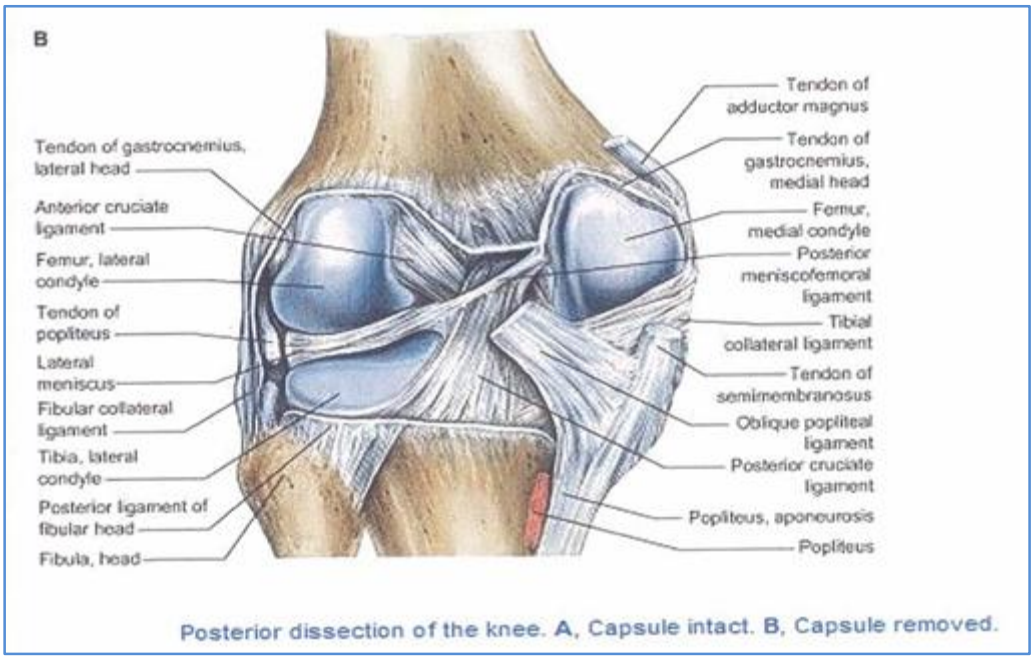
Superior aspect of the left tibia, showing the menisci and the attachments of the cruciate ligaments.



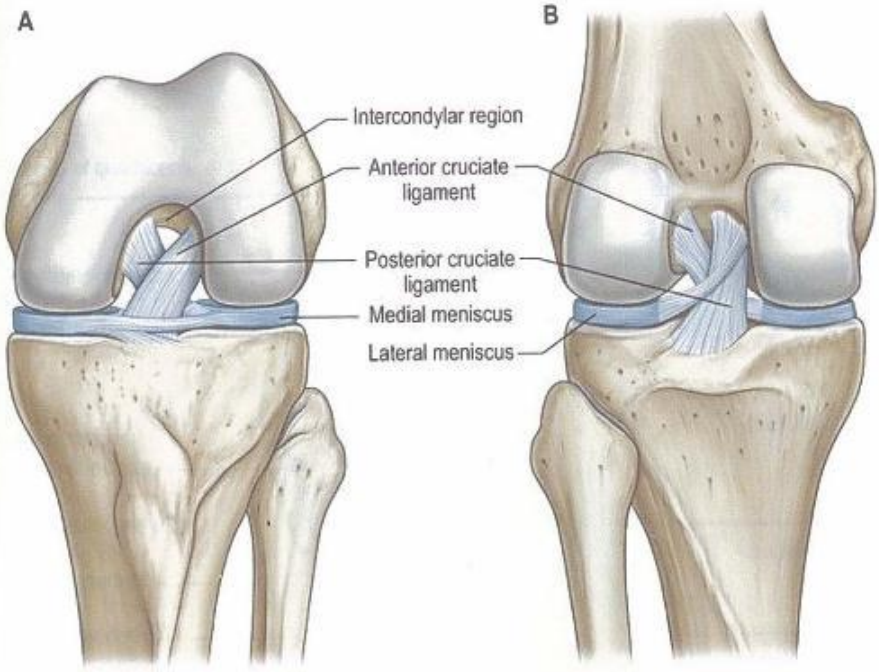
A, Sagittal T1-weighted and B, coronal STIR magnetic resonance images (MRI) of the knee in an adult male showing the anterior meniscofemoral ligament. A: 1. Patella. 2. Anterior meniscofemoral ligament of Humphry. 3. Epiphysial line. 4. Posterior cruciate ligament. B: 1. Anterior meniscofemoral ligament of Humphry. 2. Medial collateral ligament. 3. Medial meniscus. 4. Posterior cruciate ligament. 5. Lateral meniscus. 6. Lateral collateral ligament. 7. Head of fibula.

Figure 5: Showing the MRI Images of the knee in an adult male with various ligaments of knee joint.

Figure 6: Showing the medial soft tissues of knee joint



Posterior dissection of the knee. A, Capsule intact. B, Capsule removed.



The left knee joint. A, Anterior aspect in full flexion. B, Posterior aspect in extension.

Figure 9: Showing the knee in flexion and extension

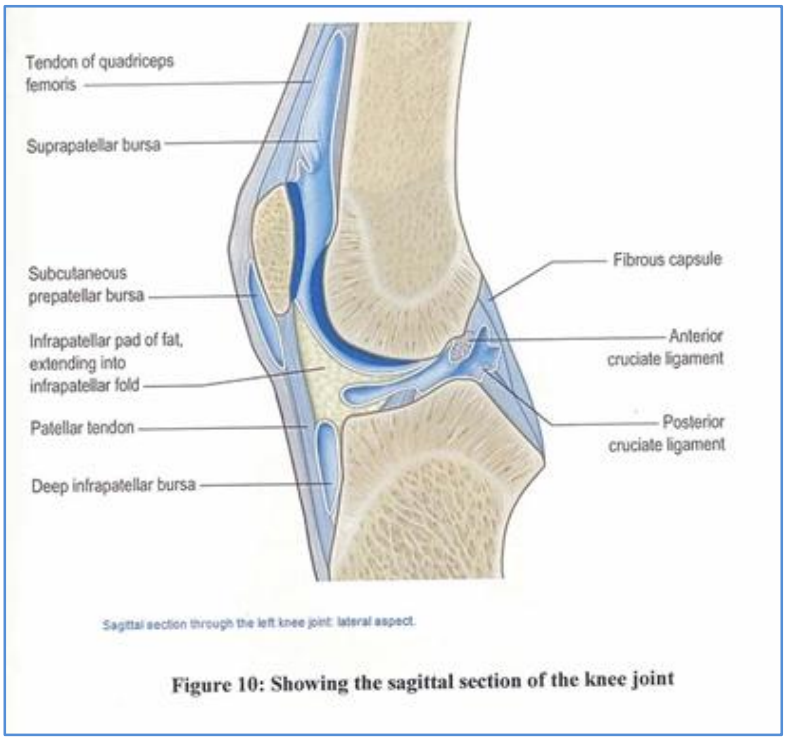


Figure 10: Showing the sagittal section of the knee joint

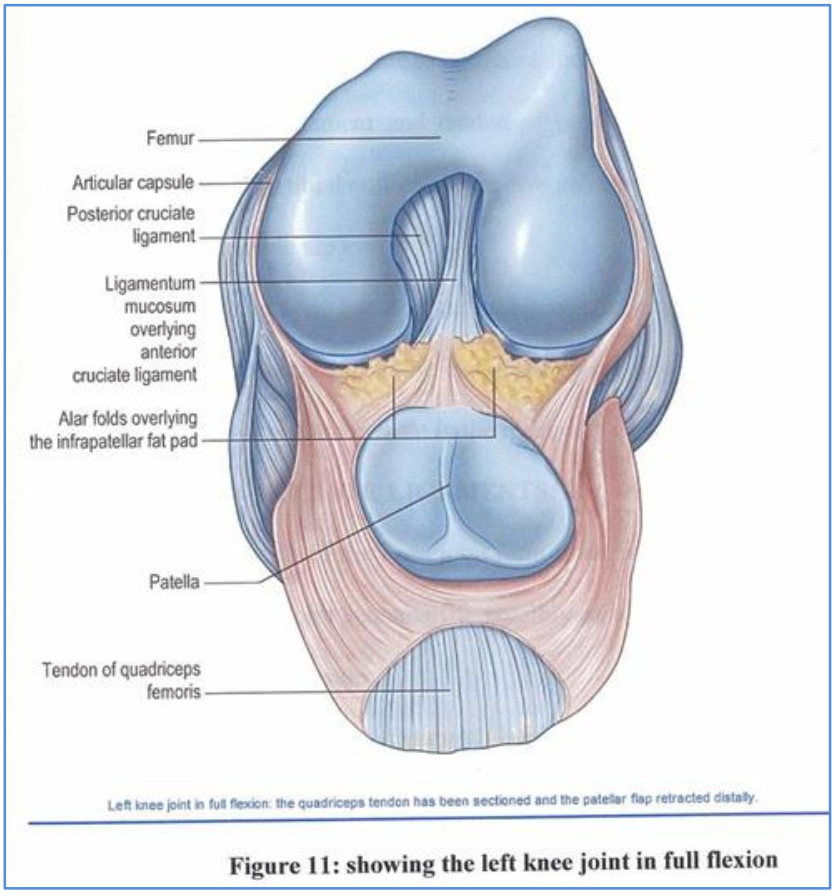
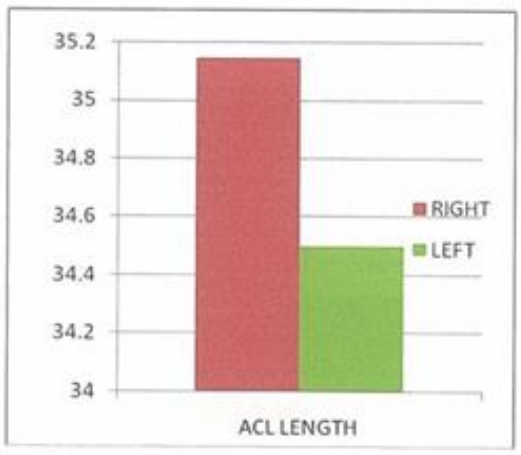
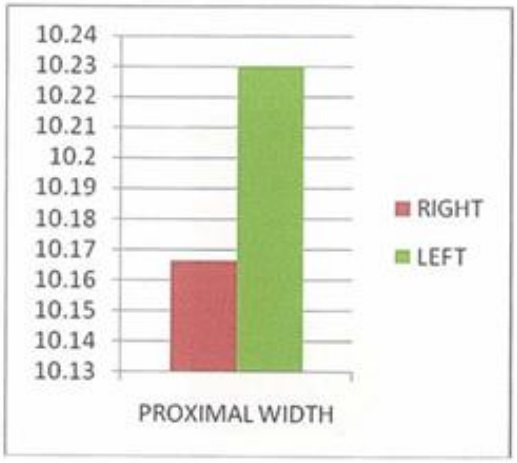
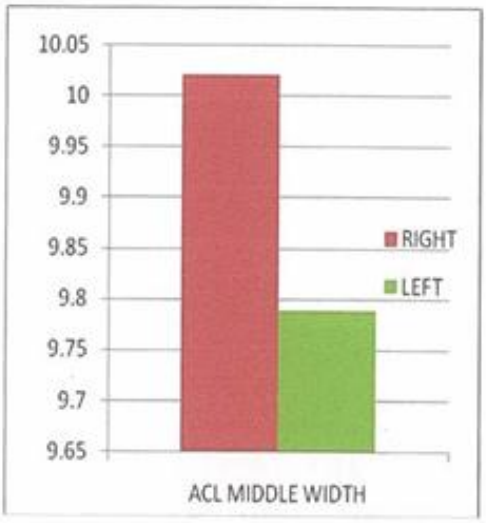
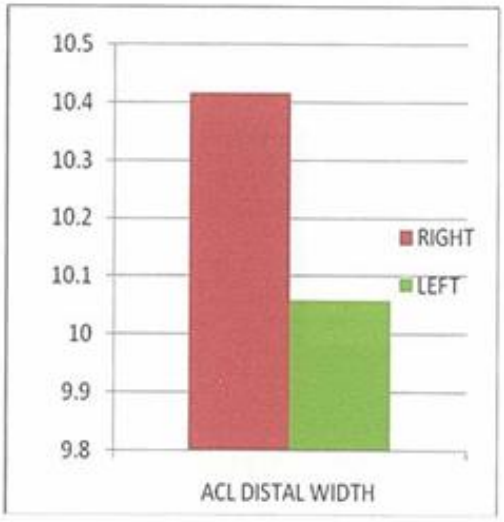


Figure 11: showing the left knee joint in full flexion



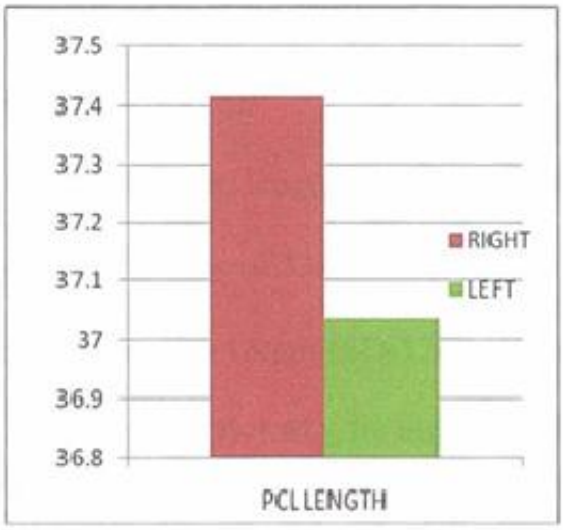


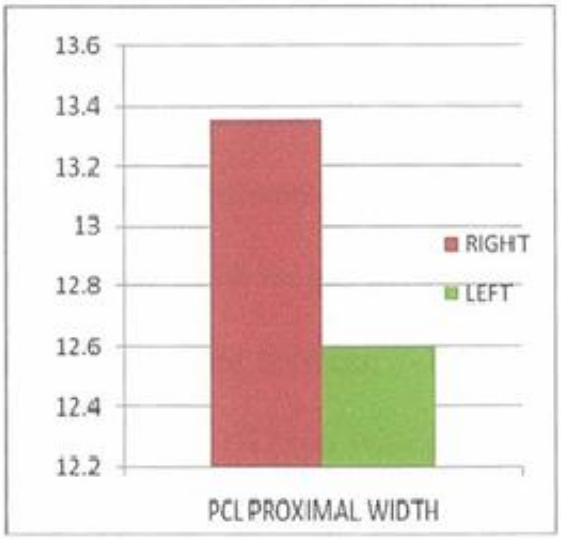


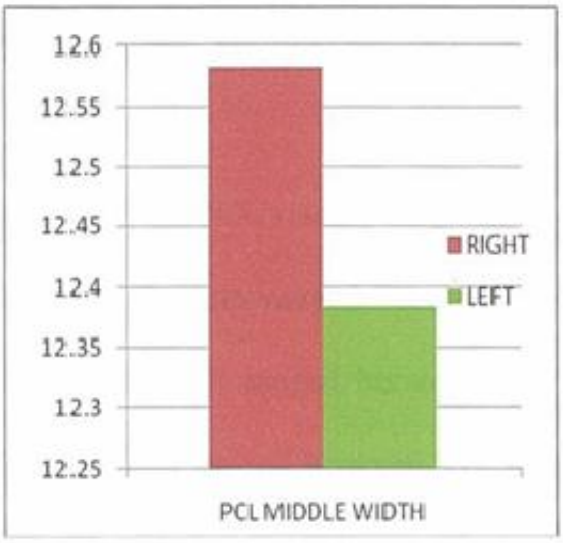


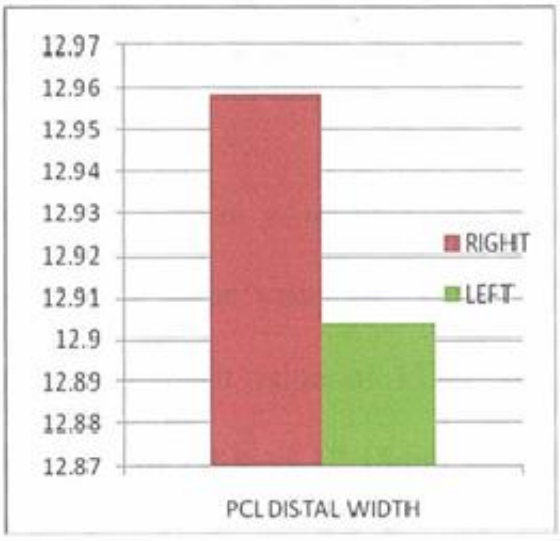
(All lengths recorded in mm)

Rep: 1 Bar diagrams showing comparison of various parameters of anterior cruciate ligament between right and left limbs.



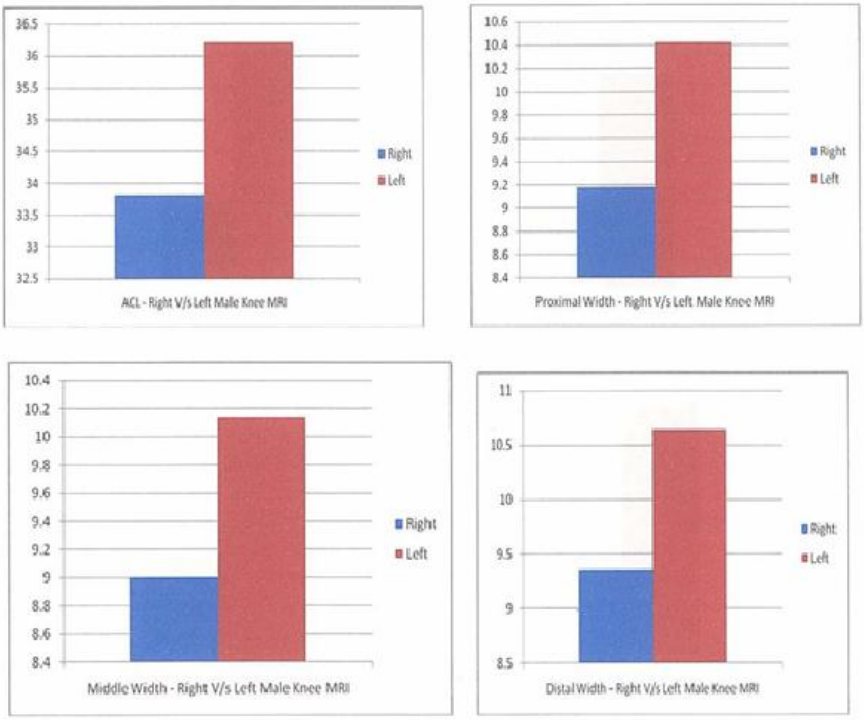




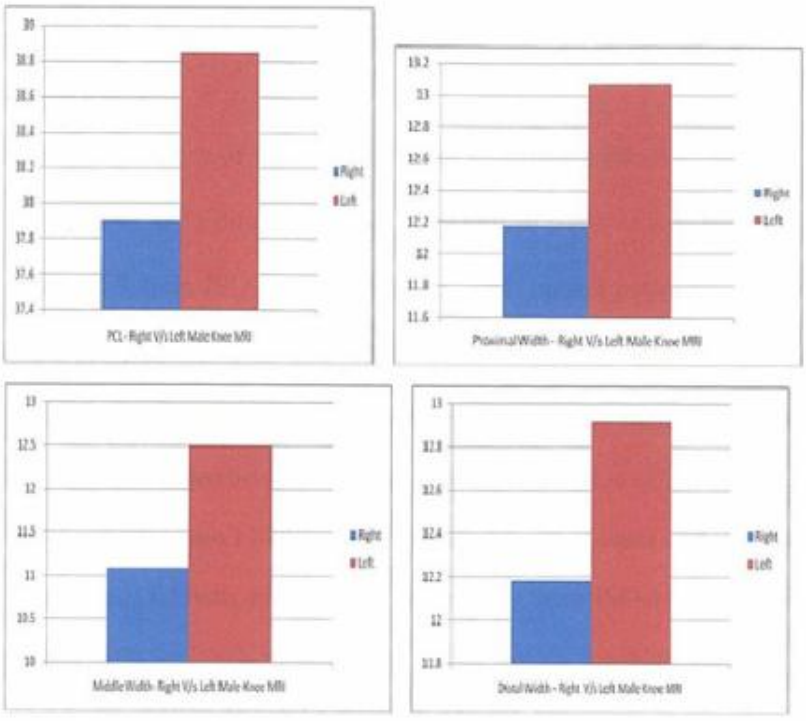


(All lengths recorded in mm)

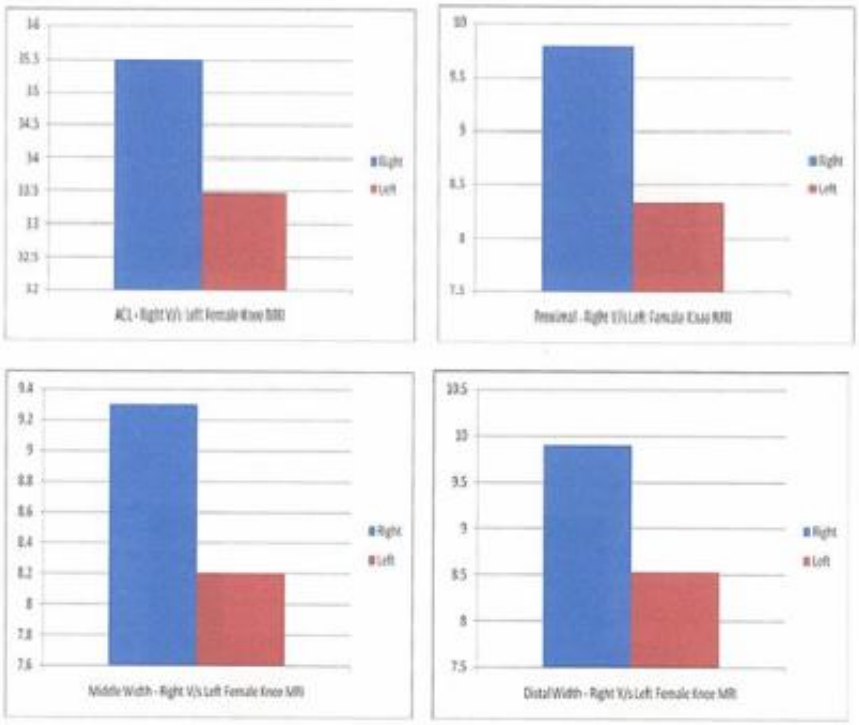
Rep 2: Bar diagrams showing comparison of various parameters of posterior cruciate ligament between right and left limbs.



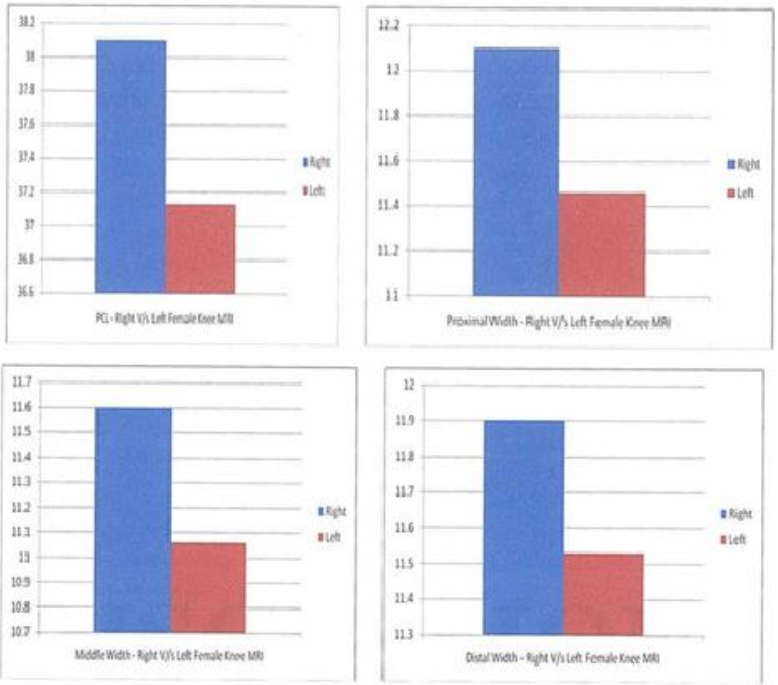
Rep 3: Bar diagrams showing comparison of various parameters of anterior cruciate ligaments between right and left limbs of male patients (MRI Method)



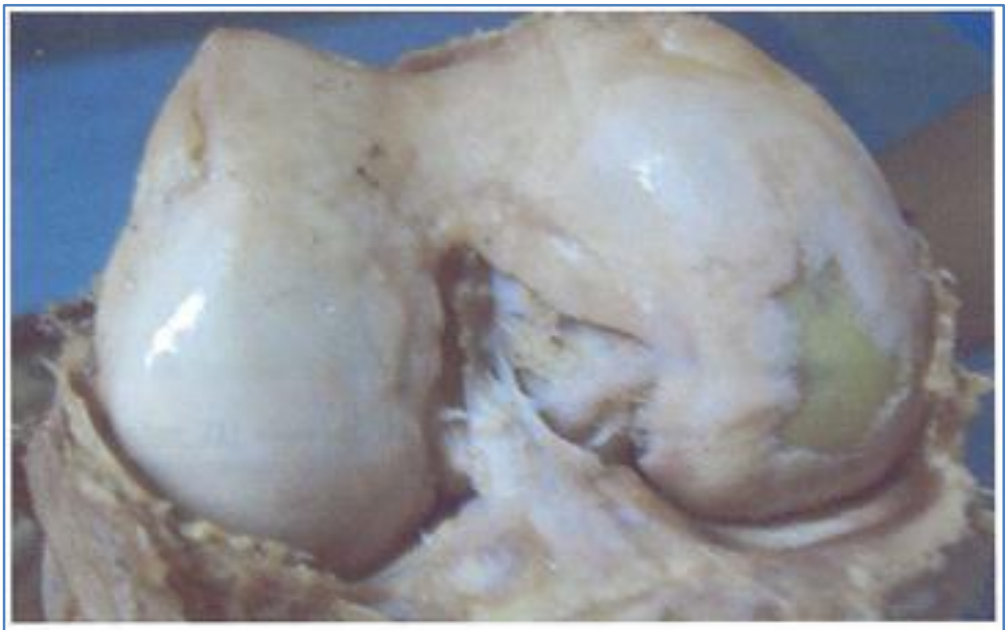
Rep 4: Bar diagrams showing comparison of various parameters of posterior cruciate ligaments between right and left limbs of male patients (MRI Method).



Rep 5: Bar diagrams showing comparison of various parameters of anterior cruciate ligaments between right and left limbs of female patients (MRI Method).



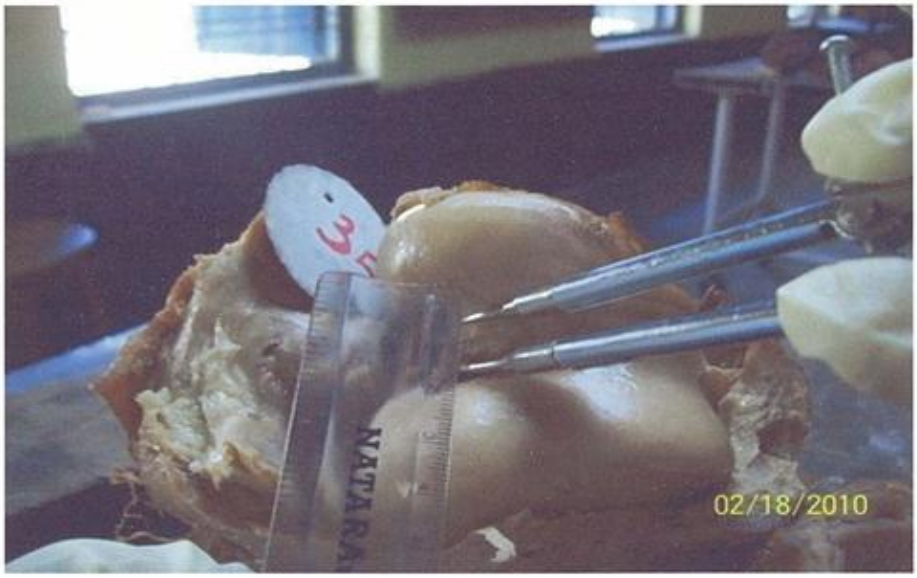
Rep 6: Bar diagrams showing comparison of various parameters of posterior cruciate ligaments between right and left limbs of female patients (MRI Method).



Photograph 3: Specimen showing cruciate ligaments.

Specimen number 21: showing the procedure of measuring the proximal width of anterior cruciate ligament.

Photograph 4: Specimen number 21.



Specimen number 35: showing the procedure of measuring the middle width of anterior cruciate ligament

Photograph 5: specimen number 35.

Specimen number 58: Showing the procedure of measuring the distal width of anterior cruciate ligament.

Photograph 6: Specimen number 58.

Photograph 7: MRI of a 42 year old male patient showing ACL and PCL.

Photograph 8: MRI of a 55 year old male patient showing ACL and PCL.

Photograph 9: MRI of a 32 year old female patient showing ACL and PCL.

Photograph 10: MRI of a 42 year old female patient showing ACL and PCL.

Photograph11: MRI of a 37 year old male patient showing ACL and PCL.

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