"FUNCTIONAL OUTCOME OF ANATOMICAL RECONSTRUCTION OF ANTERIOR CRUCIATE LIGAMENT WITH HAMSTRING GRAFT – A ONE YEAR HOSPITAL BASED – OBSERVATIONAL STUDY"

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ABBREVIATIONS

ACL : ANTERIOR CRUCIATE LIGAMENT

ADT : ANTERIOR DRAWER TEST

AP : ANTERO-POSTERIOR

BPTG: BONE PATELLAR TENDON GRAFT

CBC : COMPLETE BLOOD COUNT

ESR : ERYTHROCYTE SEDIMENTATION RATE

LM : LATERAL MENISCUS

LT : LACHMAN TEST

MM : MEDIAL MENSICUS

MRI : MAGNETIC RESONANCE IMAGING

PCL : POSTERIOR CRUCIATE LIGAMENT

PDGF: PLATELET DERIVED GROWTH FACTOR

PDT : POSTERIOR DRAWER TEST

PST : PIVOT SHIFT TEST

RBS : RANDOM BLOOD SUGAR

RCT : RANDOMIZED CONTROL TRIAL

ROM : RANGE OF MOVEMENT

SLR : STRAIGHT LEG RAISING

TGF : TRANSFORMING GROWTH FACTOR

VEGF: VASCULAR ENDOTHELIAL GROWTH FACTOR

WBTT: WEIGHT BEARING TILL TOLERANCE

ABSTRACT

TITLE: "FUNCTIONAL OUTCOME OF ANATOMICAL RECONSTRUCTION OF ANTERIOR CRUCIATE LIGAMENT WITH HAMSTRING GRAFT – A ONE YEAR HOSPITAL BASED – OBSERVATIONAL STUDY"

INTRODUCTION:

Knee injuries are more common in the modern era due to increase in the road traffic accidents and more involvement in sports related activities by young people. Anterior cruciate ligament is the often injured ligament around knee joint. Anterior cruciate ligament has a pivot role in function and stability of the knee joint, being the primary stabilizer preventing the anterior translation of tibia over femur. Arthroscopic anterior cruciate ligament reconstruction has become the gold standard in the management of these injuries.

OBJECTIVE OF THE STUDY:

To assess the functional outcome of anatomical reconstruction of ACL with quadrupled hamstring graft using Lysholm knee score.

MATERIALS AND METHODS:

Patients with post traumatic anterior cruciate ligament injury admitted to the Department of Orthopaedics at the KLE'S DR. PRABHAKAR KORE HOSPITAL AND MEDICAL RESEARCH CENTRE AND CHARITABLE HOSPITAL, BELAGAVI in between 1st January 2019 to 31st December 2019, over a period of one year – hospital based observational study.

RESULTS:

The study group comprised of 30 patients. In our study the most common mode of injury was found to be Road traffic accident followed by sports. Abundant of the patients were in the age group of 18-25yrs. In our study 13 patients had isolated ACL injury, 11 patients had medial meniscus injury, 4 patients had lateral meniscus injury and 2 patients had both the meniscus injured. It is found that 57% of them associated meniscal injury. Functional outcome was assessed using LYSHOLM and GILLQUIST SCORE. At the end of 9^{th} month follow up 80% of the patient had excellent score which were 57% at the 3^{rd} month. 13% of patient had good score at the end of 9^{th} month and 7% of patient had fair score. None of the patient had poor score.

CONCLUSION:

Anatomical reconstruction of ACL with quadrupled hamstring graft gives better clinical outcomes. The advantage of using hamstring graft are reduced donor site morbidity and less anterior knee pain in long term follow up. It has better subjective and objective functional outcome with low graft rejection or failure rate.

KEY WORDS: ARTHROSCOPIC ACL RECONSTRUCTION, HAMSTRING GRAFT, ENDOBUTTON, QUADRUPLED HAMSTRING GRAFT, LYSHOLM AND GILLQUIST SCORE

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INTRODUCTION

The knee joint is composite and prodigious joint which is contrived by three bones and immense network of ligaments and muscles. As Knee joint is one of the weight bearing joint, it plays a vital role in supporting the body in dynamic and static situation and is also subjected to tremendous forces during meticulous activities. Out of other joints in our body, knee is the often injured joint and ACL is commonly injured ligament. In this competitive world many teenagers and young adults who are obsessed with the sports and so the occurrence of ACL injury is more among them. The disruption of ACL will influence the normal kinematics of the knee leading to the instability of the knee during acceleration, deceleration and rotational activities which may end up in mechanical failure and swaying away[1].

Until late 1890, ACL injury was considered as end of the career in a sports person. Therefore, reconstruction of ACL is necessary and techniques are crucial and have evolved over a few decades in terms of choice of the graft and in surgical techniques. ACL injuries are frequently associated with meniscus and osteochondral injuries which need to be considered during the surgical repair else the person will progress towards degenerative changes of the knee[2].

Open reconstruction of ACL which has complications like post operative knee pain, stiffness, prolonged period of rehabilitation. Considering these complications and time consuming procedure, Arthroscopic reconstruction of ACL has become the gold standard procedure in recent times.[3]

If surgery is indicated for reconstruction of ACL, then the use of autologous tendon grafts for the substitution of the injured ligament is endorsed[4]. But the graft of choice is still in altercation.

Arthroscopic ACL reconstruction, with both BPTG and hamstring graft has gained popularity in recent times.

Rehabilitation following ACL reconstruction has emerged with time and is more emphasized on strengthening of the muscles and joint kinematics. An ACL deficient knee must be reconstructed to an ACL efficient knee by all means.

AIM

"Functional outcome of anatomical reconstruction of anterior cruciate ligament with hamstring graft – a one year hospital based – observational study".

OBJECTIVE

To assess the functional outcome of anatomical reconstruction of Anterior Cruciate Ligament with quadrupled hamstring graft using Lysholm knee score.

REVIEW OF LITERATURE

The joint stabilizing property of anterior cruciate ligament was first described by Galen in 170 AD[5].

The first ACL injury was described by the Ancient Greeks[5].

In 1806, the first ever endoscope was devised by Bozzini to visualize the vagina and rectum with a tube, lighting provided by a candle.

Role of ACL in the integrity of knee joint was studied by George K. Noulis[6] in the year 1875. During his study period he invented a clinical test called Lachman Test and wrote a paper on "knee sprain"

In 1895 the first ACL repair was done by Mayo Robson[7] by refastening anterior cruciate ligament from femoral attachment using a catgut ligature.

In 1917, first ACL reconstruction was done by Ernest W. Hey Groves[8] using iliotibial transplant. Alwyn Smith, augmented this technique by reinforcing the medial side.

In 1845 Amade Bonnet[9], described the necessary signs of ACL injury as a "snapping noise, hemarthrosis and loss of function in patients who have not sustained fracture are feature of knee ligament injury".

Avulsion fracture of anterolateral margin of tibia associated with ACL ruptures was described by Paul F Segond[10].

In 1926, Bennett[11] described an extra-articular procedure of medial capsule plication and reinforcement with fascia.

Later Mauck[12]in 1936 portrayed a extra-articular procedure, by advancing the bony tibial attachment of medial collateral ligament distally.

In 1930's to 1940 Intra-articular reconstruction ACL drastically evolved.

In 1935 Campbell[13], made use of a distal graft formed by the medial portion of the patella and quadriceps tendon along with its capsule routed through femoral and tibial tunnels.In the same year Bosworth reported extra-articular reconstruction using fascia lata graft.

In 1939, H.B.Macey[14] was the first to do intra-articular reconstruction of ACL with ST graft. He fixed the graft at the tibial side and at femoral side graft sutured to periosteum in full extension of knee.

The initial structuring of the current day techniques of ACL reconstruction was seeded between the years of 1950 to 1960.

In 1956 Augustine[15]vanquished dynamic ACL reconstruction by placing semitendinosus tendon.

In 1950, O' Donoghue[16] described about the "Unhappy triad" which includes rupture of ACL, medial collateral ligament and medial meniscus tear.

Kenneth G.Jones[17,18]in 1963 conceptualized the usage of central part of PTB graft. The ligament was secured to the periosteum at the superolateral exit site on the femur.

Pivot shift test first described by Galway[19] in 1972, variation of this test was described by Larson and Losee et al.

In late 1970's the primary repair of ACL was redefined and open primary repair was considered as gold standard for ACL treatment.

Rubin et al[20] in 1975 made a prosthetic ACL using Dacron.

Knee ligament instability was first classified by Hughston[21] et al in 1976.

In 1987 Kurosaka[22] et al in their study found that the weakest point in the reconstruction was in the fixation site till the graft heals. This led to remarkable invention of diverse fixation devices.

Reconstruction of ACL using gracilis was described by McMaster and Thompson[23].

Carbon fibre ligament was used in reconstruction of Anterior Cruciate Ligament in 1983 by Rushton[24].

Boltanand Brickman[25] devised first ever prosthetic ACL using polytetraflurothylene(Gore-Tex)

Dacron as a substitute for cruciate ligament was used in 1987 by Rodney, Rubin and Paddu[26]

In 1988 MJ Freidman[27] pioneered use of four stranded hamstring in arthroscopic assisted technique.

In 1992 Tom Roseberg devised Endobutton as fixation device for ACL reconstruction.

Polyethylene anchor was first used by L.Paulos[28] to fix graft in tibial tunnel and Biodegradable interference screw fixation was first described by A.Staehelin[29].

Use of knee brace after reconstruction for six months to enhance graft healing was described by Beynnonet al[30] in 1992

Ray et al[31] in 1988 compared the conservative treatment of ACL injuries with surgical treatment and found that the surgical treatment had superior results in functional outcome.

Morey et al[32] prospectively compared 20 patients operated with single bundle and 20 patients with double bundle for 48 months and concluded clinical stability is better with double bundle reconstruction of ACL.

Rachel M Frank et al[33], in their study they described about technique for harvesting Hamstring graft and its advantage over the Patellar tendon bone graft.

Silva A and Sampaio R[34] proposed a technique that aims to slender gracilis and protect bone stock. Also mentioned about quadrupled graft using semitendinosus and the construct is fixed with the endobutton in both tunnels.

Gandolfi M et al [35] assessed sensorimotor integration in 26 patients who had under ACL reconstruction using semitendinosus graft and concluded 85% patient regained balance at the end of six months.

Yunes et al reported better stability was attained with BPTG but the drawback is higher incidence of anterior knee pain in their three year follow up study.

Michael Wagner et al[36] concluded that hamstring graft has better credibility and superior to other grafts and recommending quadrupled hamstring graft in atheletes.

Bressyet al[37] in their prospective study of assessing the stability among 36 patients who had associated meniscal injury with ACL concluded that meniscus injury does not influence the post-operative laxity.

Dann T Culick et al stated "Irrespective of the type of graft used, fixation of the graft is usually the site of failure rather than the graft itself. This usually occurs during early rehabilitation phase as the graft integration has not occurred during this

time. The fixation is of less significance after two to three months as the graft would have integrated with the bone".

Shelbourne et al. in their study concluded that "ACL reconstruction within first week of injury had a high incidence of arthrofibrosis compared to those who underwent surgery after 3 weeks". Therefore injury to surgery interval necessary for the injured knee to become free of irritation.

HristijaiKostovetal[38] in their study comparing various modes of femoral hamstring graft fixation found that endobutton gives a better functional outcome than rigidfix and transfix fixation systems.

More recent studies have proved quadrupled hamstring is superior in strength but time for healing, probable loss of strength during healing and minimal hamstring weakness post operatively are considerations. Though bone patellar tendon bone graft has theoretical advantage of bone to bone healing the limitation of size and strength of the graft, incidence of quadriceps weakness and anterior knee pain are considerable

Bioabsorbable implants inOrthopaedic Surgery was introduced by Rokkanan et al[39] and Bostman et al for use in surgery of the ankle. In 1987, Kurosaka[40] introduced the current concepts of interference screw fixation

Arthroscopic ACL reconstruction procedure was started in the early 90's now has become a standardized procedure for ACL reconstruction. Studies are still being carried out on the different allografts for ACL reconstruction and fixation devices for graft.

ANATOMY

EMBRYOLOGY

In fetal development around 48th day ACL is identified as the condensation of blastoma. It originates as a anterior ligament and gradually progress towards the formation of intercondylar space. Menisci also embryogenitically gets its origin from the same blastoma. On the 16 th week of fetal development two bundles i.e. anteromedial and posterolateral can be appreciated. Since the ACL and Menisci are originated from the same blastoma they function with one accord.

GROSS ANATOMY

ACL is an extra-synovial and intra-articular structure that connects femur and tibia with its fascicles of thick connective tissue. It gets it origination from the medial surface of posterior aspect of lateral condyle and inserts into the center of tibial spine. Length of the ligament is approximately 31 to 38mm and the width is 1 cm. The cross section of ACL is 44mm^3 in its midpoint.

The ACL has two bundles

- Anteromedial
- Posterolateral

The anatomy of ACL attachment sites is important because of the emphasis placed on “anatomic positioning” of the graft during ACL reconstruction to produce an isometric position.

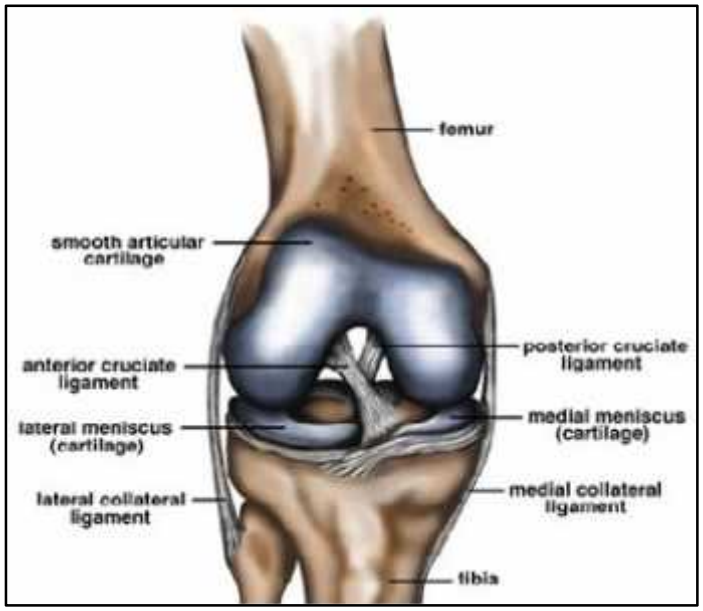


Fig 1: Anatomy of ACL

FEMORAL INSERTION:

ACL is attached from the medial surface of posterior aspect of lateral condyle. It has a Straight border on its anterior side and a convex border on its posterior side. The articular cartilage of the lateral femoral condyle and the posterior convexity of ACL is parallel. Its proximal fibres fan out along the medial wall of the femoral condyle, where the ligament comprises of fibroblast surrounded by type 1 and type 3collagen. The diameter of femoral attachment is approximately 21-23 mm. The average circular area is 113mm^2. About 50 % of total area is occupied by anteromedial and posterolateral bundle.

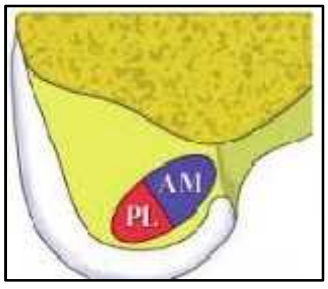


Fig 2: Femoral attachment of ACL

TIBIAL ATTACHMENT:

Distally the ACL gets attached to the tibial spine. The tibial attachment is broader than the femoral attachment measuring about 17mm antero-posteriorly and 11mm in coronal plane. It forms a triangle with apex pointing posteriorly with an average area of 136mm^2.

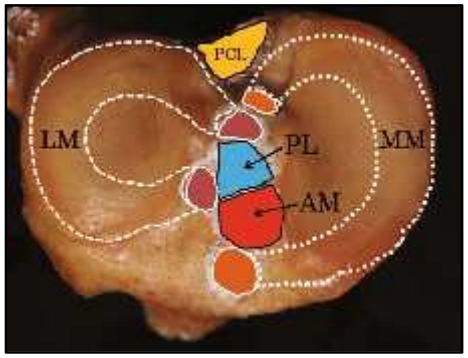


Fig 3: Tibial attachment of ACL

BLOOD SUPPLY :

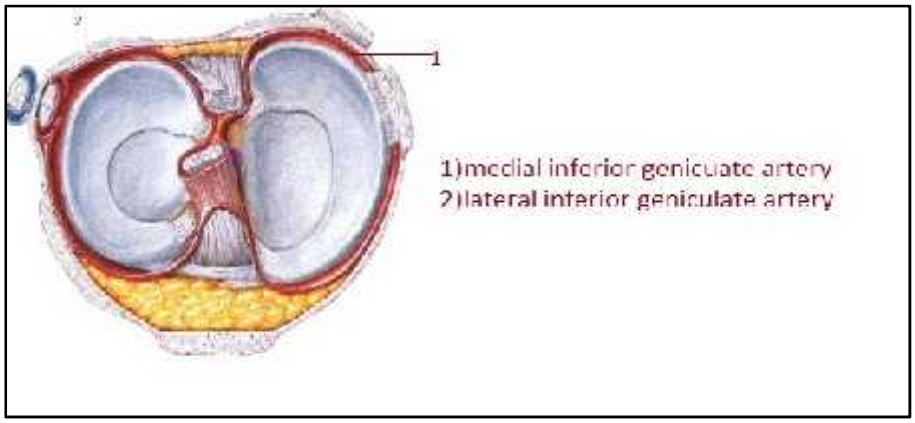
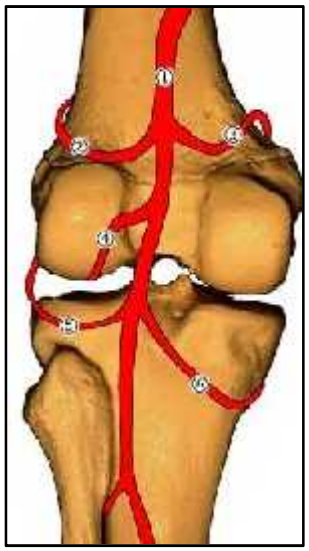


Fig 4: BLOOD SUPPLY OF ACL

ACL gets its principle arterial supply through the middle geniculate artery which is a branch of popliteal artery. It enters through the intercondylar notch near the femoral attachment.Terminal branches of lateral inferior geniculate artery also contribute to the synovial plexus around ACL, smaller periligamentous vessels which penetrates the ligament and anastomose with endoligamentous vessels. It also gets its supply from infrapatellar fat pad.The maximum supply of nutrition to ACL is by diffusion from the synovial fluid surrounding the ligament.



1)Popliteal artery

2)Superior lateral geniculate artery

3)Superior medial geniculate artery

4)Middle geniculate artery

5)Inferior lateral geniculate artery

6)Inferior medial geniculate artery

Fig 5: BLOOD SUPPLY OF KNEE

NERVE SUPPLY:

ACL is primarily innervated by posterior articular nerve which is a branch of posterior tibial nerve. The nerve fibres enters through the posterior joint capsule and take a course with synovial and periligamentous vessels surrounding the ligament. The receptors found mainly are ruffini and free nerve endings. At the femoral attachment mechano-receptors also found. ACL have small nerve fibres which are responsible for pain and proprioceptive function.

HISTOLOGY:

Microscopically ACL has three zones.

I. Proximal portion - which is highly cellular and composed of type 2 collagen, glycoprotein, fibroblast

II. Middle portion – in this collagen fibres are present in high density and it has fibroblasts which are fusiform and spindle shaped. Elastic fibres to withstand recurrent stress and oxytalinfibres to withstand multidimensional stress.

III. Distal portion – It is the most solid part of ACL with plenty of chondroblast and ovoid fibroblast. In distinct to middle part it has collagen fibres in low density.

ACL entails fibrils of collagen measuring approximately 250nm in diameter that interlace to form a compound network.

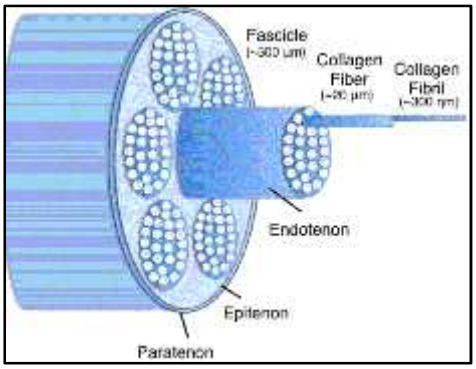


Fig 6: HISTOLOGY OF ANTERIOR CRUCIATE

- ACL has multiple fascicles covered by paratenon
- Each fascicle has sub-fascicles which are covered by epitenon.
- Sub-fascicular units contain fibres surrounded by endotenon.

The ACL fibres are arranged in a unique pattern – helical and planar, twisted and nonlinear network. The fibres in the mid substance are in planar wave pattern, whereas the peripheral substance are in helical wave pattern. The uniqueness of ACL fibril pattern has been elucidated as a “crimp” and “recruitment”. The crimp pattern mimics accordion and it acts as suspension.

It has the ability to transit from a ligament structure to rigid bone to prevent stress concentration at the attachment sites.

FUNCTIONS OF ACL:

It aids to maintain the equilibrium of the knee in coordination with structures around the knee joint. It has two main roles.

- Proprioception
- Mechanical function

Anteromedial bundle restrains anterior translation of tibia over femur. Posterolateral bundle tends to stabilize the knee near full extension. It also acts as a rotator control of the knee.

MECHANISM OF INJURY:

Ligaments can stretch upto 10-25% of its resting length. Permanent distortion with any sufficient force can cause ligament injury.

Rotational trauma results in ACL tear that is forced external rotation or hyper extension trauma. It involves a sudden change of direction with deceleration which

may be a noncontact injury sustained during sudden change of direction in football or soccer or contact injury occurred in road traffic accidents with flexed knees.

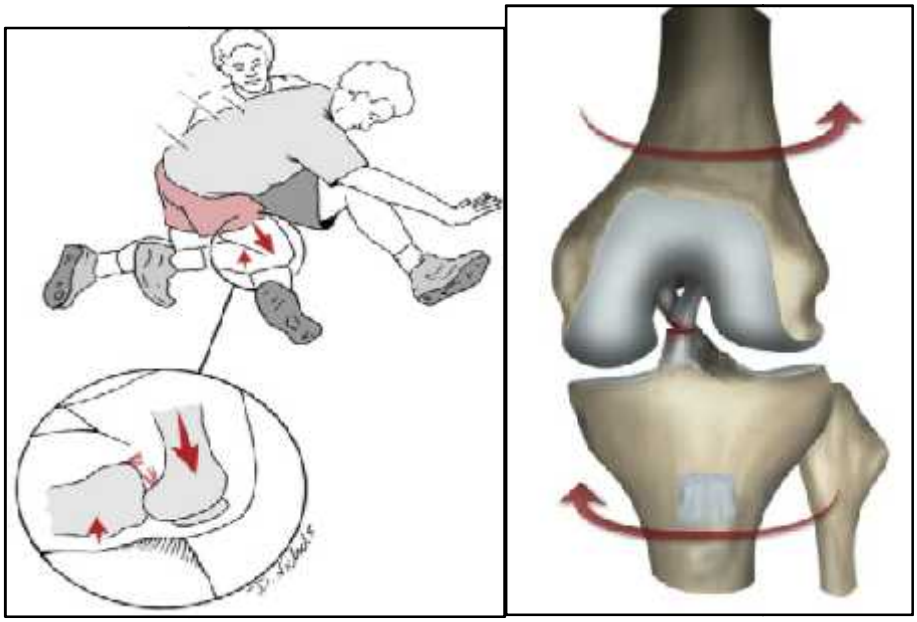


Fig 7: MECHANISM OF INJURY

If more severe and sudden, ACL injuries may be associated with O'donoghue triad, medial meniscal tears and medial collateral ligament tears. The less common pattern of injury of ACL is hyperextension of knee with associated meniscal injuries.

CLINICAL EVALUATION:

It begins with a detailed history that consists of twisting injury to knee. The patient usually presents with giving away of knee and hearing or feeling of pop is highly suspicious of injury. The other symptoms are pain and swelling. Patient with chronic ACL insufficiency often complains of instability and pain. These symptoms will hinder the activities of daily living.

LACHMAN TEST

Examiner grasps upper calf with the dominant hand, thumb over the anterior joint line. The other hand stabilizes the distal femur. Examiner pulls the tibia anteriorly in a sudden firm forward motion. Assess for laxity, (> 6-8mm shift). Compare to laxity with opposite knee. It is the most sensitive clinical test.

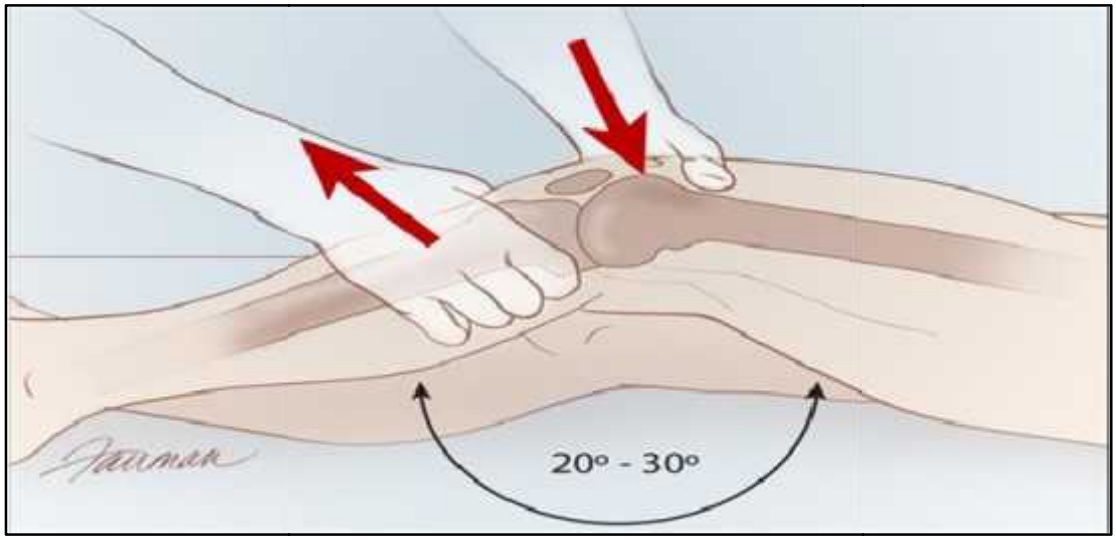


Fig 8 : LACHMAN TEST

Anterior tibial translation is graded as follows:

Grade 0 : Normal laxity 0 to 3 mm

Grade 1 : Anterior translation 3 to 5 mms

Grade 2 : Anterior translation 5 to 10 mms

Grade 3 : Anterior translation 10 to 15 mms

Grade 4 : Anterior translation > 15 mms

ANTERIOR DRAWER TEST:

Examiner grasps upper calf with the hands, fingers clasped behind the calf and both thumbs on the tibial plateau region then the examiner pulls the tibia anteriorly in a sudden firm forward motion. The test is positive if the shift the more than 8mm and it is compared with the opposite knee.

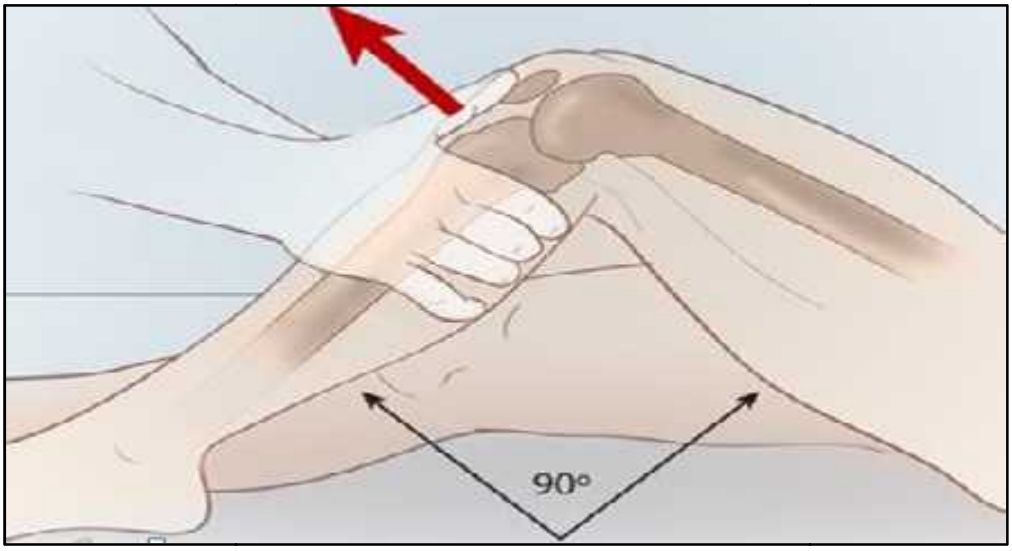


Fig 9 : ANTERIOR DRAWER TEST

PIVOT SHIFT TEST:

With patient in supine position, knee extended and tibia externally rotated. Examiner applies valgus force at lateral know with one hand. Examiner holds foot with the other hand and flexes the affected knee. It is graded as follows:

- Grade- 0 - Negative
- Grade-1 - Glide
- Grade-2 - Clunk
- Grade-3 - Gross

The test may not be accurate if full extension of knee is not done due to pain or swelling.

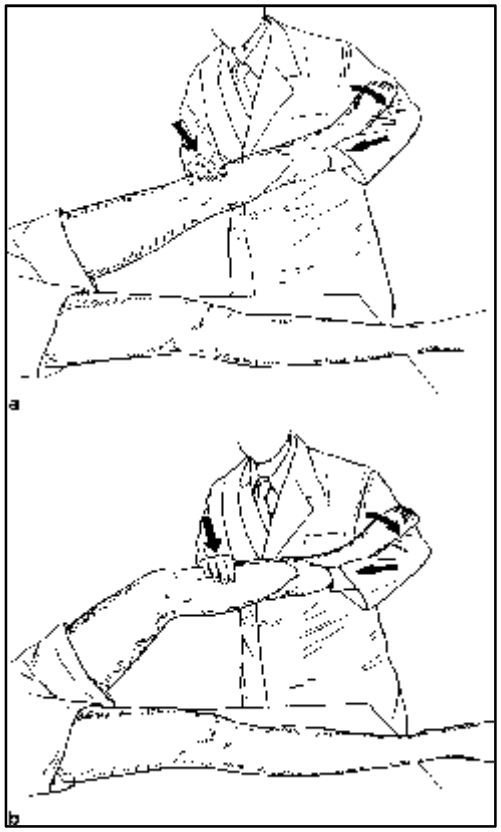


Fig 10: PIVOT SHIFT TEST

JERK TEST:

Jerk test is the rotary test for ACL insufficiency.Positive result is when lateral tibia spontaneously subluxates forward with sudden jerk during flexion of 30 degree.

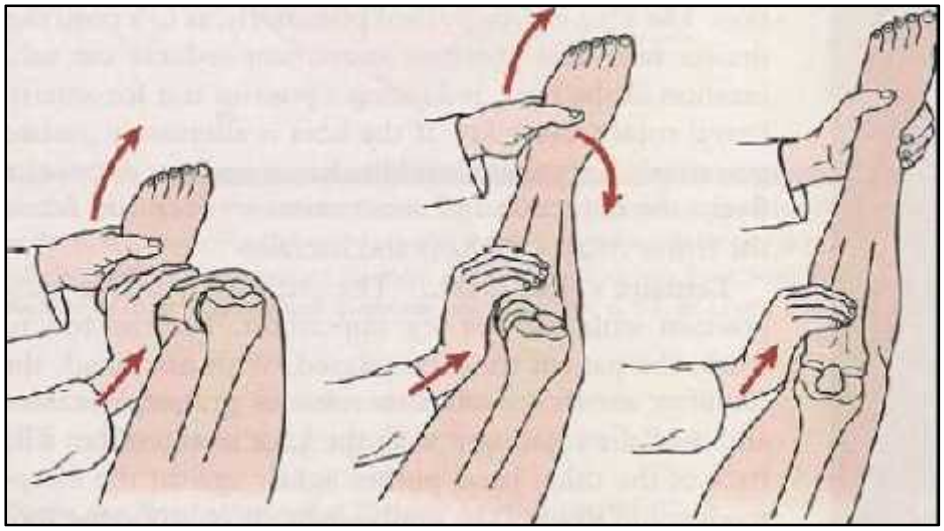


Fig 11: JERK TEST

VALGUS STRESS TEST:

The valgus stress test is applied to knee joint to assess the integrity of medial collateral ligament. Examiner applies inward pressure at lateral thigh with one hand. Examiner applies outward pressure from the medial side with other hand. Perform the maneuver twice - one with knee flexed at 0 degree and other with knee flexed at 30 degree. It infers laxity of posteromedial capsule and medial collateral ligament tear.

Fig 12: VALGUS STRESS TEST

VARUS STRESS TEST:

The varus stress test is applied to knee joint to assess the integrity of lateral collateral ligament. With patient in supine position examiner applies outward pressure at medial thigh with one hand.

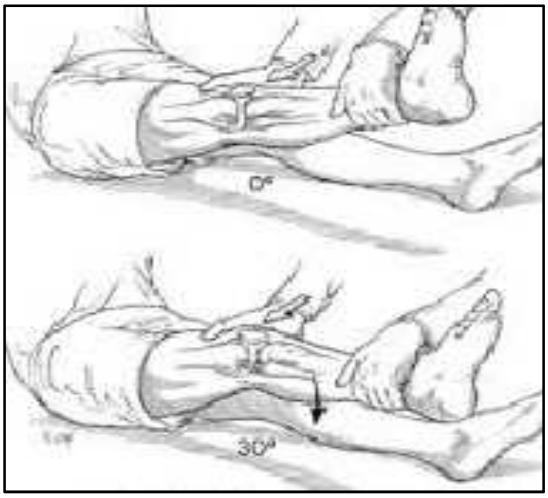


Fig 13: VARUS STRESS TEST

Examiner applies inward pressure from the lateral side with other hand. It infers laxity of posterolateral capsule and lateral collateral ligament tear.

McMURRAY'S TEST:

TEST FOR MEDIAL MENISCUS:

Patient in supine position, examiner applies one hand at knee along medial malleolus. Examiner's other hand hold the foot and ankle. Externally rotate the foot and apply valgus stress and slowly extend the knee. When the torn meniscus is trapped between thefemoralcondyleand tibialplateau, a pop or click can be felt then the test is said to be positive.

TEST FOR LATERAL MENISCUS:

Examiner applies one hand at knee along lateral malleolus. Examiner's other hand hold the foot and ankle. Internally rotate the foot and apply varus stress and slowly extend the knee. Lateral meniscal tear is implied by pain over the lateral joint line.

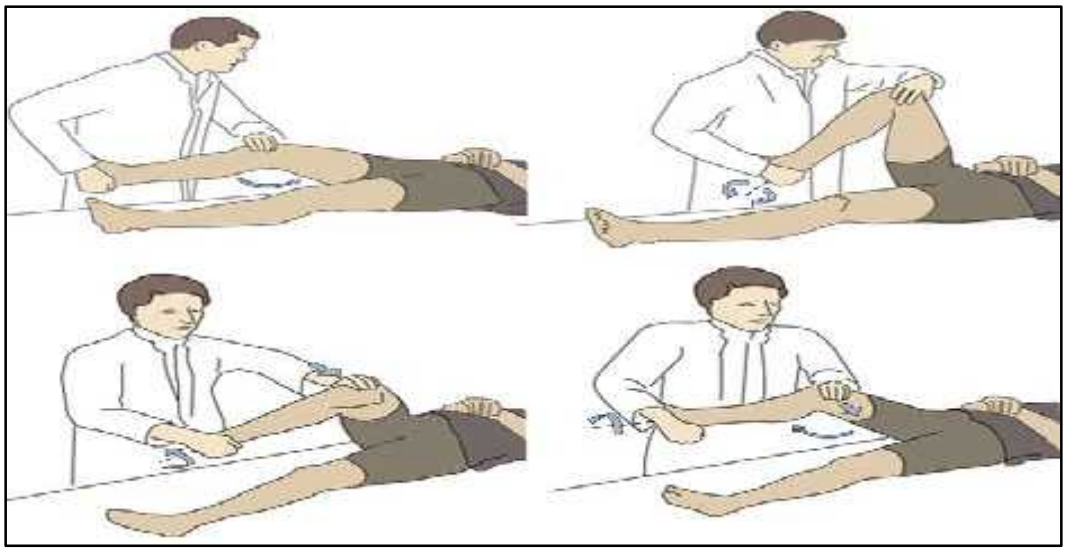


Fig 14: McMurray's test

APLEY'S GRINDING TEST:

With patient in prone position and examiner places his knee over patient's thigh so as to stabilize the thigh by applying downward pressure to the patient's foot pushing the knee to the exam table. External rotation of tibia tests the medial meniscus. Internal rotation of tibia tests the lateral meniscus.

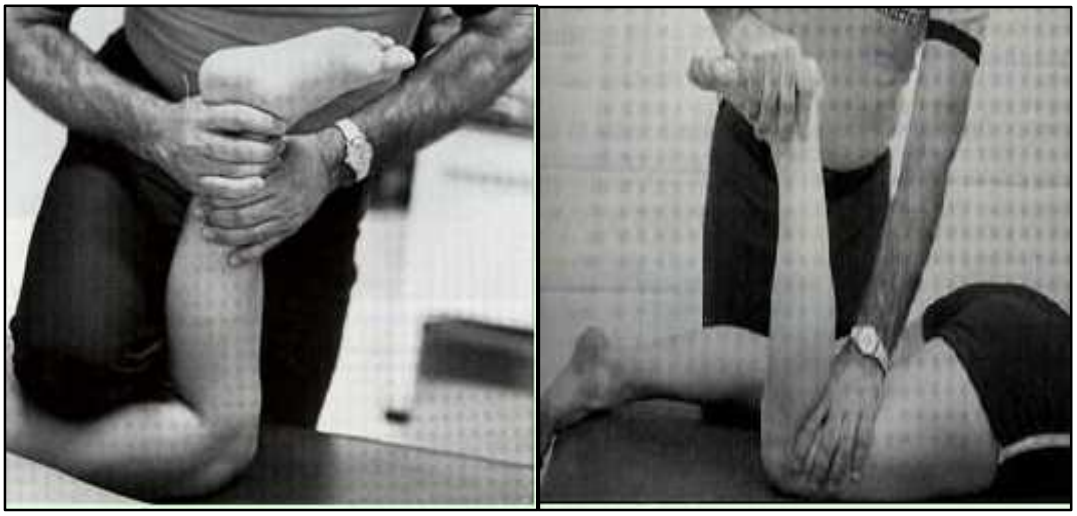


Fig 15: APLEY'S GRINDING TEST

RADIOGRAPHIC ASSESSMENT:

For any degenerative changes, fractures and other injuries of knee joint the AP and Lateral radiographs are required. One can visualize the tibial spine avulsion fractures on radiographs.

SEGOND'S FRACTURE: Avulsion fracture of the lateral articular surface of tibia. This creates a notched deficit in the lateral tibial condyle which is provisionally diagnostic of chronic ACL injury.

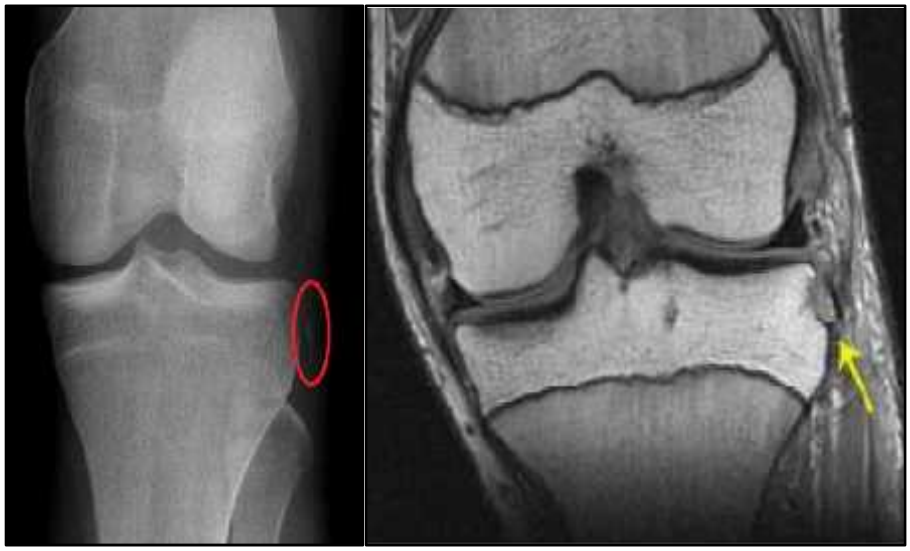


Fig 16: SEGOND'S FRACTURE IN X-RAY AND MRI

MAGNETIC RESONANCE IMAGING:

MRI being a non-invasive technique helps in preoperative assessment of the patient by depicting the ACL and other soft tissue structures in the knee joint.

The imaging of ACL should be done in T2 weighted water sensitive sequence involving two to three orthogonal planes.

It is widely used for visualizing of edema, hemorrhage, contusions that are associated with ACL injury. ACL tears most commonly occurs in the middle of the ligament.

SAGITAL SECTION:

Normal ACL is often visualized as straight, striated fan like configuration but sometimes convex inferior sagging can also be considered as normal.

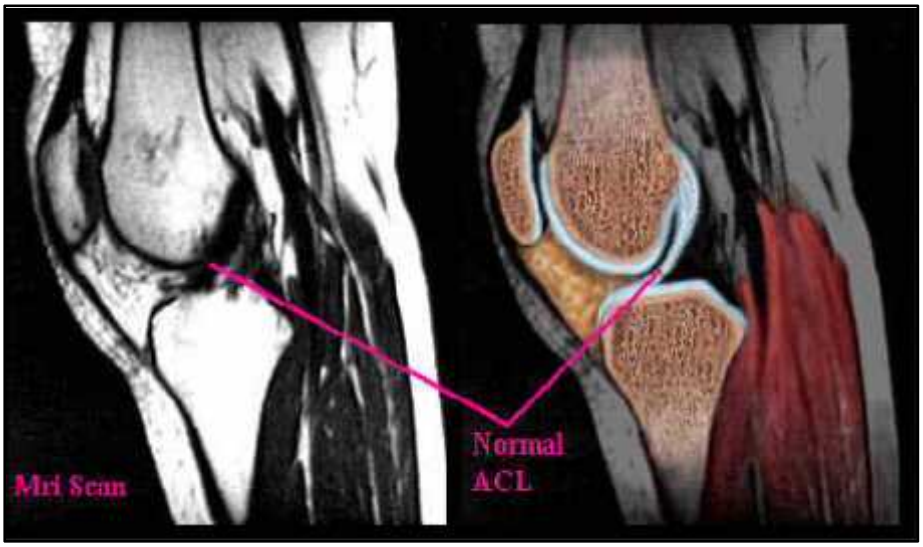


Fig 17: Normal visualization of ACL

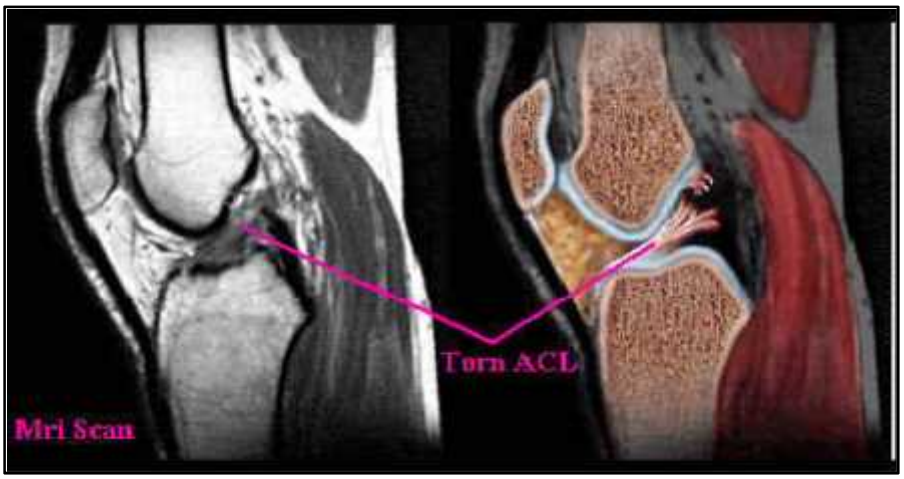


Fig 18: TORN ACL

CORONAL SECTION:

Since ACL has higher intensity than PCL, ACL is clearly visible in coronal section but with an attenuated band.

PREDOMINANT SIGNS OF ACL INJURY:

- Inability to perceive ACL in its normal anatomical location.
- Distal ACL will have flat axis and proximal ACL will not be visualized.

- On a sagittal image, if the ACL axis is more horizontal than the Blumensaat'sline then it is considered as abnormal.
- Areas of focal interruption.

Fig 19 : NON LINEARITY AS A PRIMARY SIGN OF ACL

SUBORDINATE SIGNS:

- Tibia showing counter coup medial bone bruise
- Segond's fracture
- Fibular head showing Arcuate fracture
- Unessential arched PCL
- Draw a tangential line to the posterior margin of tibia. This line will pass posterior to the meniscus in case of normal knee. In ACL injured knee this line passes through the posterior horn of lateral meniscus. This is called Uncovered Meniscus sign.

ACUTE ACL TEAR:

On sagittal images, there will be poor or no visualization of ACL. On T2 weighted images an amorphous edematous soft tissues in the intercondylar notch with focally increased signal is visualized.

PARTIAL ACL TEAR:

Less than 25 % of partial ACL tear have a good prognosis (viewedarthroscopically). 50 – 75% of ACL tears can progress to complete tears.

CHRONIC ACL TEARS:

Non visualization of the ACL is uncommon with chronic tears. Differentiating finding is abnormal course and focal angulation of the ligament without edema. Bone bruises and edema in the knee joint can be seen. MRI shows empty notch sign.

HEALING OF GRAFT:

The challenging part surgeon deal after ACL reconstruction is its healing of the graft in tunnel. The tendon to bone healing is enhanced by growth of fibro-vascular tissue which forms between the tendon and bone.

The inference between the tendon and bone is considered as the weak site in the early post operative period.

The graft healing is very crucial to start early rehabilitation and aggressive physiotherapy so that the patient can return to the pre injured state.

The healing occurs at two sites:

- ✓ Intra articular
- ✓ Intra-tunnel

The remodeling of the graft in the intra articular is known as ligamentization

The incorporation of the graft in tunnel is either by bone- bone healing or Bone – Tendon healing.

EARLY PHASE:

From ACL reconstruction to 4th post-operative week, it is called early graft healing phase.

During this phase number of cytokines and chemokine's are released which trigger growth factor expression synthesis extracellular matrix and revascularization of the graft.

Early Proliferative Phase:

The mesenchymal stem cells and fibroblast exponentially increase during this phase resulting in hyper cellular region which then secretes several growth factor, TGF- beta and PDGF. This helps in the remodeling of the graft.

Late Proliferative Phase:

Revascularization of the graft occurs during this phase which is initiated by hypoxia during early healing phase this thenup regulates VEGF during this phase. The mechanical property of the graft is weak during the phase and so the graft fails at the midsubstance.

Matrix synthesis and remodeling:

Provisional matrix formed is degraded by serine protease and matrix metalloprotease. The mechanical strength of the graft is achieved collagen fibre continuity at the interface.

MATERIALS AND METHODS

This observational study include 30 patients who had undergone Anterior Cruciate Ligament reconstruction using quadrupled Hamstring graft at Department of Orthopaedics , KLE'S Dr.Prabhakar Kore Hospital and Medical Research Centre, Belagavi.

PERIOD OF STUDY:

1st January 2019 to 31st December 2019

SELECTION CRITERIA:

INCLUSION CRITERIA:

Both genders above 18yrs of age.

1. Symptomatic unilateral ACL rupture

2. ACL injury associated with meniscus injury

3. Chondral lesion (1&2).

EXCLUSION CRITERIA:

1. ACL rupture associated with posterior cruciate ligament injury,

2. Lateral collateral ligament injury, previous ligament reconstruction,

3. Stage 3 & 4 chondral lesion and advanced osteoarthritis of knee,

4. Patient with history of concurrent fracture,

5. Patient with history of operation on either knee.

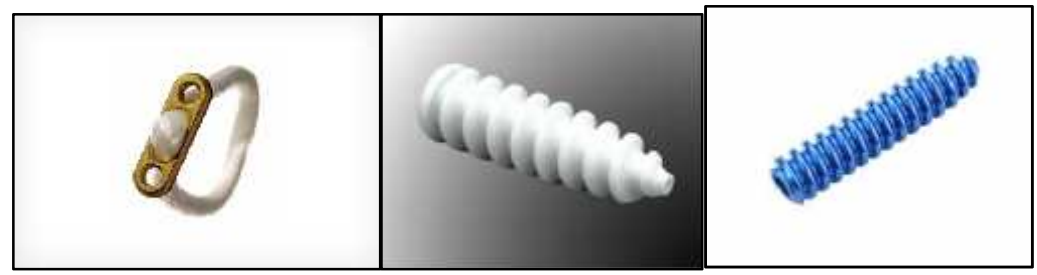
Pre-Operative Assessment:

- Routine blood investigations like CBC, ESR, RBS, Coagulation profile & serology.
- Injured Knee X-ray AP and Lateral view
- Knee Magnetic Resonance Imaging
- Anaesthetistfitness obtained for spinal and epidural anaesthesia.
- Informed consent for surgery was taken.

SURGICAL TECHNIQUE:

Dedicated instruments are required for arthroscopic reconstruction of ACL.

- Monitor
- Arthroscope
- Camera
- Light source and cable
- Pneumatic tourniquet
- Arthroscopic instruments: Trocar , Cannula , 30 degree arthroscopic instruments, probe
- Reconstruction instruments: Drill bit, Tibial guide, femoral Aimer, notch curette, Graft sizer.
- Implants: Interference screw and endobutton.



Endobutton | Bio-degradable | Titanium

Fig 20: IMPLANTS

Fig21: INSTRUMENTS

PROCEDURE:

After combined spinal and epidural anesthesia patient positioned supine on a standard operating table with knee joint little further from the distal breakpoint of the table. 1 liter saline bottle is placed below the injured knee to allow easy mobilization during the procedure. Uninjured limb is placed on a well-padded support. The following tests are performed under anesthesia ADT, PDT, LT & PST.

Fig 22: ELICITING SPECIAL TESTS

The tourniquet is placed on the upper thigh. The limb is then scrubbed from the foot till the tourniquet and drapped with sterile aseptic precautions.

Fig 23: EXSANGUINATION

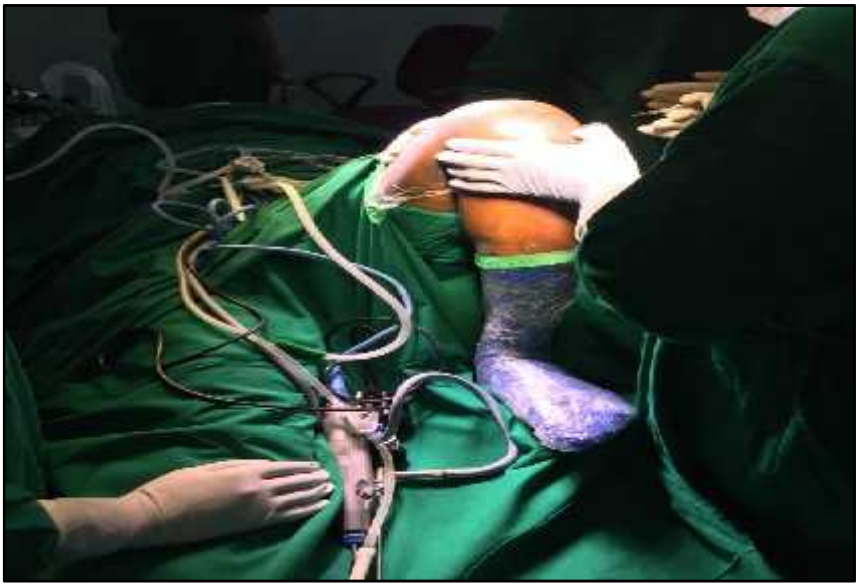


Fig 24: SKIN INCISION FOR PORT

Illumination of the scope and monitor brightness ensured in advance before making a skin incision. Diagnostic arthroscopy was performed to detect any associated meniscal lesion.

Fig 25: ANTEROLATERAL PORT

Fig 26: DIAGNOSTIC ARTHROSCOPY

DIAGNOSTIC ARTHROSCOPY:

Before the harvesting of graft, diagnostic arthroscopy was done first. In 90 degrees of knee flexion, anterolateral port (viewing portal) is made using 11 number blade at the level of inferior pole of patella just lateral to the patellar tendon. Then the scope is introduced and knee is examined ina sequential manner of the following:

1. Suprapatellar pouch
2. Patellofemoral joint
3. Medial gutter
4. Medial meniscus
5. Intercondylar notch
6. Lateral meniscus
7. Lateral gutter
8. Posterolateral compartment

After all the pathologies have been recorded, the anteromedial (working) portal is then established. The associated pathologies are dealt accordingly such as partial / total meniscectomy for meniscal tears and loose body removal.

Fig 27:NORMAL ACL

Fig 28: TORN ACL

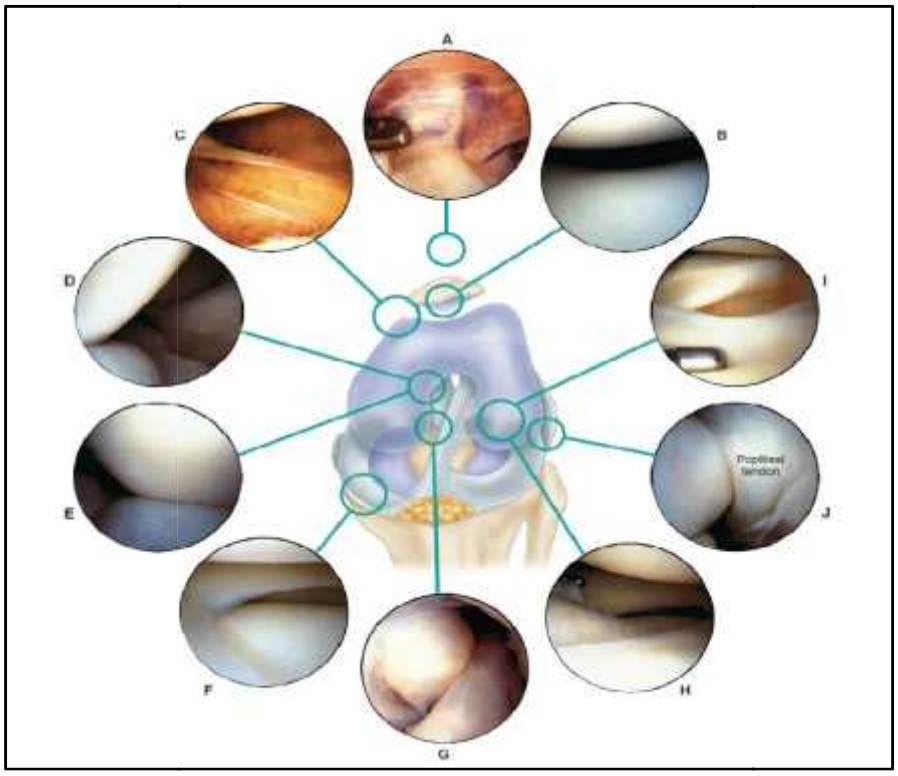


Fig 29:VARIOUS STRUCTURES OF KNEE ARTHROSCOPICALLY

A. Suprepatellar pouch
B. Patellofemoral articulation
C. Normal medial parapatellar plica
D. Posteromedial compartment
E. Posteromedial compartment when seen through posteromedial portal, which is made after completion of routine examination if complete posteromedial view is unsatisfactory
F. Medial meniscus and medial compartment
G. Cruciate ligament with fatty synovium covering PCL
H. Lateral meniscus and lateral compartment
I. View of posterior horn of lateral meniscus and popliteal tendon through hiatus

STANDARD PORTALS:

- ANTEROLATERAL PORTAL
- ANTEROMEDIAL PORTAL
- POSTEROMEDIAL PORTAL
- SUPEROLATERAL PORTAL

ANTEROLATERAL PORTAL:

Most of the used portal by arthroscopic surgeon since it allow visualizing most of the structure within the joint. The main limitation of this portal in PCL, anterior portion of LM and part of posterior portion of MM cannot be seen.

The portal is established 1cm lateral to patellar tendon and 1cm superior to lateral joint line. It should be exactly1cm below the patella.

ANTEROMEDIAL PORTAL:

This portal is usually established for seeing lateral compartment. It is located 1cm abovethe medial joint line, 1cm below lower pole of patella and 1cm towards the patellar tendon. The precise placement is eased by passing a spinal needle percutaneously.

POSTEROMEDIAL PORTAL:

The pre-requisite for the portal are

1) Knee should be distended maximally with irrigating solution.

2) Knee should be flexed to 90 degree

3) Bony landmarks are marked.

Thin located 1cm post to the posteromedial margin of the femoral condyle and 1cm super posteriorly to medial joint line. It is helpful to repair posterior horn meniscal tear and removal of loose bodies in posterior compartment.

SUPEROLATERAL PORTAL:

It allows for evaluation patellar tracking, patellar longitudinally. Thin portal is placed lateral to the quadriceps tendon and approximately 2.5cm above the superolateral border of patella. Patello-femoral articulation can be viewed.

OTHER OPTIONAL PORTALS:

- Posterolateral
- Proximal mid patellar
- Medial and lateral portal
- Accessory far medial and lateral portals
- Central trans patellar tendon (GILLQUIST PORTAL)

HAMSTRING GRAFT HARVEST:

A 4cm skin incision is taken 3cm medial to tibial tuberosity and 4cm below the joint line. Subcutaneous dissection done. Hemostasis achieved and insertion of pesanserinus is exposed.

Fig 30 : SKIN INCISION FOR GRAFT HARVEST

The superior and inferior border of Sartorius tendon is palpated and gracilis and semitendinous tendon are identified 3-4 cm medial to tendinous insertion.

A small incision is made in line with the superior border of the gracilis tendon and the underlying medial collateral ligament is protected with care. Staying in the same plane adequate exposure is maintained by retracting without injuring the saphenous vein and nerve.

The tendons are identified and with aid of right angled arteryforceps gracilis, semitendinous are released from its fibrous extension to gastrocnemius and semimembranous muscle.

Keeping the knee in 90 degree flexion, dissection is done using finger upto musculo-tendinous junction, inorder to release adhesion with persistent tractionapplied through the double loop knotin end of tendon with threads.Now the distal part of the tendon is dissected subperiosteally and released from its origin

Before releasing the tendon with stripper, the tendon carefully palpated to ensure that it is free from any adhesions and fibrous extension, then the tendon is stripped with controlled traction.In the same manner semitendinous tendon is also stripped.

Fig 31: HARVESTED GRAFT

The Harvested graft is then soaked in a saline bowl and its residual muscle fibres are carefully removed.

The second graft is then folded and quadrupled and placed on graft master. The graft is then trimmed to same size, looped to form quadrupled graft and stitched together with whip stitch pattern. The graft length and diameter measured.

Fig 32: PREPARATION OF GRAFT

Fig 33: GRAFT SIZER

Fig 34 (a): TENSIONING THE GRAFT

Fig 34 (b): TENSIONING THE GRAFT

Through Anterolateral port scope is inserted and shaver introduced through the anteromedial port. Joint is debrided of reflections of synovial fat and torn ACL. Femoral and tibial footprints are visualized and marked.

To gain access to the medial aspect of lateral femoral condyle notchplasty is done. It has a significance in chronic ACL tear where osteophytes intrude the notch and it presents the impingement of graft in full extension of knee.

Notchplasty

Notchplasty restricted to anterior intercondylar notch, excess lateral notchplasty is refrained, else lateralization of graft will occur in the femoral attachement site.

Fig 35: Notchplasty

FEMORAL TUNNEL PREPARATION:

The native ACL footprint is marked keeping knee in 90 degrees of flexion and entry point is marked with aid of femoral offset aimer the marked point is drilled till the tip of guide wire pierces the lateral side of thigh.

Now with drill bit the femoral tunnel is established by drilling both the cortices. Later the tunnel is reamed according to the diameter of the graft. The reaming is limited to 20mm from the far cortex.

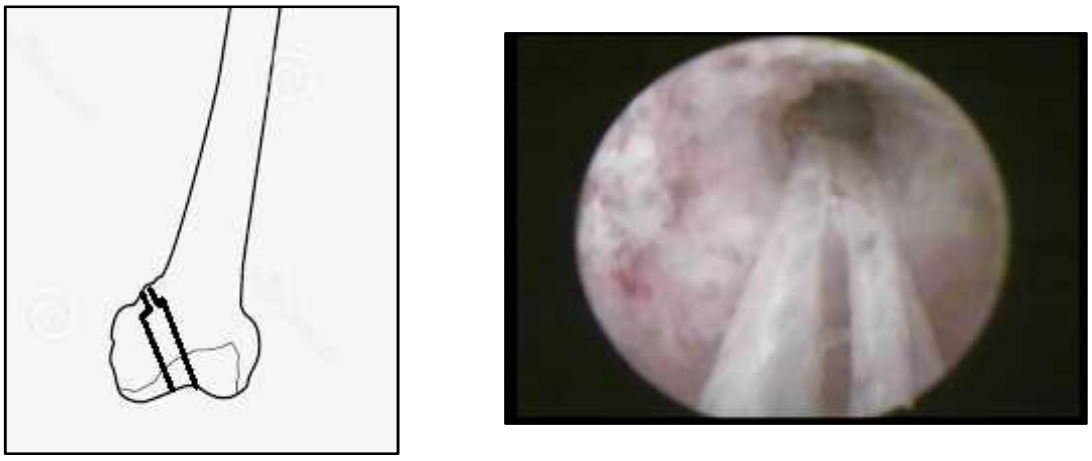


Fig 36:Femoral tunnel after reaming

TIBIAL TUNNEL:

With the aid of tibial guide, the tibial tunnel is established by keeping the knee in 70-90 degree flexion. The tibial guide placed 55-60 degree to tibial plateau to obtain accurate angle of native ACL. For stable fixation it should have a minimum of 20mm bone to secure the graft. With the rasp the tunnel is contoured and confirmed the outer portion tunnel is free of any soft tissues.

Fig 37 (a): TIBIAL AIMER

Fig 37 (b): ARTHROSCOPIC VIEW

Fig 38 : TIBIAL TUNNELING

GRAFT FIXATION:

Graft is then passed through the femoral tunnel through arthroscopic guidance and the endobutton in flipped, cyclical tensioning of the graft is done by flexion and extension of the knee joint and then fixed with interference screw on the tibial side.

Fig 39: GRAFT FIXATION

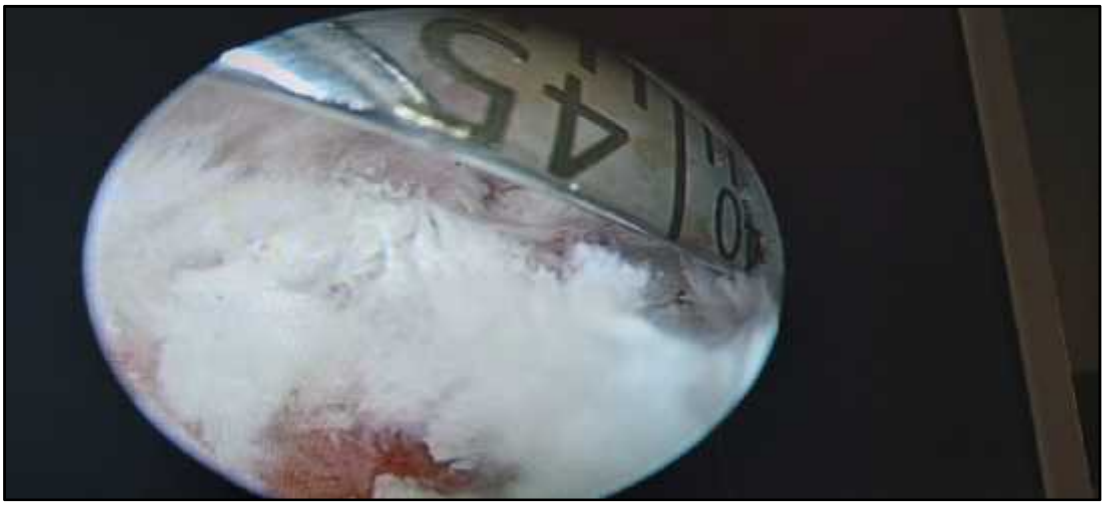


Fig 40: GRAFT IN FEMORAL TUNNEL

Fig 41: ILLUSTRATION OF GRAFT FIXATION IN FEMORAL TUNNEL WITH ENDOBUTTON

Fig 42: ENDOBUTTON

Fig 43 : GRAFT FIXATION IN TIBIA WITH INTERFERENCE SCREW

The excess graft is trimmed and the stability of the knee is assessed by Lachman and pivot shift test. The incision is closed in layers.

POSTOPERATIVE MANAGEMENT:

Rehabilitation protocol initiated from POD 1.

Dressing done on POD 2, 5, 7 and suture removed on 12th day.

The patients were evaluated by ADT, PST & LT and Lysholm knee scoring scale.

REHABILITATION PROTOCOLS:

Phase1: Surgery to 2 weeks

- ✓ Patellar mobilization
- ✓ Heel press
- ✓ Sitting slide and wall slide
- ✓ Passive extension
- ✓ Prone hangs
- ✓ Partial weight bearing with crutches with knee brace
- ✓ WBTT without crutches with knee brace.
- ✓ Quadriceps strengthening
- ✓ SLR in all planes
- ✓ Prone/standing hamstring curls

GOALS:

- Knee extension full range
- Knee flexion upto 90 degree
- Normal gait pattern
- Quadriceps strength

Phase 2.1: 2- 4 weeks

- ✓ Full ROM with knee brace
- ✓ Progression of ROM to 120 degree by the end of 4th week
- ✓ Full weight bearing with crutches
- ✓ Progress SLR
- ✓ Lateral step-ups

GOALS:

- Full weight bearing without crutches
- ROM from 0 – 120 degree

PHASE 2.2: 8- 10 weeks

- ✓ Full ROM by 6 weeks
- ✓ Progressed closed chain exercise
- ✓ Aquatic exercise
- ✓ Climbing stairs
- ✓ Strengthening of hamstring and quadriceps

PHASE 3: 12 – 16 weeks

- ✓ Isokinetic quadriceps exercise to full extension by 16 weeks
- ✓ Sports specific fitness

PHASE 4: 16- 18 weeks

- ✓ Begin jogging
- ✓ Full range of motion

PHASE 5: 5- 6 months

- ✓ Sports specific drill
- ✓ Agility training

PHASE 6: 6 months

Return to sport if

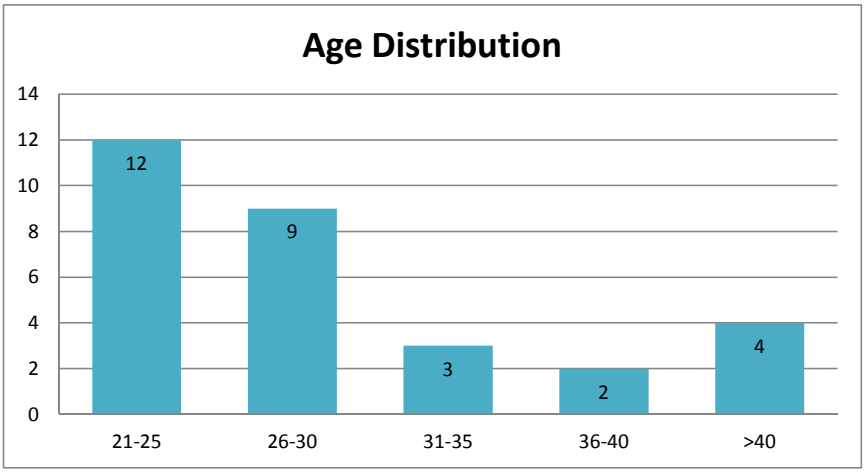
- ➢ 90% quadriceps strength relative to uninjured limb
- ➢ >90% hop symmetry relative to uninjured limb.

RESULTS

DISTRIBUTION OF CASES BASED ON AGE

Age in years	Number	Percentage
18-25	12	40
26-29	9	30
30-34	3	10
35-39	2	7
>40	4	13
TOTAL	30	100

TABLE 1: DISTRIBUTION OF CASES BASED ON AGE



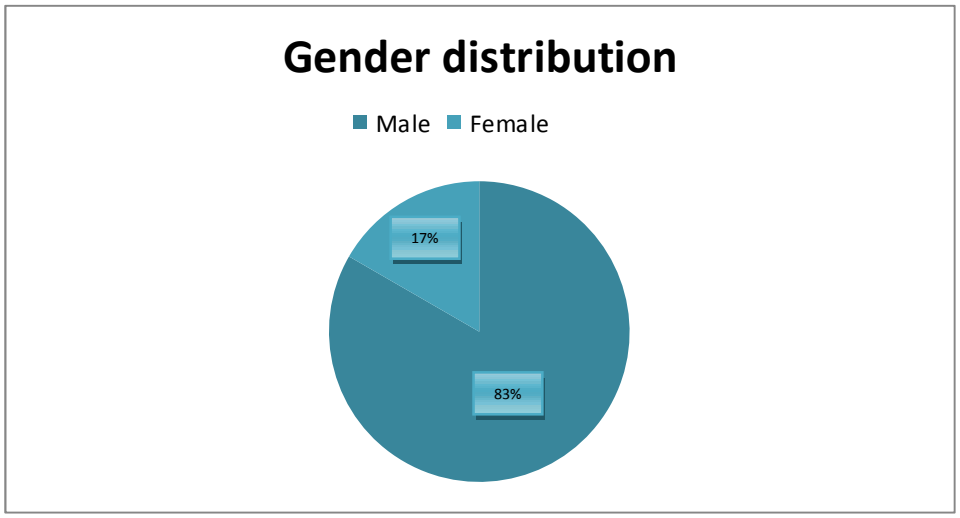
Graph 1: DISTRIBUTION OF CASES BASED ON AGE

The youngest patient was 21 years and the oldest patient was 52 years old. The maximum number of patients were in the age group of 18-25 (40%) followed by the age group 26-29yrs (27%). The mean age was 29.2yrs

DISTRIBUTION OF CASES BASED ON SEX

	Number	Percentage
Male	25	83
Female	5	17
Total	30	100

TABLE 2: DISTRIBUTION OF CASES BASED ON SEX



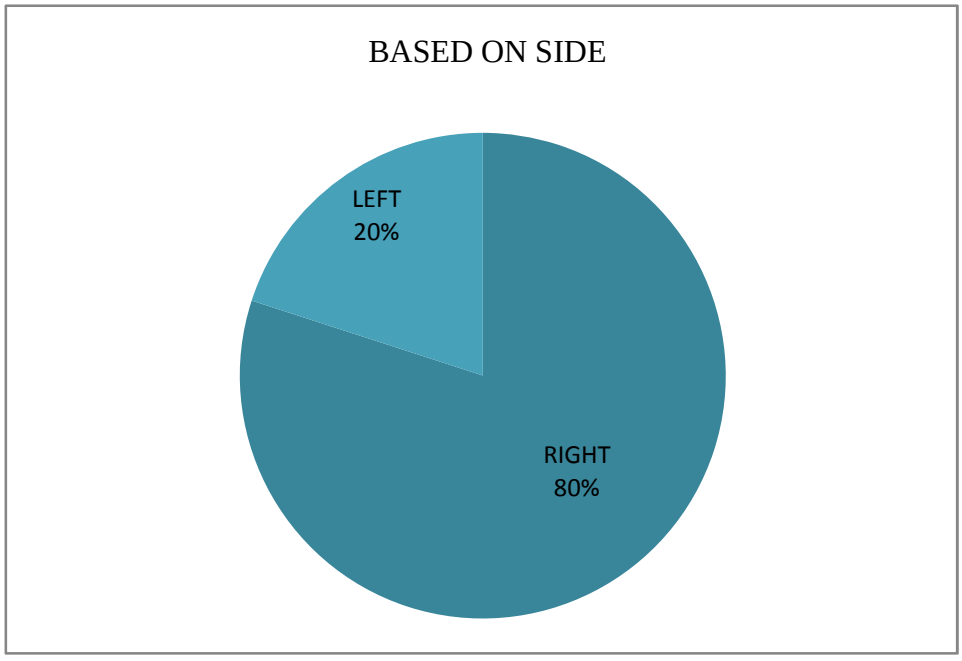
Graph 2: DISTRIBUTION OF CASES BASED ON SEX

In our series of 30 patients, 25 patients (83%) were males and 5 patients (17%) female, (Male Predominance). It may be because of the involvement of males in outdoor activities like sportsand motor vehicle accidents.

DISTRIBUTION OF CASES BASED ON SIDE

	Number	Percentage
Left	6	20
Right	24	80
Total	30	100

TABLE 3: DISTRIBUTION OF CASES BASED ON SIDE



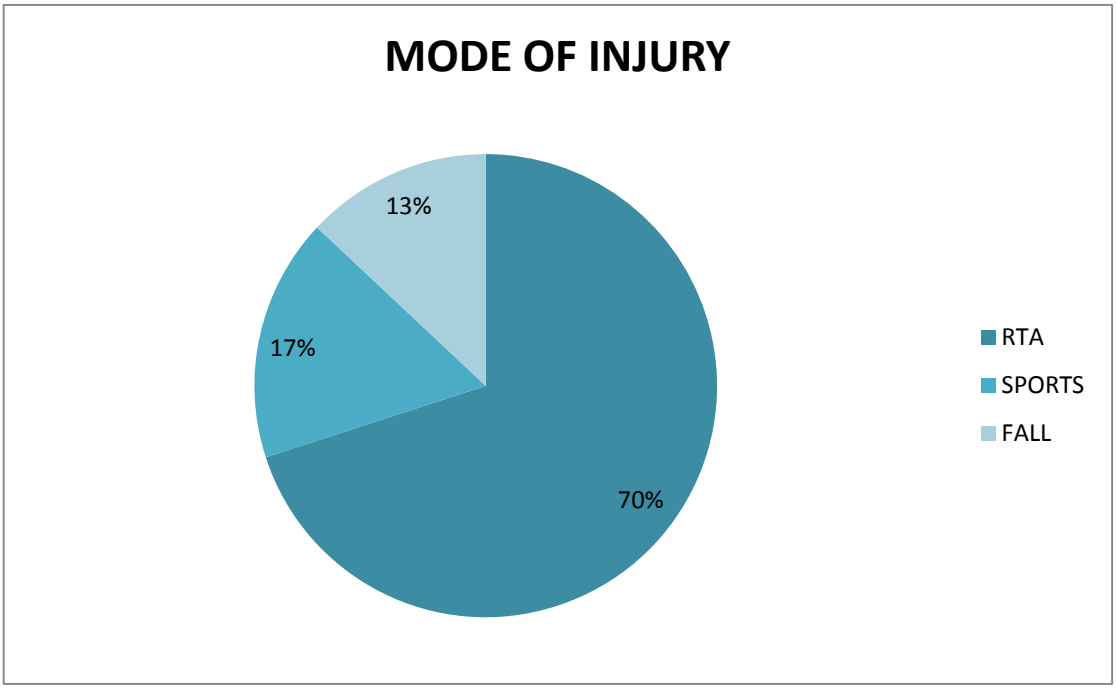
Graph 3: DISTRIBUTION OF CASES BASED ON SIDE

Right knee was injured in 24 patients (80%) and left knee was injured in 6 patients (20%).

DISTRIBUTION BASED ON MODE OF INJURY

	Number	Percentage
RTA	21	70
Sports	5	17
Fall	4	13
Total	30	100

TABLE 4: DISTRIBUTION OF CASES BASED ON MODE OF INJURY



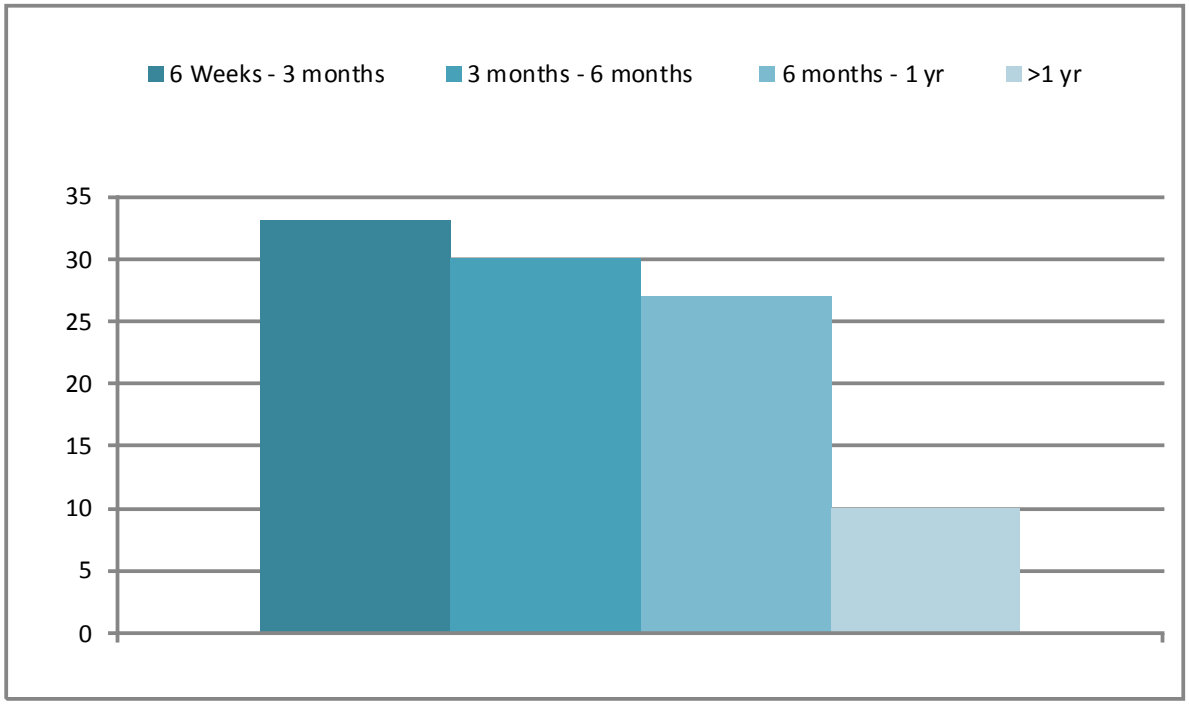
Graph 4: DISTRIBUTION OF CASES BASED ON MODE OF INJURY

Most of the ACL tears were caused by RTA (70%). Next common cause was sports activities (17%). Few patients (13%) got injured while doing daily activities like slip and fall.

DISTRIBUTION OF CASES ACCORDING TO DURATION SINCE INJURY

Duration	Number	Percentage
6 weeks- 3 months	10	33
3months-6months	9	30
6months-1yr	8	27
>1yr	3	10
Total	30	100

TABLE 5: DISTRIBUTION OF CASES BASED ON DURATION



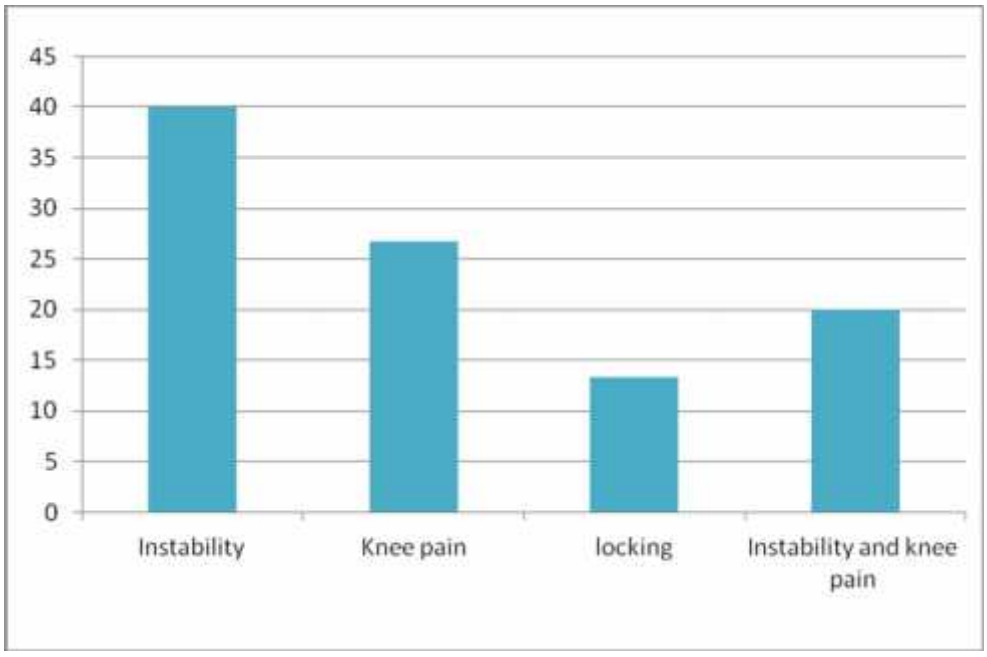
Graph 5: DISTRIBUTION OF CASES BASED ON DURATION

Majority of the patients who were operated had a time interval from injury to surgery between 6 weeks – 3 months (33%) followed by 3 months- 6months (30%)

DISTRIBUTION OF CASES BASED ON PRESENTING SYMPTOMS

Symptoms	Number	Percentage
Instability	12	40
Knee pain	8	27
Locking	4	13
Instability and knee pain	6	20
Total	30	100

TABLE 6: DISTRIBUTION OF CASES BASED ON PRESENTING SYMPTOMS



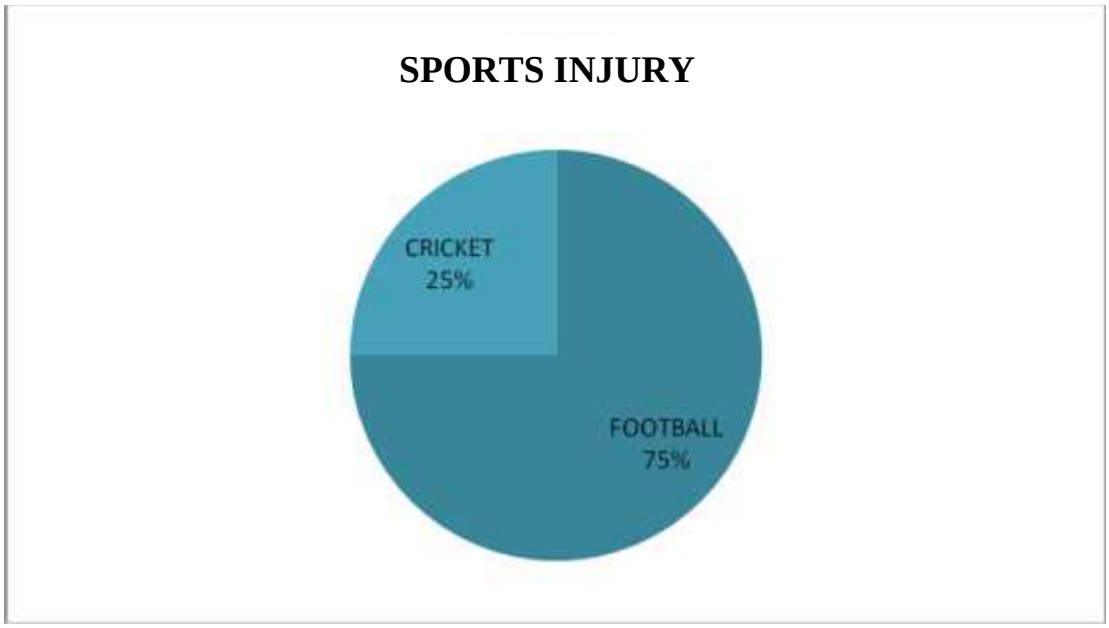
Graph 6: DISTRIBUTION OF CASES BASED ON PRESENTING SYMPTOMS

40% Patients were having instability and 27% cases presented with knee pain. 13% gave history of locking of knee, 20% presented with instability and knee pain.

DISTRIBUTION OF CASES ACCORDING TO SPORTS INJURY

Sports	Number	Percentage
Football	3	75
Cricket	1	25
TOTAL	4	100

TABLE 7: DISTRIBUTION OF CASES ACCORDING TO SPORTS INJURY



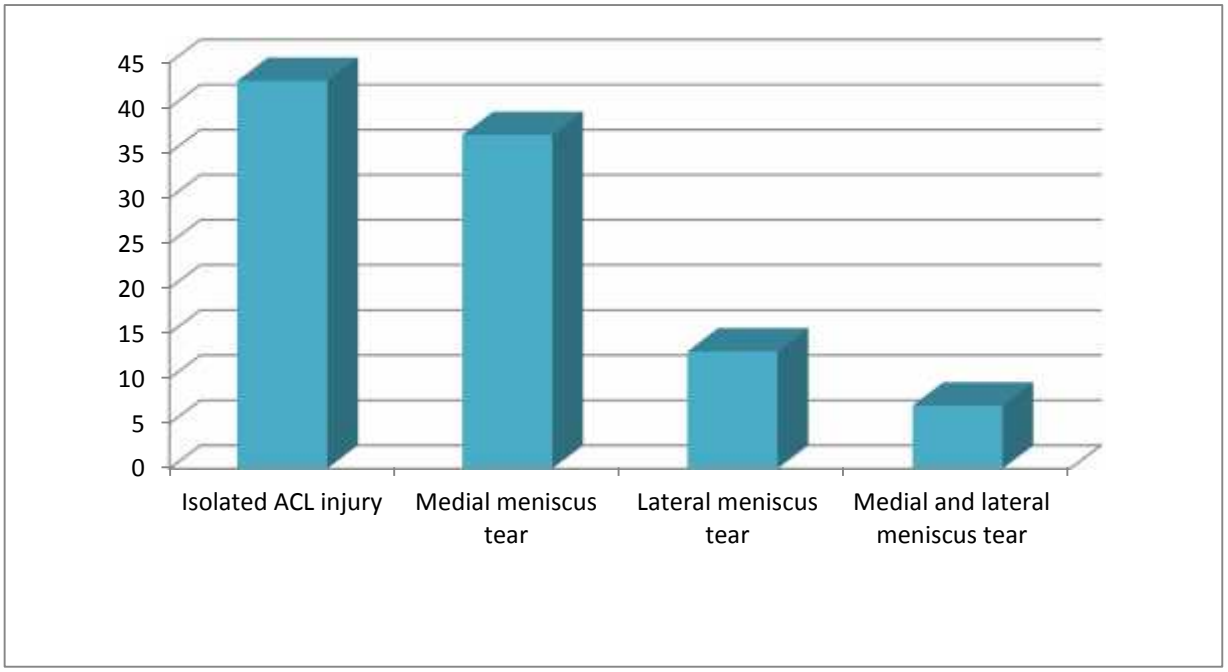
Graph 7: DISTRIBUTION OF CASES ACCORDING TO SPORTS INJURY

Out of 30 patient's 4 patient's sustained injury during sports activities.

DISTRIBUTION OF CASES BASED ON ASSOCIATED INJURIES

Number	Associated injury	Frequency	Percentage
1	Isolated ACL tear	13	43
2	MM Tear	11	37
3	LM Tear	4	13
4	MM and LM tear	2	7
	total	30	100

TABLE 7: DISTRIBUTION OF CASES BASED ON ASSOCIATED INJURIES



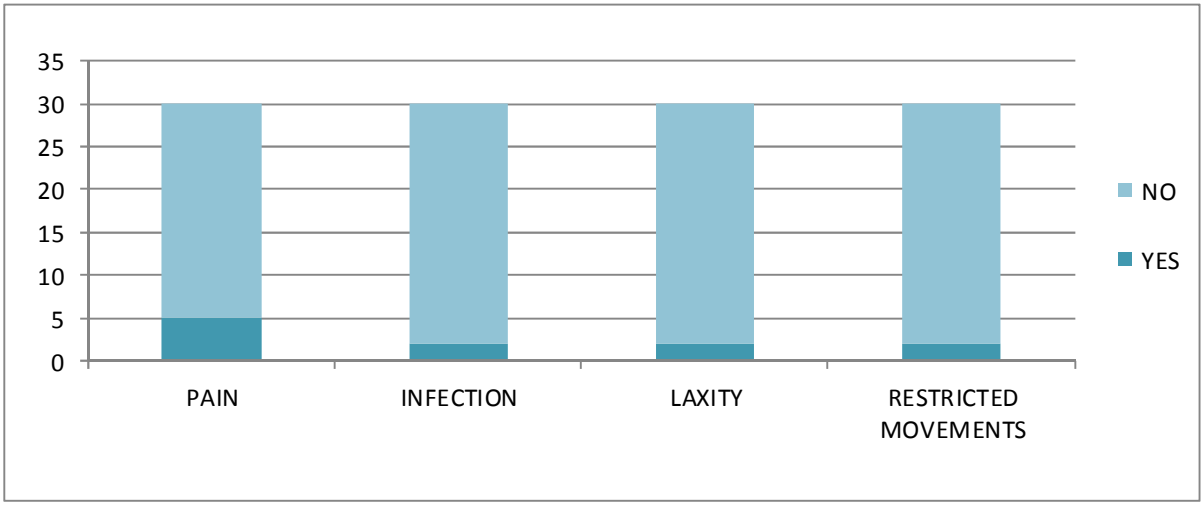
Graph 7: DISTRIBUTION OF CASES BASED ON ASSOCIATED INJURIES

Diagnostic arthroscopy prior to ACL reconstruction confirms the medial meniscal tear in 37% cases and 13% lateral meniscal tear. Both the menisci were injured in 7%. 43% were isolated ACL injuries.

DISTRIBUTION OF CASES BASED ON POSTOPERATIVE COMPLICATIONS

	Number	Percentage
Pain	5	17
Infection	2	7
Laxity	2	7
Restricted flexion	2	7

TABLE 8: DISTRIBUTION OF CASES BASED ON POSTOPERATIVE COMPLICATONS



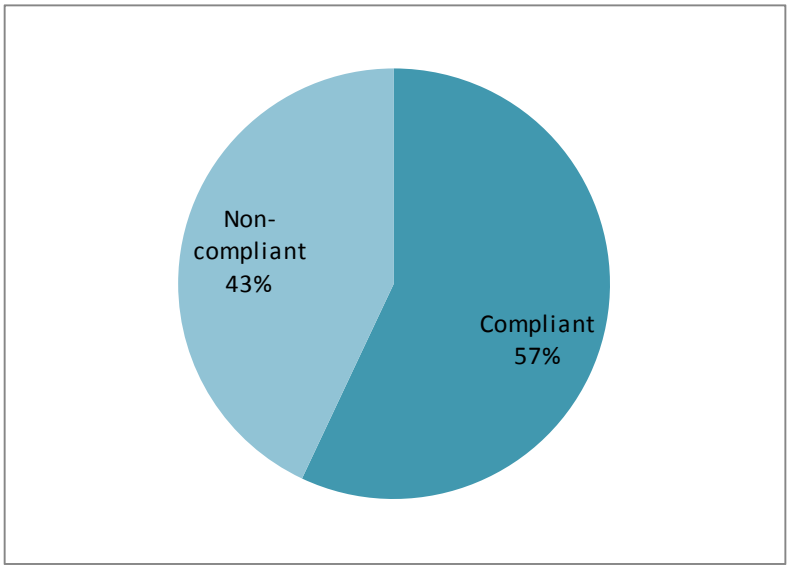
Graph 8: DISTRIBUTION OF CASES BASED ON POSTOPERATIVE COMPLICATONS

5 patients (17%) had pain. Infection was present in 2 cases (7%). patients (7%) were having grade I laxity. 2 patients (7%) had flexion difficulty.

DISTRIBUTION OF CASES BASED ON PHYSIOTHERAPY COMPLIANCE

	Number	Percentage
Compliant	17	57
Non-compliant	13	43
TOTAL	30	100

TABLE 9: DISTRIBUTION OF CASES BASED ON PHYSIOTHERAPY COMPLIANCE



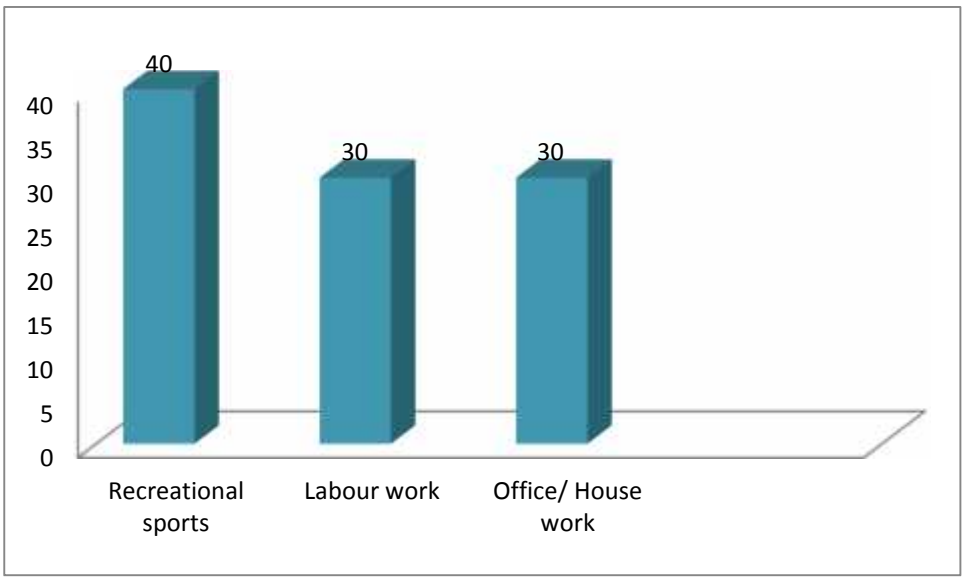
Graph 9: DISTRIBUTION OF CASES BASED ON PHYSIOTHERAPY COMPLIANCE

57% of patients were compliant to postoperative rehabilitation protocol and 43% wereNon- compliant.

DISTRIBUTION OF CASES BASED ON OCCUPATION PROFILE

	Number	Percentage
Recreational sports	12	40
Labour work	9	30
Office/house work	9	30
TOTAL	30	100

TABLE 10: DISTRIBUTION OF CASES BASED ON OCCUPATIONAL PROFILE



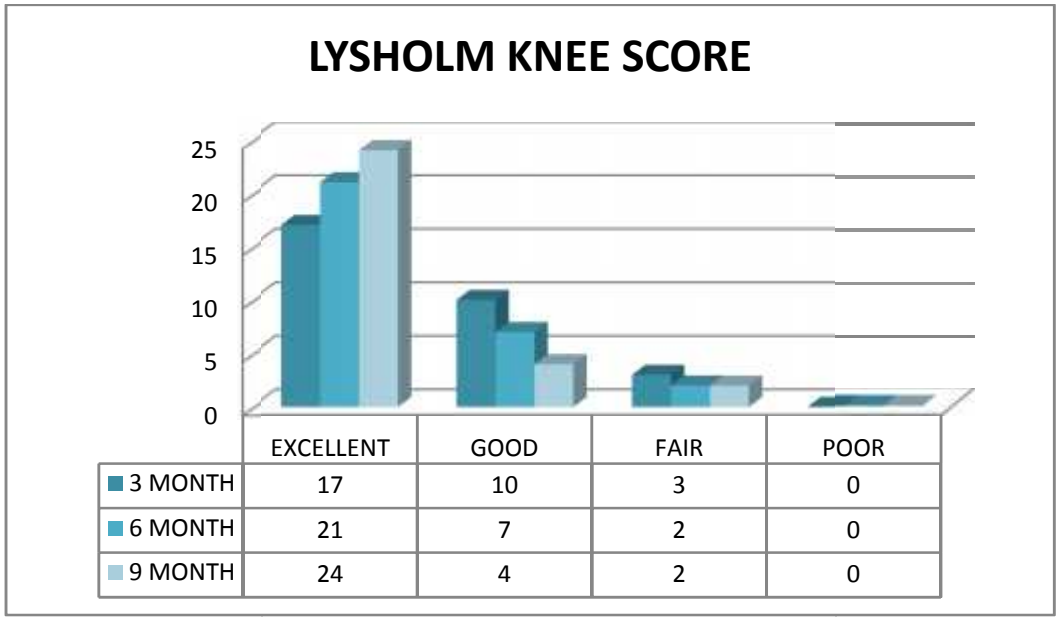
Graph 10: DISTRIBUTION OF CASES BASED ON OCCUPATIONAL PROFILE

40% of the study population were actively involved in sports activities.

LYSHOLM KNEE SCORE

	3 months	6months	9 months
Excellent	17 (57)	21 (70)	24 (80)
Good	10 (33)	7 (23)	4 (13)
Fair	3 (10)	2 (7)	2 (7)
Poor	0 (0)	0 (0)	0 (0)

TABLE 11: DISTRIBUTION OF CASES BASED ON LYSHOLM KNEE SCORE



Graph 11: DISTRIBUTION OF CASES BASED ON LYSHOLM KNEE SCORE

At the 9th month follow up 80% of the patient had excellent score which were 57% at the 3rd month. 13% of patient had good score at the end of 9th month and 7% of patient had fair score.None of the pateint had poor score.

DISCUSSION

In the past, ACL tear was contemplated to be of faintly a tiny importance to the extensive function of the knee.

The concept of ACL reconstruction and evolution of the surgery over the period of years had made awareness among young surgeons and led to a riveting transformative path and now it is considered as one of the common procedures in Orthopaedics.

As the technique of ACL reconstruction progressed in the last few decades and secured infallible results. Exchange of views on the choice of graft has become a altercation in the recent years.

The options of graft for ACL reconstruction comprehend Hamstring autograft , bone patellar tendon graft , quadriceps graft, allograft and various synthetic graft.Out of these frequently used grafts are Hamstring graft and bone patellar tendon graft.

David Jean Bieau et al[41]conducted a meta-analysis of six RCT comparing Hamstring with BPTG a two year follow up study concluded BPTG to have a significantly low risk for positive pivot-shift test compared with the hamstring graft graft.

Leo A Pinczewki et al[42] concluded “The use of BPTG constitute certain problems not only encountered during Intra-op but also posed post-operative complications like anterior knee pain, residual flexion contracture, risks of patellar fracture and secondary problems of patellar tendinitis” from a ten year randomized control trial. Though the graft has stubborn fixation with its bony ends and high tensile strength comparing to its native ACL.

Beard et al[43] concluded that there is no significance in concerned to the Lysholm score using biodegradable and titanium screw in one year follow up study conducted in 45 patients.

Aligetti et al[44] in their study they found notable difference in Lysholm score and improved ability in walking after two years of follow up using titanium screw in hamstring auto-graft.

Petre et al[45] concluded there was less thigh muscle atrophy in patients who had undergone reconstruction using hamstring graft after 2 year follow up. They also commented on stability and range of movements was better.

The use of hamstring graft had credence as panacea for the problems with bone patellar tendon graft and has advantage in spite of having a reduced strength of the native ACL.

Our study is to assess the functional outcome of reconstruction of ACL using quadrupled HS autograft.

This observational study was conducted in Jawaharlal Nehru Medical College, Dr.Prabhakar Kore Hospital, Belagavi to clinically assess the efficacy of arthroscopic reconstruction of ACL with quadrupled hamstring graft. The study group comprised of 30 patients.

In our study the most common mode of injury was found to be Road traffic accident followed by sports. Among sports football was the commonest cause of ACL injury. Male form most part in our study. Abundant of the patients were in the age group of 18-25 (40%) patients underwent ACL reconstruction 6 weeks to 3 months after initial injury.

Tetsuo Hagino et al[46] commented that in acute group medial meniscus tear was found in 69.4% , lateral meniscus was 10.8% and both meniscus in 19.9% ,

whereas in chronic group medial meniscus 33.9% , lateral meniscus in 24.7% and both the meniscus in 41.4%. The study concluded that meniscal tear associated with ACL injury is more in chronic cases and medial meniscus predominantly higher.

In our study associated meniscal injury is found to be 50%. 13 patients had isolated ACL injury, 11 patient's had medial meniscus injury and 4 patients had lateral meniscus injury and 2 patients had both the meniscus injured. Commonly injured was isolated ACL which was in commiserating with the other studies.

In our study among the patients with meniscal injury 3 patients were treated by partial meniscectomy and meniscus repair was done for 6 patients and rest were managed conservatively. We have tried to avoid doing meniscectomy since that accelerates the degenerative changes the knee joint. So this in commiserate with the functional outcome of isolated ACL injury.

All patients are evaluated with Lysholm and Gillquist scoring at the end of 6 months. The maximum score achieved was 100 and minimum score was 80. Initial follow up at 3^{rd} month , out of 30 only 17 (57%) patients had excellent score, at 6^{th} month 21 (70%) had excellent score, it improved to 80% at 9^{th} month follow up. 13% of patient had good score at end of 9^{th} month and 7% of patient had fair score. None of them had poor score.

The fixation of the graft has been proved to be the site of failure rather than the graft itself irrespective of the type of graft especially in the early rehabilitation phase when the graft integration has not taken place and the fixation is of little significance after 8 to 12 weeks when graft has integrated with the bone as proposed by Dawn T Gulick. There has not been a single graft failure in our study from early rehabilitative phase to 9 months of follow up.

There was no significant patellofemoral pain noticed in the patients in our study. This is similar to the study by Railey et al. who did not observe any clinically relevant patellofemoral pain in patients in whom arthroscopic ACL reconstruction using hamstring graft was done.

Williams et al[47]in their study of 2500 cases of arthroscopic ACL reconstruction, reported an infection rate of 0.3%. In our study 2 patientshad superficial infection which subsided with IV antibiotics.

The rehabilitation programme followed in our study ensured from preventing the complication due to ACL reconstruction like pain, inflammation, swelling, restoring normal range of motion, preventing muscle atrophy.

CONCLUSION

ACL injury is more commonly seen in young males due to their sporting life style and present day high speed motorized vehicles.

The ACL rupture leads to instability of the knee and hinders the patient in daily activities. The minimally invasive arthroscopic reconstruction is highly advocated for ACL injury. Anatomical reconstruction of ACL with quadrupled hamstring graft gives better clinical outcomes.

The advantage of using hamstring graft are reduced donor site morbidity and less anterior knee pain in long term follow up. It has better subjective and objective functional outcome with low graft rejection or failure rate.

The success of the Anterior Cruciate Ligment Reconstruction depends of experience of the surgeon in arthroscopic technique, exact placement of the graft and patients compliance on rehabilitation protocol.

SUMMARY

In young active population, arthroscopic reconstruction of ACL using quadrupled hamstring autograft gives excellent functional outcomes.

Mechanical and biological improvements in hamstring tendon graft fixation have been achieved using endobutton and interference screw.

The absence of patellofemoral pain with the use of hamstring makes it more desirable choice for patients with patellofemoral cartilage disorders.

Aggressive early rehabilitation will ensure early return to pre-injury level of activity.

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ANNEXURE I

INFORMED CONSENT

CONSENT TO PARTICIPATE IN RESEARCH STUDY

"I voluntarily agree to take part in this study by signing below. I may withdraw at any time. I am not giving up any of my legal rights by signing this form. My signature below indicated that I have read this entire consent form or it has been read to me, and had all my questions answered. I will be given a copy of this consent form."

Signature of the Participant or legally authorized representative

Participant's Name:

Signature:

Name of legally authorized representative:

Signature:

Witness's Name:

Signature:

Investigators Name and Signature:

Date and Place:

From

ANNEXURE II

PROFORMA

Patient details:

Name		IP NO:	
Age/sex		UNIT	
Address		Date of surgery	

Mode of injury:

Diagnosis:

Duration between injury and surgery:

Clinical assessment:

LT

ADT

PST

Investigation X-Ray / MRI details:

Associated injuries:

Type of anesthesia –

Spinal/ CSE

Meniscectomy: done / not done

Implants used: stainless steel / titanium

Endobutton 15,20, 25mm

Bioabsorbable screw and interference screw

Follow up:

Immediate post op

6 weeks

12 weeks

Six months

Nine months

Post-operative Assessment:

Test	3 months	6 months	9 months
LT			
ADT			
PST			

Lysholm score:

LYSHOLM KNEE SCORING SCALE

Instructions: Below are common complaints which people frequently have with their knee problems. Please check the statement which best describes your condition.

I. LIMP:
- _____ I have no limp when I walk. (5)
- _____ I have a slight or periodical limp when I walk. (3)
- _____ I have a severe and constant limp when I walk. (0)

II. USING CANE OR CRUTCHES
- _____ I do not use a cane or crutches. (5)
- _____ I use a cane or crutches with some weight-bearing. (2)
- _____ Putting weight on my hurt leg is impossible. (0)

III. LOCKING SENSATION IN THE KNEE
- _____ I have no locking and no catching sensations in my knee. (15)
- _____ I have catching sensation but no locking sensation in my knee. (10)
- _____ My knee locks occasionally. (6)
- _____ My knee locks frequently. (2)
- _____ My knee feels locked at this moment. (0)

IV. GIVING WAY SENSATION FROM THE KNEE
- ____ My knee never gives way. (25)
- ____ My knee rarely gives way, only during athletics or other vigorous activities. (20)
- ____ My knee frequently gives way during athletics or other vigorous activities, in turn I am unable to participate in these activities. (15)
- ____ My knee occasionally gives way during daily activities. (10)
- ____ My knee often gives way during daily activities. (5)
- ____ My knee gives way every step I take. (0)

V. PAIN:
- ____ I have no pain in my knee. (25)
- ____ I have intermittent or slight pain in my knee during vigorous activities. (20)
- ____ I have marked pain in my knee during vigorous activities. (15)
- ____ I have marked pain in my knee during or after walking more than 1 mile. (10)
- ____ I have marked pain in my knee during or after walking less than 1 mile. (5)
- ____ I have constant pain in my knee. (0)

VI. SWELLING
- ____ I have no swelling in my knee. (10)
- ____ I have swelling in my knee only after vigorous activities. (6)
- ____ I have swelling in my knee after ordinary activities. (2)
- ____ I have swelling constantly in my knee. (0)

VII. CLIMBING STAIRS:
- ____ I have no problems climbing stairs. (10)
- ____ I have slight problems climbing stairs. (6)
- ____ I can climb stairs only one at a time. (2)
- ____ Climbing stairs is impossible for me. (0)

VIII. SQUATTING
- ____ I have no problems squatting. (5)
- ____ I have slight problems squatting. (4)
- ____ I can not squat beyond a 90 degree bend in my knee. (2)
- ____ Squatting is impossible because of my knee. (0)

TOTAL____/100

INSTRUCTIONS: Please place an X on the line to indicate the amount of pain you have had in your knee(s) the past 24 hours. The scale ranges from "no pain at all" to the "worst possible pain".

RIGHT KNEE _____

no pain worst possible pain

LEFT KNEE _____

no pain worst possible pain

ANNEXURE III

ETHICAL CLEARANCE CERTIFICATE

K.L.E. ACADEMY OF HIGHER EDUCATION AND RESEARCH
(Deemed – to-be- University)
Accredited 'A' Grade by NAAC (2nd Cycle) Placed in Category 'A' by MHRD (GoI)
JAWAHARLAL NEHRU MEDICAL COLLEGE,
NEHRU NAGAR, BELAGAVI-590010 (KARNATAKA-INDIA)
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Principal: 2471701
Fax No. +91 (0)831 – 2470759

Ref: MDC/DOME/ 53 **Date: 24/11/2018**

To.

Registration No. Bl0118004
PG student in Orthopaedics,
J.N.Medical College,
BELAGAVI.

Sub: Institutional Ethical Clearance for the study.

With reference to the above, we wish to inform you that your proposed research project titled **"FUNCTIONAL OUTCOME OF ANATOMICAL RECONSTRUCTION OF ANTERIOR CRUCIATE LIGAMENT WITH HAMSTRING GRAFT – A ONE YEAR HOSPITAL BASED – OBSERVATIONAL STUDY",** is ethical and justifiable. The proposed research project has been cleared by the JNMC Institutional Ethics Committee on Human Subjects Research.

(Dr. Arathi Darshan)
Member Secretary
JNMC Institutional Ethics Committee
on Human Subjects Research,
J.N.Medical College, Belagavi.

(Dr. Roopa M Bellad)
Chairman,
JNMC Institutional Ethics Committee
on Human Subjects Research,
J.N.Medical College, Belagavi.

ANNEXURE 1V:

CASE ILLUSTRATIONS

CASE 1:

Name: SANGAPPA

Age/ Sex: 32/M

IP. No: 920891

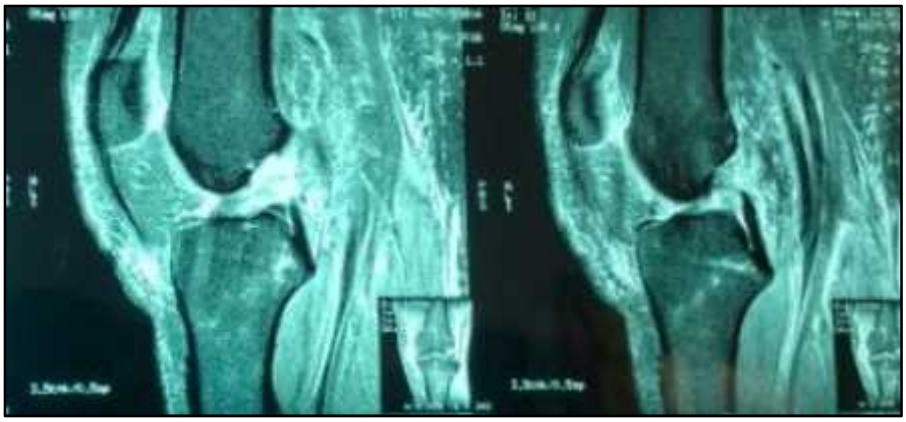
Diagnosis: (R) ACL Rupture

Associated meniscal injury: NO

Follow up period: 9 months

Range of movements: O° - Full flexion

Lysholm Knee score: 95



PREOP MRI- SHOWING TORN ACL

POST OP XRAY - ACL RECONSTRUCTION WITH FEMORAL SIDE ENDOBUTTON AND TIBIAL SIDE INTERFERENCE SCREW

Clinical image after 9 months of follow up showing full range of movements – full knee flexion and extension

CASE2:

Name : SHEETHAL

Age/ Sex : 42/M

IP. No : 942154

Diagnosis : (L) ACL Rupture

Associated meniscal injury : YES

Follow up period : 9 months

Range of movements : O° - Full flexion

Lysholm Knee score : 90

PREOP MRI- SHOWING TORN ACL

POST OP XRAY - ACL RECONSTRUCTION WITH FEMORAL SIDE ENDOBUTTON AND TIBIAL SIDE INTERFERENCE SCREW

Full range of movements without extension lag after 6 months of follow up.

Full flexion at the end of 6 months of follow up.

CASE 3

Name: ARUN KUMAR

Age/ Sex: 21/M

IP. No: 93587

Diagnosis: (R) ACL Rupture

Associated meniscal injury:YES

Follow up period: 9 months

Range of movements: O° - Full flexion

Lysholm Knee score: 90

PREOP MRI- ILLUSTRATING TORN ACL

POST OP XRAY - ACL RECONSTRUCTION WITH FEMORAL SIDE ENDOBUTTON AND TIBIAL SIDE INTERFERENCE SCREW

Clinical image after 9 months of follow up showing full range of movements – full knee flexion and extension.

SL.NO	AGE	SEX	IP NO	MODE OF INJURY	SIDE OF INJURY	TIME SINCE INJURY MONTHS	MENISCAL INJURY	FOLLOW UP (MONTHS)	LYSHOLM KNEE SCORE
1	32	MALE	920891	RTA	RIGHT	3	NO	6	95-EXCELLENT
2	26	MALE	921427	FOOTBALL	RIGHT	8	YES	6	100-EXCELLENT
3	28	FEMALE	924671	RTA	RIGHT	4	NO	4	95-EXCELLENT
4	26	FEMALE	925683	RTA	LEFT	6	NO	6	96-EXCELLENT
5	29	MALE	928453	RTA	RIGHT	2	YES	6	95-EXCELLENT
6	36	MALE	934527	RTA	RIGHT	4	NO	6	95-EXCELLENT
7	24	MALE	935120	FOOTBALL	LEFT	1	NO	8	95-EXCELLENT
8	21	MALE	935987	RTA	RIGHT	8	YES	6	90-GOOD
9	21	MALE	941274	RTA	RIGHT	2	NO	6	95-EXCELLENT
10	42	MALE	942154	RTA	LEFT	5	NO	6	80-FAIR
11	26	MALE	945865	RTA	RIGHT	2	YES	6	90-GOOD
12	21	FEMALE	953174	RTA	RIGHT	14	NO	8	95-EXCELLENT
13	24	MALE	961834	FOOTBALL	RIGHT	6	NO	9	82-FAIR
14	34	MALE	962537	RTA	RIGHT	2	NO	6	95-EXCELLENT
15	32	MALE	968416	RTA	RIGHT	4	NO	10	90-GOOD
16	24	MALE	970085	FOOTBALL	LEFT	2	NO	6	95-EXCELLENT
17	21	MALE	972652	RTA	RIGHT	5	YES	4	95-EXCELLENT
18	29	FEMALE	978149	SELF FALL	RIGHT	15	NO	6	100-EXCELLENT
19	24	MALE	983714	RTA	RIGHT	3	NO	6	95-EXCELLENT
20	39	MALE	991243	RTA	RIGHT	9	NO	6	90-GOOD
21	24	MALE	996517	RTA	RIGHT	2	NO	6	100-EXCELLENT
22	21	MALE	994218	RTA	RIGHT	4	YES	9	90-GOOD
23	45	MALE	996231	RTA	RIGHT	6	YES	2	90-GOOD
24	30	MALE	1000364	RTA	RIGHT	12	YES	2	90-GOOD
25	23	MALE	1001587	RTA	RIGHT	10	YES	1	95-EXCELLENT
26	44	MALE	1005361	RTA	LEFT	3	YES	1	90-GOOD
27	27	MALE	1009521	CRICKET	RIGHT	11	NO	1	90-GOOD
28	52	MALE	1009621	SELF FALL	LEFT	15	YES	6	90-GOOD
29	30	MALE	1009758	SELF FALL	RIGHT	12	NO	8	95-EXCELLENT