"A PROSPECTIVE STUDY OF OUTCOME OF ARTHROSCOPIC RECONSTRUCTION OF ANTERIOR CRUCIATE LIGAMENT WITH HAMSTRING TENDON AUTOGRAFT"

By

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Under the Guidance of

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ABSTRACT

Background:

A wide variety of techniques and graft types are now available for the reconstruction of ACL. The development of new surgical techniques and recent advances in instrumentation has enabled surgeons to achieve better results. However, varying opinion exist among experts with regard to the ideal technique and graft type to be used. Arthroscopic ACL reconstruction using quadrupled semitendinosus tendon autograft with fixation in the femoral tunnel using endobutton and in the tibial tunnel with hybrid fixation using suture disc and anchored with a cancellous screw and washer is a relatively new technique. We have undertaken this study to analyse the postoperative outcome in our experience with this procedure..

Objectives:

1. To study the functional outcome of arthroscopic anterior cruciate ligament reconstruction using semitendinosus autograft.
2. To study the complications following arthroscopic anterior cruciate ligament reconstruction using semitendinosus autograft

MATERIALS AND METHODS:

This was a prospective study of consecutive 30 patients with ACL injury who underwent Arthroscopic ACL reconstruction using quadrupled hamstrings tendon autograft in Department of Orthopaedics at R.L Jalappa Hospital and Research Centre, Kolar, from November 2012 to April 2014 Postoperatively.

All patients were initiated on the same rehabilitation protocol. All patients were followed up for four to six months period at regular intervals using IKDC scoring system and a subjective questionnaire. Functional assessment with hop test was done.

Results:

90% of the patients had a favorable outcome as per three scoring systems. There was good correlation between IKDC and the functional outcome – Pearson's correlation co- efficient of - 0.192 with IKDC and was statistically significant; p: 0.001 with IKDC. The mean limb symmetry index of hop tests were 83.503 +/- 3.65 [range: 66.36 to 93.33].

Interpretation & Conclusion:

We conclude that the functional outcome of arthroscopic anterior cruciate ligament reconstruction using quadrupled semitendinosus tendon autograft is excellent to good (90%). With proper patient selection and physiotherapy regimen, full occupational and recreational activities can be expected for most of the patients within four to six months of the procedure.

LIST OF ABBREVIATIONS

A	Anterior drawer test
ACL	Anterior Cruciate Ligament
AMB	Anteromedial Band
BPTB	Bone Patellar Tendon Bone
IP No	In patient Number
EUA	Evaluation under anaesthesia
IKDC	International Knee Documentation Committee
L	Lachman test
LM	Lateral Meniscus
LCL	Lateral collateral ligament
MM	Medial Meniscus
MCL	Medial collateral ligament
MRI	Magnetic Resonance Imaging
OPD	Out patient department
P	Pivot shift test
PCL	Posterior Cruciate Ligament
PLB	Posterolateral Band
RTA	Road Traffic Accident
SQ	Subjective Questionnaire

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INTRODUCTION

Over the last few decades injuries of the knee joint have played a major role, due to many popular knee pivoting sports including soccer, skiing and basketball.[1]

Ligament injury accounts for nearly 40% of all knee injury problems and isolated anterior cruciate ligament injury constitutes nearly 50% of all knee ligament injuries[2,3,4]. Approximately 3,00,000 anterior cruciate ligament reconstructions are performed in the USA alone each year[5].

Better understanding[6] of injury mechanisms lead to prevention strategies against anterior cruciate ligament injury with some effectiveness although, anterior cruciate ligament injury is still not fully preventable.

Anterior cruciate ligament was considered of little importance for the long term function of the knee in the past[7].

Studies have shown that acl deficient knees are prone to greater risk of meniscal and articular injuries in short term progressing to joint degeneration in the long term compared to subjects with normal anterior cruciate ligament function[8,9].

Non operative management has not been proven to prevent or delay long term sequelae of anterior cruciate ligament deficiency[10]. Early surgical methods such as primary repair of anterior cruciate ligament injury with or without augmentation[11] showed a modest to poor improvement over non-operative management in terms of subjective and functional outcome of symptomatic knee instability[12].

Numerous authors have described successful reconstruction of the ACL with use of a donor auto graft (patellar tendon, hamstring tendon or quadriceps tendon) and allograft (Achilles, patellar tendon, hamstring tendon or tibialis anterior) tendons. Anterior Cruciate Ligament Reconstruction has been attempted using Silver wire, Fascia lata[13], and Iliotibial band[14].

To date more than 400 different techniques have been described for Anterior Cruciate Ligament Reconstruction from open to arthroscopic technique[15]. The bone-patellar tendon- bone is the most commonly used graft in ACL reconstruction. However, concerns regarding problems with the extensor mechanism of the knee, loss of motion, patellar fracture and the development of chronic anterior knee pain have promted surgeons to seek other graft materials for use in ACL reconstruction. As such, the semitendinosus and gracilis tendon represent an alternative auto graft donor material that may be used for reconstruction of the ACL without disturbance of the extensor mechanism.

In 1954, the development of successful arthroscope brought new possibilities to the field of knee surgery[16]. Since 1982, the Anterior Cruciate Ligament Reconstruction has often been performed arthroscopically[17].

Arthroscopically assisted Anterior Cruciate Ligament Reconstruction has the advantage of being minimally invasive, accurate graft placement, less disturbance of normal tissue resulting in quicker recovery and rehabilitation, minimal hospital stay and very less infection rate.

Anterior cruciate ligament (ACL) reconstruction with Hamstring tendon is becoming increasingly popular in patients with symptomatic instability and in appropriately selected patients can yield successful and satisfactory results[18].

Biau, et al, in 2007, performed a meta analysis to provide qualitative data to ascertain whether bone-patellar tendon- bone graft or hamstring graft provided superior knee function as determined by final overall IKDC evaluation and return to pre injury level of activity. They found no difference in the final number of patients restoring to fill activity after hamstring tendon graft and bone-patellar tendon- bone graft reconstruction[19].

There is fair evidence that patients reconstructed with hamstring graft report less morbidity than those reconstructed with bone-patellar tendon- bone graft. The improvement of stability with bone-patellar tendon- bone graft compared with 4 strand hamstring graft remains of questionable importance for most patients. However, functional results between the two types of reconstruction remains unclear.

The present study is designed to analyse the postoperative outcome of arthroscopic ACL reconstruction with quadrupled semitendinosus tendon autograft fixed in femoral tunnel using endobutton and in the tibial tunnel using interference screws.

AIMS AND OBJECTIVE

1. To study the functional outcome of arthroscopic anterior cruciate ligament reconstruction using semitendinosus autograft.
2. To study the complications following arthroscopic anterior cruciate ligament reconstruction using semitendinosus autograft

REVIEW OF LITERATURE

The classic history of anterior cruciate ligament injury begins with a noncontact deceleration jumping or cutting action. Usually patient describes the knee as having been hyperextended or poping out of joint and then reducing.

The anterior cruciate ligament is the primary restraint to anterior tibial displacement, accounting for approximately 85% of the resistance to the anterior drawers test when knee is at 90 degree flexion.

With the natural history in mind, the treatment options available include nonoperative management, repair of the anterior cruciate ligament (either isolated or with augmentation), and reconstruction with either autograft or allograft tissues or synthetics.

Nonoperative treatment is a viable option for a patient who is willing to make lifestyle changes and avoid the activities that cause recurrent instability.

In one of the most comprehensive series, Daniel et al. observed 236 patients with unstable knees. The patients were assessed by physical examination, KT-1000 measurements, and activity and frequency of sports participation.

Nineteen percent elected early anterior cruciate ligament reconstruction, 20% required late reconstruction, and 61% were able to deal with their injury, although many were symptomatic.

The authors found three factors known at the time of the initial examination that correlated with the need for surgery: younger age, pre injury hours of sports participation, and amount of anterior instability.

If a nonoperative approach is chosen, it should include an aggressive rehabilitation program and counseling about activity level. The use of a functional knee brace is controversial and has not been shown to reduce the incidence of reinjury significantly if a patient returns to high level sports.

Bozzini, in 1806 devised the first endoscope consisting of a bifid tube with illumination provided by the candle. The devise was originally used to view the vagina and rectum.

In 1853, Desormaux produced the gazogens endocystoscope. A mixture of turpentine and alcohol was used to provide the fuel for a fire in a small combustion chamber.

In 1876, Max Nitze developed the first modern cystoscope.

Incandescent lamp was developed by Sir Thomas Edison in 1880 which proved to be a milestone in the science of endoscopy.

Prof. Kerji Takagi of Tokyo University, in 1918 first applied the principles of endoscopy successfully to knee joint of a cadaver using a cystoscope.

Dr. Watanabe released No. 21 arthroscope in 1951 which proved to be the first successful arthroscope.

In 1875, Georges K. Noulis[20] (1849-1919) accurately described the role of the ACL, and showed how the integrity of the ligament should be tested with the knee in extension. The test proposed by Noulis was identified with the one now known and used as the Lachman test.

In 1935, Willis C. Campbell[21], of Memphis, Tennessee, reported the first use of a tibia based graft of the medial one third of the patellar tendon, the patellar retinaculum, and a portion of the quadriceps tendon. The technique involved drilling two tunnels, one in the tibia and one in the femur. The graft was stitched to the periosteum at the femoral tunnel exit. The operation was followed by posterior splint fixation for a period of 3 weeks.

In 1939, Harry B. Macey[22], of Rochester, Minnesota, described the first technique using the semitendinosus tendon. The tendon was left attached to the tibia, then passed through a tibial and a femoral tunnel, and sutured to the periosteum.

The joint was approached via an anterior oblique parapatellar incision. Only the tendinous portion of the semitendinosus was harvested, stopping short of the musculotendinous junction. The tunnels were 4.7 mm in diameter, and the graft was attached with the knee in full extension. A plaster of Paris cast was applied and worn for 4 weeks, full activity was permitted at the end of 8 weeks.

In 1963, Kenneth G,Jones[23,24], of Little Rock, Arkansas, introduced the concept of using a central one-third of patellar tendon graft with an attached patellar bone block. The tendon was left attached to the tibia; there was no tibial tunnel; and because of the shortness of the graft, the author had to drill the femoral tunnel from the anterior margin of the notch. The ligament was secured to the periosteum at the superolateral exit site on the femur.

Jones reported on 11 cases that had been operated on successfully. In the discussion of the article, Don H.O'Donoghue made the point that the femoral tunnel was in the wrong place; however, the technique was simple and caused minimal operative trauma, which made it a distinct improvement.

In 1969, Kurt Franke (Berlin) pioneered the use of a free bone-tendon-bone-graft consisting of one quarter of the patellar tendon and attached patellar and tibial bone blocks. The graft was fixed with a wedge like piece of bone anchored in the tibial plate, and a shell-like piece implanted into the femoral condyle. Franke recommended that the procedure be performed as early as possible, before cartilage damage had occurred; he had found cartilage damage to be associated with postoperative pain on knee loading, in 10% of his patients. Also, the procedure should not be used in patients over 50.

In 1975, M. Lemaire[25] described his exclusively extra articular ligament reconstruction techniques. Medially, gracilis was used for the management of the medial collateral ligament injuries; while, laterally, fascialata was employed for the reconstruction of the torn ACL. In patients with isolated ACL tears, the rate of good results was 91%. In his conclusions, Lemaire drew attention to the fact that any associated meniscal lesions tended to have an adverse effect on the outcome.

In 1981, D.J.Dandy (Cambridge) was the first to implant a carbon fiber-reinforced ligament substitute, using an arthroscopic procedure. The results were rather poor[26,27]. Unfortunately, carbon deposits were found in the synovial membrane and the liver, which put a stop to the further use of the technique. As carbon fiber went out, Dacron and Gore- Tex came in, and the ‘arthroscopy generation’ of surgeons seized on these synthetic materials, as a means of performing ACL reconstruction quickly, with minimal trauma, and effectively. However, towards the end of the 80s, there was an unacceptably high rate of synovitis and subsequent rupture of the neoligaments. This rate was seen to be rising with the passage of time. As a result, this line of ACL reconstruction had to be abandoned as well.

In 1987, M. Kurusoka[28] (Kobe, Japan) showed that the mechanically weak link of the reconstructed graft was its fixation. The research had been done in young human cadavers, and showed clearly that 9-mm diameter cancellous screws were much superior to other fixation systems. Within a few years, such screws came to be made of resorbable materials such as PLA (polylactic acid – France, 1992) or PGA (polyglycolic acid – US, 1990).

A.B. Lipscomb et al, researched on hamstring tendons for ACL Reconstruction and found that the ultimate strength of quadrupled semitendinosus tendon autograft is 4108N which is thrice the strength of normal ACL, stiffness is 807N/m which is twice that of BPTB autograft, and on cybex machine could not find any differences between normal and ACL Reconstructed knee at 26 months follow up[29].

In 1988, M.J.friedman[30] pioneered the use of an arthroscopically assisted four-stranded hamstring autograft technique. He was followed in 1993, by R.L.Larson, S.M.Howell[31], Tom Rosenberg (US) and Leo Pinczewski[32,33] (Sydney), who used the pes tendons in three or four strands , with graft placement in a femoral socket.

Pinczewski used an “all-inside” technique, with a special large (8mm) round-headed interference screw, known as the RCI screw. Other leading edge groups started using hamstring tendons, with different means of fixation. Tom Rosenberg devised fixation with the so-called Endo-Button that locked itself against the lateral aspect of the femoral condyle. L. Paulos used a polyethylene anchor. G. Barrett, a bone graft; S. Howell and e. Wolf, cross- pinning; A. Stacheiolin[34], biodegradable interference screws; L. Johnson[35], a staple, and others, screws and washers.

Jomha NM & Co-workers did the study on arthroscopic reconstruction of anterior cruciate ligament with Bone- Patellar Tendon- Bone auto graft and interference screw fixation in 1999 among 59 patients using central 1/3rd of patellar tendon, the results suggested anterior cruciate ligament reconstruction stabilizes the knee joint, prevents early onset of osteoarthritis associated with complications like bony defect, compromises function of extensor apparatus, anterior knee pain and kneeling problems[36].

Leo Chan & Co-workers reconstructed ACL by quadrupled semitendinosus auto graft using endobutton technique for femoral fixation and found little morbidity and low reoperative rate and excellent clinical results[37].

Chaudhary D & Co-workers reconstructed anterior cruciate ligament with Bone- Patellar Tendon- Bone autograft in 100 cases and concluded anterior knee pain is the most common complication followed by difficulty in regaining full range of motion[38]. Wiliams et al, in 2005, analyzed the clinical outcomes at a minimum of two years follow up reconstruction of the anterior cruciate ligament with use of a four- strand hamstring tendon autograft in patients who had presented with a symptomatic torn anterior cruciate ligament.

They concluded that reconstruction of the anterior cruciate ligament with use of a four-strand hamstring tendon autograft eliminated anterior tibial subluxation in 89% of patients who were examined at a minimum of two years postoperatively. The overall rate of failure was 11%. The functional knee scores were significantly increased at the time of follow-up, but these results did not correlate with the results of knee arthrometric testing[39].

Goldblatt and others in their meta analysis of many studies on BPTP autograft and hamstring tendon auto grafts used for ACL Reconstruction noted that the cases with hamstring tendon autograft reported less anterior pain and significantly less extension loss in knee joint[40].

Gobbi et al. described the use of a quadrupled semitendinosus tendon graft with a bone block harvested from the tibial end of the tendon. This technique combines the advantage of having low donor site morbidity and at the same time achieves bone-to-bone healing with bone blocks incorporated in the tunnels. Results revealed that in 100 cases reviewed, 90% of the knees were either normal or nearly normal on final follow-up. Computerized analysis of knee laxity also demonstrated evidence of graft incorporation in the tunnels.

The BPTB technique is superior only in terms of post operative laxity and tunnel enlargement. The functional results of the subjective rating of the results by the patient are better with Hamstring Tendon graft than the BPTB (PTG) graft. The IKDC score and anterior knee pain favor Semitendinosus Tendon as the graft material of choice[41].

Pinczewski et al., in their 10year comparative study of ACL Reconstruction with hamstring tendon and patellar tendon autograft reported that hamstring tendon autograft is superior to BPTB autograft in post operative knee stability, Lysholm score and radiographic osteoarthritic change[42].

Yasuda et al, compared morbidity associated with harvesting hamstring tendons without doing ACL Reconstruction with another group with ACL Reconstruction using hamstring tendon graft.

31 cases with ipsilateral hamstring tendon and 34 cases with contralateral hamstring tendon were done. At 1 month follow up ipsilateral group had significant weakness of hamstring power, but by 12months follow up there was no difference. They also observed that healing of tendon graft within the bone tunnel took 12-26weeks[43].

The use of autogenous hamstring tendon as a graft source for anterior cruciate ligament (ACL) reconstruction continues to gain in popularity. The low harvest morbidity and excellent biomechanical graft properties coupled with improved fixation of soft tissue grafts are all reasons for excellent clinical outcomes of ACL reconstruction using hamstring tendons[44].

Jung Hwan Lee and co workers compared the outcomes after ACL Reconstructive surgery in 338 patients by use of BPTB autograft, Tibialis anterior allograft and Hamstring tendon autograft. The comparative parameters included the grade of range of motion, Lachman test, Pivot shift test, IKDC scores and also second look arthroscopicfindings after 1year reconstruction.

They concluded that hamstring tendon autograft group had better synovial coverage on second look arthroscopy presenting with better clinical results on IKDC form[45].

Hop testing has frequently been proposed as a practical, performance based outcome measure that reflects the integrated effect of neuromuscular control, strength (force- generating capacity), and confidence in the limb and requires minimal equipment and time to administer. Based on a review of the potential use of hop tests as measure of dynamic knee stability, it has been suggested that hopping may be appropriate for use as a predictive tool for identifying patients who may have future problems as a result of knee injury or pathology and as an evaluative method to reflect change in patient status in response to treatment[46].

A combination of 4 different hop tests originally described by Noyes et al.[47] may be particularly suitable as a performance based outcome measure for patients who are undergoing rehabilitation after ACL reconstruction. The tests incorporate a variety of movement principles (ie, direction change, speed, acceleration-deceleration, rebound) that mimic the demands of dynamic knee stability during sporting activities. This series of hop tests involves a single hop for a distance, a 6-m timed hop, a triple hop for distance, and cross-over hops for distance.

Measurements are obtained on both extremities so that performance on the operative limb can be expressed as a percentage of test performance on the opposite limb, termed the “limb symmetry index”. Based on performance of these 4 hop tests, the limb symmetry index has been used to help differentiated individuals with and without dynamic knee stability and to compare different rehabilitation strategies following ACL reconstruction. Some authors also have advocated the use of these hop tests when monitoring progress in individual patients who are undergoing rehabilitation following ACL reconstruction[48].

Havard Moksnes and others evaluated functional outcome following ACL Reconstruction. The outcome was compared with non operated ACL deficient knees and concluded Single-legged Hop Tests, Isokinetic Muscle Strength Measurements, and Functional Questionnaires (IKDC 2000, and Lysholm) can be Used as Outcome Measurements[49].

Andrea Reid and co workers in March 2007 investigated the reliability and validity of hop tests during rehabilitation after ACL reconstruction in forty-two patients and concluded that the series of hop tests provide a reliable and valid performance-based outcome measure for patients undergoing rehabilitation following ACL reconstruction[48].

Jesper and others in their study to analyse the ability of hop test to determine functional deficits after ACL reconstruction concluded that the exercise protocol, combined with the single-leg hop test, improved testing sensitivity when evaluating lower-extremity function after ACL reconstruction[50].

Newer-generation bioabsorbable screws were designed to promote osseointegration, no tunnel narrowing was noted, and in the majority of cases the remains of the screws were present at approximately three years[51].

Greater anterior laxity of the uninjured knee was associated with poorer stability and functional outcomes after ACL reconstruction. Excessive anterior laxity of the uninjured knee thus appears to represent a risk factor for inferior outcomes[52].

Tunnel characteristics including anatomic position, graft obliquity, and tunnel widening after single-bundle ACL reconstruction performed with use of the modified transtibial technique were not significantly different from those of the anteromedial transportal technique, and clinical results were comparable[53].

Cigarette smoking appeared to have a negative effect on subjective and objective outcomes of ACL reconstruction,and heavy smokers showed greater knee instability.

Patients who had stopped smoking at least one month prior to ACL reconstruction had no significant difference in outcomes compared with patients who had never smoked[54].

At the time of return to sports, the STG group had better performance in terms of quadriceps strength and the results of the triple-hop, crossover-hop, and jump-landing tests compared with the BPTB group. Compared with controls, soccer players who had undergone ACL reconstruction had less quadriceps and hamstrings strength and inferior hop performance and jump-landing strategy[55].

Femoral tunnels drilled with anatomic footprints had sufficient length for adequate femoral fixation. Femoral tunnels positioned anterior to the native insertion of the ACL were longer than those in anatomic position[56].

To optimize functional and clinical outcomes after ACL Reconstruction and to prevent a second knee injury, an evidence based medicine approach is proposed in this review that directly addresses known, modifiable neuromuscular and biomechanical risk factors for increased risk of second ACL tears.

Inadequate neuromuscular control and biomechanical asymmetries of the trunk and lower extremities predict first knee injury risk. Addressing these impairments in athletes after ACL Reconstruction using targeted rehabilitation may significantly reduce the second injury incidence and subsequent functional disability. The proposed evidence based medicine approach will target these highly impactful impairments by way of focused sports symmetry training to optimize the safe return to high-risk activity and increase both the efficiency and efficacy of strategies[57].

ANATOMY

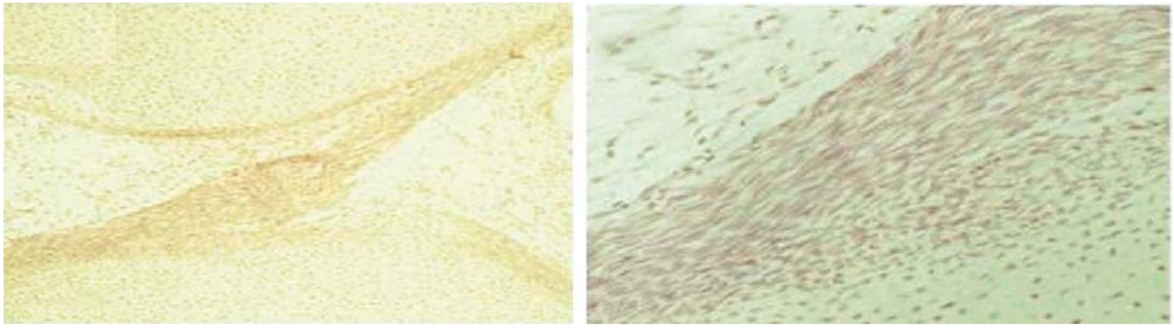
The knee, the largest human synovial joint, is described as a complex and compound hinge type joint. The presence of menisci compensate for the incongruity of the articular surfaces. It can be described as having two condylar joints between femur and tibia and a sellar type joint between patella and femur.

These joint features account for the complexity of the knee joint movements. Towards end of extension, the knee locks into a very stable position which provides stability in standing posture and for the stance phase of walking. This is facilitated by relative internal rotation of femur in relation to tibia when tibia is fixed in stance phase or relative external rotation of tibia when tibia is free from ground and not fixed. Integrity of the cruciate ligaments, anterior cruciate ligament in particular is very much essential for this smooth glide of movement.

Gardener and O'Rahilly[58] studied development of the knee joint in staged embryos knee develops from a cavity between the mesenchymal rudiments of the femur and tibia during the $7_{1/2}$ to 8th week of the human embryo[59].

Mesenchyme in the region of the future knee joint condenses to form the precartilage and the capsule of the joint and vascular mesenchyme becomes isolated is the precursor to the cruciate ligaments and the menisci. At approximately 8 weeks of postovulatory period, both cruciate ligaments are composed of numerous immature fibroblasts, orientated to the axis of the ligaments.

Appearance and orientation of cruciate ligaments during 10th week[59]



Around 10th week of gestation anterior and posterior cruciate ligaments are separate structures. As the gestation age increases cruciate ligaments become well defined from surrounding articular structures and capsule and insertion sites are well marked. The mature anterior cruciate ligament is a band of regularly oriented, dense connective tissue which connects the femur and tibia. It is surrounded by a fold of synovium that originates from the posterior intercondylar area of the knee, and completely envelopes both the anterior and posterior cruciate ligaments due to which cruciate ligaments are intraarticular and extra synovial.

ATTACHMENTS OF ACL[60]

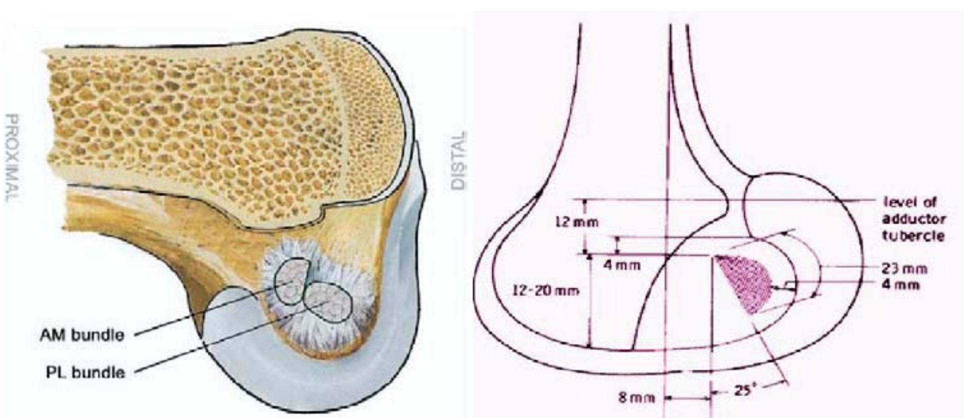


Figure No: 1a

The anterior cruciate ligament is attached to a fossa on the posterior aspect of the medial surface of the lateral femoral condyle. The femoral attachment is in the form of segment of circle, with the anterior border straight and the posterior border convex. The posterior convexity is parallel to the posterior articular margin of the lateral femoral condyle. The long axis of the femoral attachment is tilted slightly forward from the vertical, and is about 23 mm long[60].

On the tibia, the anterior cruciate ligament is attached to a fossa in front of and lateral to the anterior tibial spine. This fossa is a wide, depressed area approximately 11 mm wide (range, 8–12 mm) and 17 mm (range, 14–21 mm) in the antero-posterior direction. The anterior part of the tibial attachment lies beneath the transverse meniscal ligament, and a few fascicles of the anterior cruciate ligament may blend with the anterior attachment of the lateral meniscus. In some instances, fascicles from the posterior aspect of the tibial attachment of the anterior cruciate ligament may extend to, and blend with, the posterior attachment of the lateral meniscus.

Tibial attachment of anterior cruciate ligament

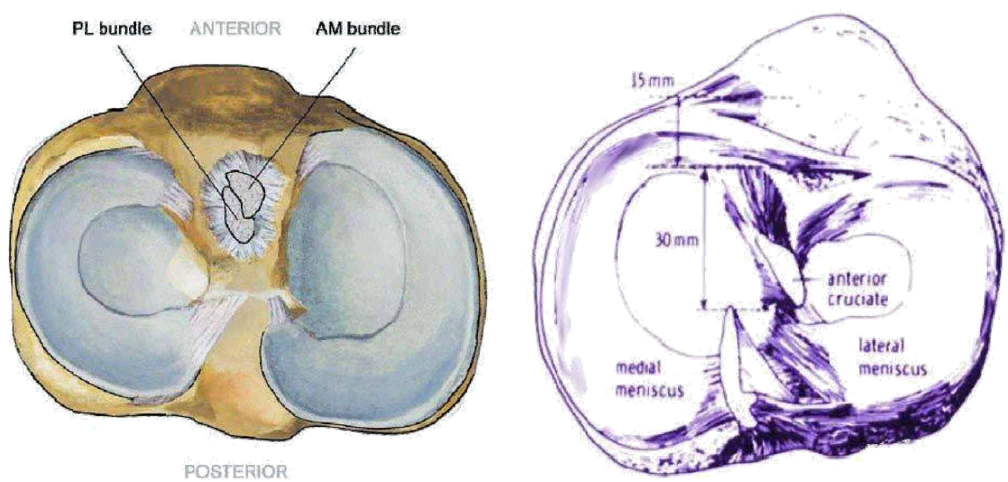


Figure No: 1b

The tibial attachment of the anterior cruciate ligament is somewhat wider and stronger than the femoral attachment because of which this ligament is fan-shaped. The anterior cruciate ligament courses anteriorly, medially and distally across the joint as it passes from the femur to the tibia. It also has a slight outward spiral form because of orientation of its bony attachments. The anterior cruciate ligament is lateral to the midline and occupies the superior across. The average thickness of the anterior cruciate ligament is 11 mm and the cross-sectional area is irregular and varies along its length, being larger at its insertion sites than in the mid-region. The cross-sectional area increases from the femur to the tibia, as follows: 34 mm proximally to 42 mm distally[61]. Its length ranges from 22 to 41 mm (mean, 32 mm)[62] and its width from 7 to 12 mm. The size of the bony attachment can vary from 11 to 24 mm.

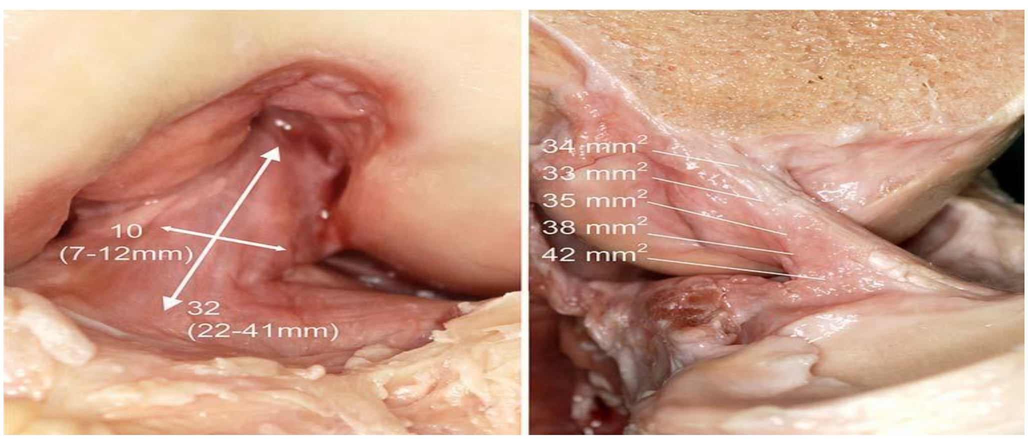


Figure No: 1c 66% of the lateral aspect of the notch on an anterior view of the flexed knee joint[66].

Functionally, Girgis et al. divided the anterior cruciate ligament into two parts, the anteromedial bundle (AMB) and the posterolateral bundle (PLB), while other authors have separated the anterior cruciate ligament in three functional bundles (AMB, intermediate band, and PLB).

The fibers on the anterior border of the anterior cruciate ligament are longest, whereas those on the posterior edge are the shortest. The fascicles of the AMB originate at the most anterior and proximal aspect of the femoral attachment and insert at the anteromedial aspect of the tibial attachment. Conversely, the fascicles of the PLB originate at the postero-distal aspect of the femoral attachment and insert at the posterolateral aspect of the tibial attachment. A larger number of fascicles make up the PLB as compared to the AMB. With the knee in extension the fascicles of the anterior cruciate ligament run in a fairly parallel fashion when viewed sagitally.

During flexion, there is a slight lateral rotation of the ligament as a whole around its longitudinal axis, and the AMB begins to spiral around the rest of the ligament. This relative movement of one bundle upon the other is due to the orientation of the bony attachments of the anterior cruciate ligament. In full extension there is a significant difference in length between the AMB (34 mm) and the PLB (22.5 mm). The two bundles are not isometric in flexion/extension, but experience different patterns of length changes during passive knee flexion. Hollis et al[63] showed that the AMB lengthens and tightens in flexion, while the PLB shortens and becomes slack.

As compared to full extension, the posterior fibers become slack in flexion, and thus leave the anteromedial fibers as the restraint to anterior tibial load. The two bundles are no longer parallel because the AMB spirals around the rest of the ligament. Internal rotation lengthens the anterior cruciate ligament a little more than does external rotation, most noticeably at 30° of flexion. Indeed, tibial rotation torques of 1 N m does not cause significant anterior cruciate ligament elongation. Twisting is resisted by a combination of capsular shearing, slanting collateral ligament action, joint surface and meniscal geometry, while the cruciates play only a secondary role.

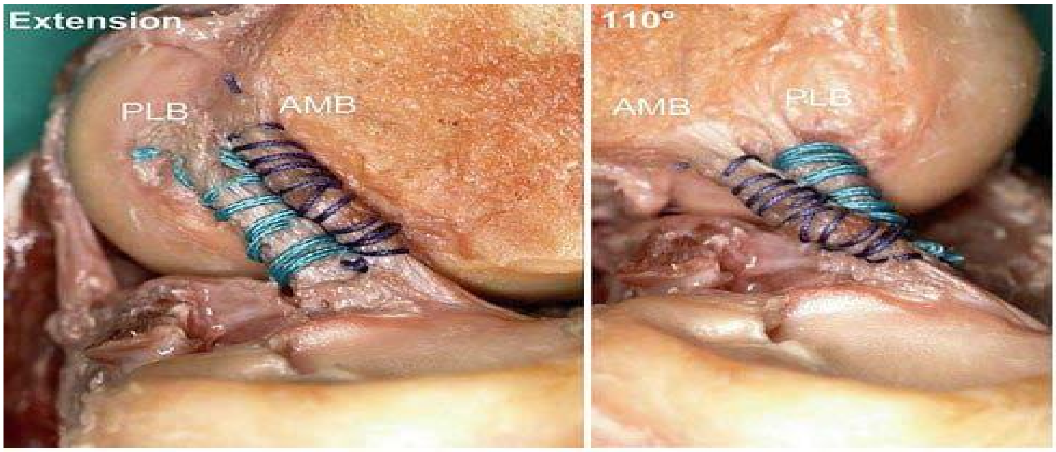


Figure No: 1d

However, these macroscopic bundles lack a corresponding microstructure in the substance of the anterior cruciate ligament. The functional significance of the fascicles of the anterior cruciate ligament is that groups of fascicles work together throughout the range of joint motion[64].Microscopically, the anterior cruciate ligament can be distinguished into three zones.

Histological appearances of different parts of anterior cruciate ligament

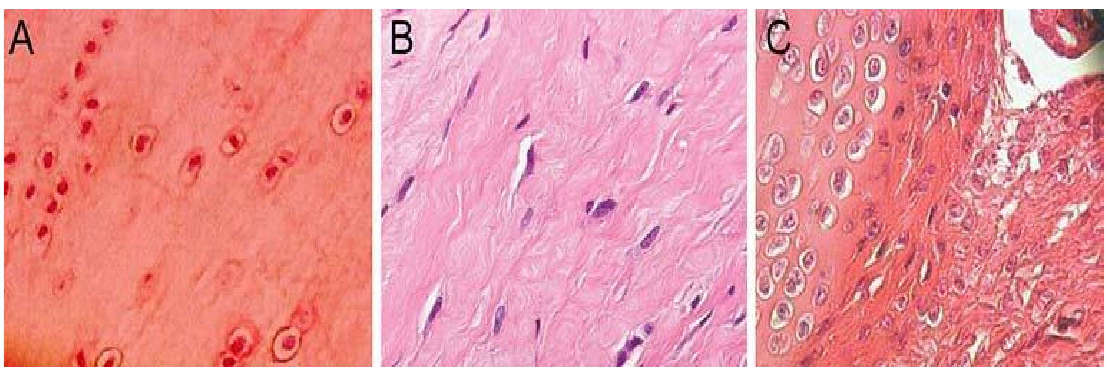


Figure No: 2

A) The proximal part -highly cellular with round and ovoid cells

B) The middle part - fusiform and spindle-shaped fibroblasts and a high density of collagen bundles.

C) The distal part –the most solid part with chondroblasts, ovoid fibroblasts and a low density of collagen bundles .

The middle part also has a special zone of cartilage and fibrocartilage and elastic, and oxytalan fibers. The oxytalan fibers withstand modest multidirectional stresses, while elastic fibers absorb recurrent maximal stress. The distal part, which is mostly solid in the anterior portion of the anterior cruciate ligament, approximately 5–10 mm proximal to the tibial attachment, has a layer of dense fibrous tissue around it instead of synovial tissue. This area corresponds to the zone where the ligament impinges on the anterior rim of the femoral intercondylar fossa in full knee extension.

Structurally anterior cruciate ligament is composed of multiple fascicles, the basic unit of which is collagen and these fascicles range from 250 lm to several millimeters and are surrounded by a connective tissue known as the paratenon. Each fascicle is composed of 3–20 subfasciculi which are enclosed by an epitenon. The subfasciculi have an undulating course and consist of groups of subfascicular units (100–250 lm in diameter) surrounded by loose connective tissue, the endotenon consisting of collagen type II. These subfascicular units are composed of fibers (1–20 lm in diameter) which are made up of collagen fibrils (25–250 nm in diameter).

The matrix of the anterior cruciate ligament consists of four different components.

Collagen: Type I collagen is the major collagen responsible for the tensile strength of the ligament .Type II collagen is found in the fibro cartilaginous regions of the anterior cruciate ligament, specifically the tibial and femoral sites of attachment. Type III collagen is located in the loose connective tissue that divides the type I collagen bundles found in maximal concentrations near the attachment zones. It is important for the pliability of the ligament. Most of the newly synthesized collagen in the early phase of healing is type III. It is also increased after tendon graft in a remodeling process termed ‘‘ligamentization’’. Type IV collagen is found mainly in the proximal and distal parts of the anterior cruciate ligament and less in the middle third which is less vascularised. Type VI collagen has an orientation parallel to that of type III collagen. It serves as a gliding component between functional fibrillar units. This distribution is due to significantly higher strains in the attachment regions in comparison with the mid-region.

Glycosaminoglycans(GAGS): anterior cruciate ligament has GAGS concentration two to four times that observed in tendons. This accounts for the viscoelastic properties of the anterior cruciate ligament representing ‘‘shock-absorbing’’ feature in the ligament.

Glyco-conjugates: These include laminin, entactin, tenascin, and fibronectin. **Elastic components**: This group includes oxytalan , elaunin, mature elastic fibers, and elastic membranes.

Fibrils arrangement is a combination of helical and planar, parallel or twisted, nonlinear networks. The centrally located fascicles in the anterior cruciate ligament are either straight or undulated in a planar wave pattern, whereas those located at the periphery are arranged in a helical wave pattern. The purpose of the wave and nonlinear pattern of the fibrils has been interpreted as ‘‘crimp’’ and ‘‘recruitment’’, respectively. Crimp provides a mechanism for control of tension and acts as a ‘‘shock-absorber’’ along the length of the tissue. During tensile stretch, fibril ‘‘crimp’’ is first straightened out by small loads, after which larger loads are needed to elongate these fibrils. As such, an increasing number of fibrils become load bearing as larger loads are applied (‘‘recruitment’’) and a gradual increase in tissue stiffness is seen, resulting in a nonlinear load–elongation curve. This phenomenon allows the anterior cruciate ligament to rapidly provide additional protection to the joint. The complex ultra structural organization and abundant elastic system of the anterior cruciate ligament makes it different from the other structures and allows it to withstand multi-axial stresses and varying tensile strains[74].

The Blood & Nerve supply

The blood supply of the cruciate ligaments is provided by the **middle genicular artery** which originates from the anterior aspect of the popliteal artery most commonly at the level of the proximal contours of the femoral condyles. It pierces the posterior capsule crosses the posterior capsule in an oblique, almost vertical descending direction. It ramifies and provides branches to the soft tissues lodged in the intercondylar notch such as the anterior cruciate ligament. The synovial vessels run obliquely and longitudinally over the entire length of the anterior cruciate ligament and form a web-like network of periligamentous vessels to ensheath the entire ligament and penetrate the ligament transversely to anastomose with a network of endoligamentous vessels which lie parallel to the collagen bundles within the loose connective tissue that separates the parallel collagen fibrils into bundles. No intraligamentous vessels cross the bony attachment site of the ligament to femur and tibia.

The proximal part of the anterior cruciate ligament has better blood supply than the distal part. The periligamentous fold of vessels is absent in a small zone approximately 5–10 mm proximal to the tibial attachment, and in this anterior fibro cartilaginous part the tissue is avascular contributes to the poor healing potential of the anterior cruciate ligament.

The anterior cruciate ligament receives nerve fibers from **the posterior articular branches of the tibial nerve**. Most of the fibers are associated with the endoligamentous vasculature and have a vasomotor function. Smaller myelinated nerve fibers (2–10 lm in diameter) and unmyelinated nerve fibers (1 lm in diameter) lie alone among the fascicles of the ligament.

Receptors found in the substance of anterior cruciate ligament are Ruffini receptors (sensitive to stretch), Vater–Pacini receptors (sensitive to rapid movements), Golgi-like tension receptors and free-nerve endings (nociceptors).

The mechanoreceptors cited above (Ruffini, Pacini, and Golgi-like receptors) have a proprioceptive function and provide the afferent arc for signaling knee postural changes. Deformations within the ligament influence the output of muscle spindles through the fusimotor system. Activation of afferent nerve fibers in the proximal part of the anterior cruciate ligament influences motor activity in the muscles around the knee; a phenomenon called ‘‘anterior cruciate ligament reflex.’’ But this reflex cannot confer an automatic protection for the anterior cruciate ligament because of reflex latency and electromechanical delay. None the less it is an essential part of normal knee function which is obvious in patients with a ruptured anterior cruciate ligament, where the loss of feedback from mechanoreceptors in the anterior cruciate ligament leads to quadriceps muscle weakness and the loss of accuracy of joint position sense. Therefore, preserving anterior cruciate ligament remnants during anterior cruciate ligament reconstruction could help to maintain proprioception after reconstruction.

BIOMECHANICS AND FUNCTION

Knee joint is exposed to external forces in excess of five times the body weight per step. The normal range of motion can be from 10^0 of hyperextension to 140^0 of flexion with 8^0 to 10^0 of rotation through the entire arc[20].

The stability of the knee joint depends upon the strength of the surrounding muscles and ligaments. The most important muscle in stabilizing the knee joint is the quadriceps femoris, particularly the inferior fibers of the vastus medialis and vastus lateralis and the most important ligament in stabilizing the knee joint is the ACL[Error! Bookmark not defined.].

The anterior cruciate ligament is the primary restraint to anterior tibial translation. The anterior cruciate ligament also functions as a secondary restraint on tibial rotation and varus-valgus angulation at full extension.

When the knee comes into the fully extended position, the femur internally rotates on the tibia until the remaining articular surface of the medial condyle is in contact (15^0-30^0). When the knee is in flexion the femur externally rotates on the tibia. In extension, the posterior portion of the lateral condyle rotates forward laterally thus producing a “Screw Home mechanism”, locking the knee in fully extended position[65,66].

In flexion of knee, AMB tightens and PLB relaxes & with extension of knee, PLB tightens and AMB relaxes *i.e*, during flexion & extension of knee they twist & untwist.

The AMB shortens from 0-30^0 of knee flexion followed by progressive lengthening from30^0-120^0 of flexion. The PLB is longest with the knee in full extension and undergoes progressive shortening with diminished strain as the knee flexes reaching minimal strain at 120 degrees[67].

When the knee is flexed to 90^0 passive motion of about 25^0 to 30^0 of tibia is possible over femur. This passive rotation varies with individual. Internal rotation is always more than the external rotation. No rotation is possible in full extension.

Sagittal displacement of the tibia on the fixed femur is detectable in both anterior and posterior directions. Under normal condition the extent of excursion should not exceed 3 to 5mm.

ACL is commonly injured by contact in sports like football, skiing, tennis; road traffic accidents resulting in sudden bending and twisting of the knee or trivial injuries like a slip off while climbing down the stairs.

The absence of ACL or ACL deficient knee leads to asynchronicity. This leads to functional instability and unphysiologic loading of the articular cartilage, secondary meniscal tears, subchondral fractures, and ultimately results in accelerated osteoarthritis of the knee joint.

The goal of ACL reconstruction is to prevent symptomatic instability, restore normal knee kinematics and prevent premature degenerative joint disease.

PRINCIPAL FUNCTIONS OF ACL[68]:

1. The ACL is a primary restraint to anterior tibial translation on femur in flexion with ACL resisting 86% of the total resisting forces on anterior drawer test.
2. ACL prevents hyper extension of the knee.
3. ACL checks the internal axial rotation of tibia and thereby affords rotator knee control acting as a secondary restraint to prevent excessive valgus and varus force.

The cruciate ligaments and bones form a mechanical linkage that guides the movement of the bones relative to each other during flexion and extension.

Abnormal anterior translation of the tibia at 30^0 with loss of coupled rotation and a relatively normal translation at 90^0 is indicative of an isolated ACL tear.

In comparison of patients with ACL deficiency and normal subjects, patients with ACL deficient knee have a significantly lower than normal net quadriceps movement during the middle portion of the stance phase of walking. This is known as quadriceps avoidance gait[69].

Patients with ACL deficiency have a higher than normal loading of medial compartment[70]. The patients with combined ACL deficiency and various alignment walk in a way that will cause the lateral compartment to open, thus resulting in excessively high medial compartment loads.

The normal anterior cruciate ligament has been shown to carry loads throughout the entire range of flexion and extension of the knee. Consequently, the anterior cruciate ligament can fail differently under different loads, depending on the position of the bones and the direction in which the loads are applied at the time of injury.

The complexity of the arrangement of the ligament fibers and their response to load, have important implications regarding the results of tensile tests. Tensile testing of the anterior cruciate ligament depends on age of the specimen, angle of knee flexion, direction of tensile loading with respect to the anterior cruciate ligament, and rate of the applied load. In other words, the maximal strength of the anterior cruciate ligament should not be assumed to have one fixed value.

MECHANISM OF INJURY

As a rule ligament can stretch 10-25% of usual resting length. Ligament injury occurs if the force is sufficient to cause permanent deformation with any mechanism of injury.

ACL ruptures are often a result of rotational trauma *viz*. flexion-valgus-external rotation, flexion- varus- external rotation, forced external rotation or hyper extension trauma.

Rotational trauma usually involve a sudden change of direction and / or with deceleration which may be non contact injury incurred during sudden change of direction in football or soccer or may be contact injury incurred in road traffic accidents with flexed knees.

If more severe and sudden, ACL injuries may be associated with O'donoghue Triad, medial meniscal tears, medial collateral ligament tears.

Hyper extension of knee is the less common pattern of injury of ACL with associated meniscal injuries.

However, an 'adequate trauma' is not always recognized and some patients may give history of trivial incident like sudden sharp pain in the knee while climbing down the stairs.

CLINICAL EXAMINATION OF KNEE FOR ACL TEAR

Patient gives a typical history of twisting or hyper extension injury followed by feeling or hearing a pop in the knee at the time of injury and inability to continue the previous activity.

De Haven, Noyes et al., indicated that the ACL is injured in approximately 70% of all knee with acute haemarthrosis.

Patients with chronic ACL tears, complains of pain, a feeling of instability or both. Patients more likely states that they “can’t trust the knee” or that the knee is “giving away”.

Symptoms may occur during normal daily activities or in some patients only during specific movements or during athletic activity.

LACHMAN TEST:

The most sensitive clinical test for ACL injury is the Lachman test. More than 90% of ACL ruptures can be reliably detected with this test.

A stable Lachman test is performed by placing the patient’s thigh on the thigh of the examiner. While pressing the patient’s thigh down against his own thigh, the examiner grasps the proximal lower leg and pulls it forward to test the amount of anterior tibial displacement and the quality of the end point. With a normal ACL there should be no increased displacement as compared with unaffected knee and the end point should be firm. Anterior translation of tibia with a soft end point indicates positive test.

LACHMAN TEST

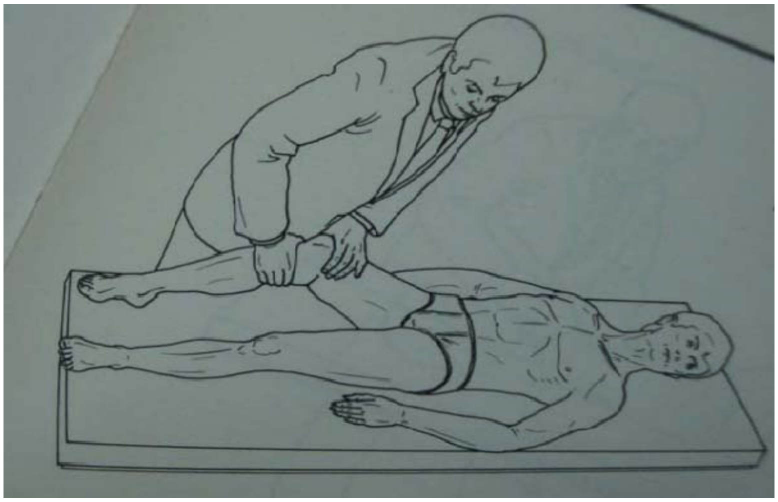


Figure No: 3a Lachman test

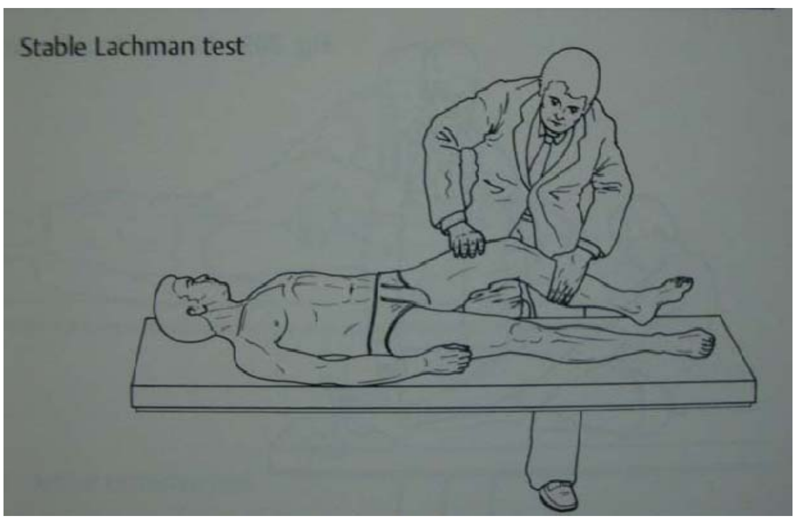


Figure No: 3b Lachman test.

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

In thin patients, if the examiner can encompass >50% of the patient's thigh, knee flexed $15^0 – 30^0$ with one hand on the distal thigh and the other hand on the proximal leg with thumb on the antero medial joint margin. Then holding thigh firmly, displace the proximal leg forwards and measure the anterior translation.

Lachman test has numerous advantages over other tests. Besides high sensitivity, it can be performed in acute injuries with little pain and slight flexion relaxes muscles around the knee.

ANTERIOR DRAWER TEST:

It is performed with the patient in supine position and the knee flexed to 90^0. The examiner should ensure that the foot points forward without any rotation and the patient is relaxed. It must be made sure that tibia is not sagging posteriorly due to posterior cruciate ligament laxity before anterior drawer stress is applied. In such cases an apparent sign of anterior drawer instability may be return of the tibia to the neutral position.

ANTERIOR DRAWER TEST

Figure No: 4 Anterior Drawer Test

If a positive pivot does not accompany a positive anterior drawer (sign) shift phenomenon, posterior cruciate ligament insufficiency exists, unless proved otherwise.

The Hamstrings can be palpated, allowing the examiner to sense the appropriate relaxation, with the foot stabilized and each hand enveloping the proximal tibia, a forward pull is made. The examiner notes the difference in excursion from one knee to other and the firmness of the end point. Abnormal translation is described in terms of millimeters. Sometimes there is a disparity between the Lachman test and Anterior drawer test. This should be attributed to differential injury to the antero medial and postero lateral bundles of ACL. A negative Lachman test indicates an intact postero lateral bundles and a positive Anterior drawer test indicates disrupted antero medial bundles.

PIVOT SHIFT TEST:

Of the various Pivot shift tests, Soft Pivot shift test has proven most satisfactory. The leg is held in a specified position of tibial or foot rotation combined with a valgus stress, and then the knee is forcibly flexed and extended.

The Soft pivot shift test is easier to perform and more comfortable for the patient. With the patient laying supine, the examiner first alternatively flexes and extends the knee to allay the patient's anxiety about the test. With the leg abducted at the hip and tibia in neutral or external rotation, the examiner carefully exerts a simultaneous axial and anterior pressure with the hand cradling the lower leg. If ACL deficiency is present, a gentle subluxation will occur near full extension and will gently reduce as the knee is flexed. By varying the speed of flexion/extension and the force of axial compression and anterior displacement, the examiner can control the intensity of the subluxation-reduction process to suit the patient's tolerance level.

The following tests are used in detecting associated injuries:

Medial opening in extension and 20^0 of flexion: Medial collateral ligament, postero medial capsule.

Lateral opening in extension and 20^0 of flexion: Lateral collateral ligament and postero medial capsule.

PIVOT SHIFT TEST

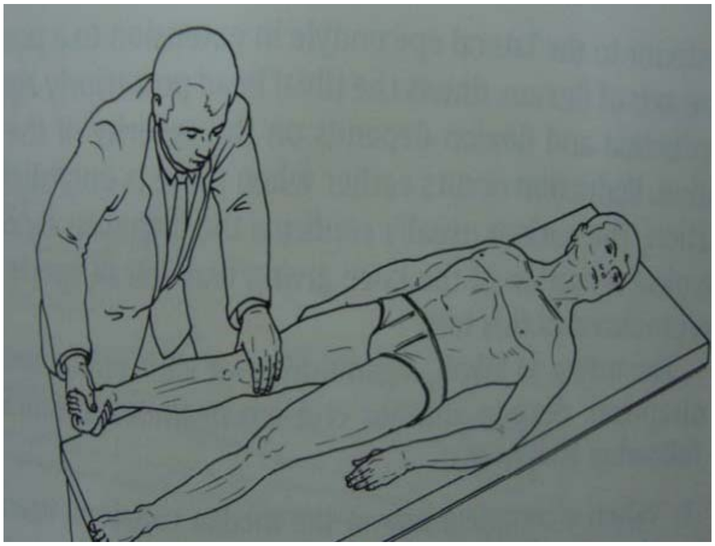


Figure No: 5a Pivot Shift Test

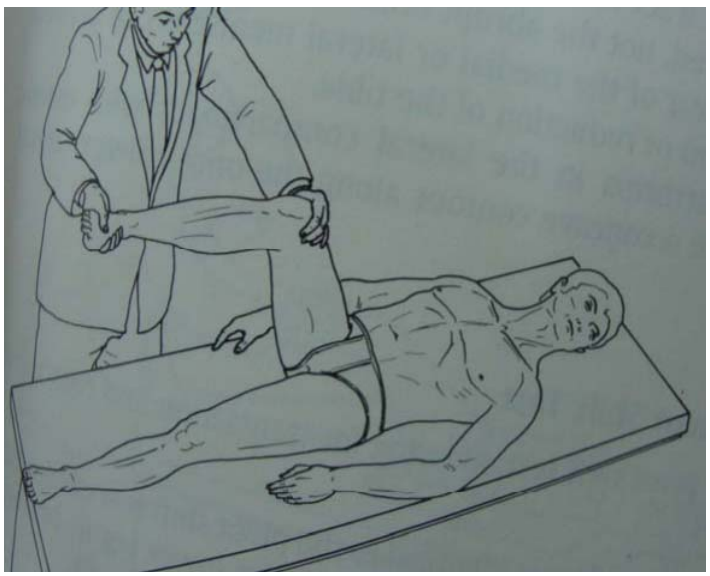


Figure No: 5b Pivot Shift Test

External rotation in 30^0 and 90^0 of flexion: The range of external rotation, combined with lateral opening in extension, gives information on the integrity of the postero lateral capsule.

Meniscal tests:

There are about 18 meniscal tests and combination of various meniscal tests is recommended, because no single test is conclusive. The accuracy rate of the tests ranges from 60% to 95%, depending on the clinical experience of the examiner.

In addition to joint line tenderness, the McMurray test (maximum flexion, external rotation, and joint line palpation during extension in external rotation), the Steinmann I sign (tenderness shifting from anterior to posterior with increasing flexion), and the Fouche sign (reversed McMurray sign with internal rotation of the tibia) are among the most important tests for meniscal lesions.

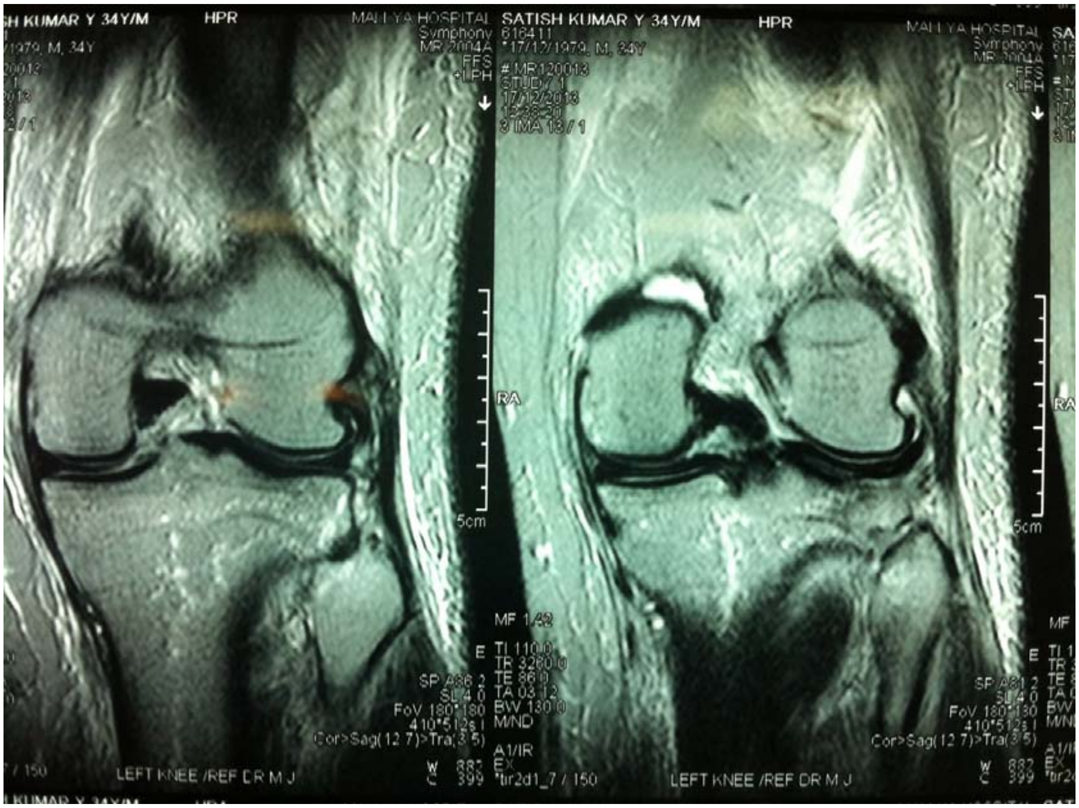
The diagnosis of ACL injury can be adequately established by clinical examination. Biplane radiographs are obtained to check for bony injuries. The intercondylar notch and eminence are more clearly demonstrated by a Frick Tunnel view or by postero anterior Rosenberg view. The indications for MRI are limited to provide additional information on concomitant injuries.

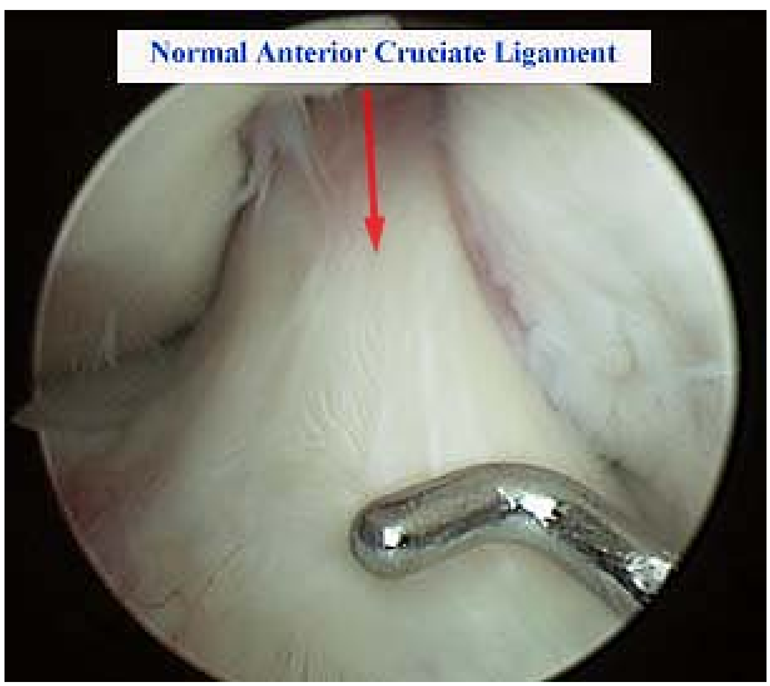
Patient Selection:

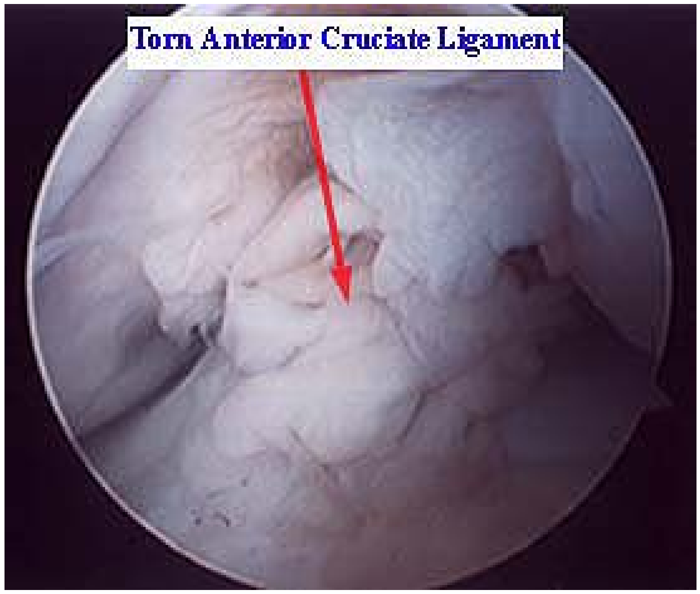
A specific indication for surgical treatment of the ACL deficient knee remains a debated topic. However each knee must be assessed and treatment must be individualized based on the patient’s activity level and expectation.

MRI FILM

TORN ANTERIOR CRUCIATE LIGAMENT







Activity level profiling: the patient's need and expectations are an important part of the decision making process. If the patient wishes to regain the best knee possible for an active lifestyle, reconstruction of the injured ACL is necessary.

MANAGEMENT OF ACL INJURIES

The management goal of ACL injured patient is to prevent recurrent knee injury while allowing the patient to return to his/her desired work and the level of activities. Various factors should be considered in devising a treatment plan.

Conservative treatment options for ACL deficiency are still reported with symptomatic instability and with progression of degenerative joint changes. In a review of 1450 patients who had ACL reconstruction was found that 95% of the patients who sustained an ACL rupture > 10yrs before had Grade III and Grade IV chondromalacic changes.

Obtaining a normal range of motion and regaining strength equal to the non injured leg are important. Tremendous emphasis has been placed on hamstring strengthening program since hamstrings are protagonists of the ACL.

Various criteria are applied in selecting patients in selecting patients for operative treatment including

- Degree of instability
- Instability related lesions
- Patient's age
- Activity level
- Timing of operation

If the patient has a positive Lachman test with soft end point and a positive pivot shift test that reproduces the subjective feeling of instability, the ACL should be reconstructed.

The presence of instability related lesions indicates that the joint is coping poorly with its ACL-deficient status. Without a stabilizing procedure, progression of the instability related lesion is almost inevitable. They should be considered for ACL reconstruction.

Young and middle aged active individuals with symptomatic instability and pain and willing to undergo rehabilitation program effectively should be considered for the surgery. Generally it is advisable to reconstruct ACL after 6-8 weeks of injury. By that time the knee should be free of irritation.

SURGICAL METHODS:

Open surgery may require release of Vatus Lateralis muscle and lateral dislocation of patella and now it is considered obsolete, having been superseded by miniarthrotomy and arthroscopy.

In miniarthrotomy technique, joint is entered through a small arthrotomy is commonly used for ACL reconstruction using BPTB graft. Arthroscopy technique is superior of all as the graft is harvested without opening the joint, bone drilled and reconstruction is performed. It has the advantage of accurate placement of bone tunnels, cosmetic scars and low morbidity. The graft materials available for ACL reconstruction consist of autograts, allografts and synthetic materials. Auto graft options available are Patellar tendon; Semitendinosus tendon; semitendinosus-Gracilis tendon; Quadriceps tendon; Plantaris tendon and Iliotibial band.

Patellar tendon was the most widely used and was considered Gold standard. This graft includes bone plugs from patella and tibial tuberosity to provide a very stable primary fixation. Donor site morbidity is the greatest drawback of this technique, affecting 3% to 65% of patients according to various studies and these are very difficult and sometimes impossible to treat.

Given the disadvantages of BPTB graft, semitendinosus tendon graft is becoming increasingly important as an alternate graft. The tensile strength of the quadrupled semitendinosus tendon autograft is superior than BPTB graft.

Currently semitendinosus tendon is the graft of choice.

Table no: 1 Tensile strength of grafts[71,72]

Graft	Ultimate tensile load (N)
ACL	2160
Bone tendon bone (Patellar tendon-10mm)	2376
Single strand Semitendinosus Tendon	1216
Two strand Semitendinosus Tendon	2330
Four strand Semitendinosus Tendon / Gracilis Tendon	4090

Other autografts, allografts and synthetic materials pose more damaging complications.

Graft fixation

Despite the historically increased laxity with hamstring tendon autograft reconstructions, the technique gained popularity as a result of the high graft site morbidity associated with patellar tendon harvest. Hamstring harvest has less morbidity and, although some clinically relevant. Soft tissue grafts have two other advantages over patellar tendon grafts. First, quadrupled hamstrings are generally larger in a cross-sectional area than similarly sized patellar tendon grafts as a result of the rectangular shape of the patellar tendon. More collagen in cross-section makes the graft stronger. Second, hamstring grafts require smaller bone tunnels, which heal circumferentially if the traditional interference screw is eliminated. For these reasons, better soft tissue fixation was sought.

Interestingly, much of the hype about the poor performance of soft tissue grafts is unfounded. In fact, recent literature shows no difference between hamstring and patellar tendon reconstructions in regard to anterior laxity. These studies use data that precedes the widespread use of transfixion devices.

Different fixation of semitendinosus tendon autograft has improved the compatibility of this soft tissue graft which mimics the normal ACL. Several fixation concepts are distinguished according to distance of the fixation point from the joint cavity. Each of these fixation techniques have advantages and pitfalls.

Kouse et al examined the pullout strength of the soft tissue fixation devices that are currently in widespread use for hamstring grafts. For the femur, the Bone Mulch Screw (1112 N), Endobutton (1086 N) and Rigidfix (868 N) systems had the best fixation for soft tissue grafts. All were substantially stronger than patellar tendon grafts fixed with an endoscopic interference screw (588 N). The advantages of endobutton make it the preferable femoral fixation device. On the tibial side, the fixation is much more secure. Among various tibial fixation technique, hybrid fixation in which two different techniques were combined provides better stable fixation and also the strength of a single fixation technique can be increased.

Tunnel positioning

It is clear that a good result cannot be achieved solely by selecting correct graft and applying adequate, stable fixation, but principal reason for graft success is an accurate positioning of the bone tunnels.

There is ample evidence that anterior placement of the tibial tunnel produces impingement, resulting in graft failure, loss of extension, or both. Evidence also exists that anterior placement of the femoral tunnel is detrimental to graft function[73] .

In 1998, Bach et al, reviewed the results of a group of patients with ACL reconstruction five to nine years postoperative and compared the results to those for the same population assessed earlier at two to four years postoperatively. The KT-1000 results did not deteriorate with time. Similarly, KT-1000 values remained constant in a five year study of endoscopic ACL reconstruction followed at yearly intervals.

Howell and Clark in 1992, established that tibial tunnels located within 37%-47% were within the impingement free range.

Linter et al in their 1996 cadaver study found that the center if the intact ACL tibial insertion was 40% from the anterior end of the tibial articular surface. Stilubli and Rauschning's in their 1994 MRI and cadaveric study calculated this value to be 41%.

Merchant et al, in 2001, compared the results of three different "bone – patellar tendon- bone" anterior cruciate ligament reconstruction techniques in order to determine if recent changes in tunnel placement during anterior cruciate ligament reconstruction are producing better outcomes. These techniques were: two- incision with the tibial tunnel at the anterior " footprint" of the anterior cruciate ligament (group 1), two incision with freehand placement of the tibial tunnel in the central or posterior "footprint" (group II), and endoscopic single incision utilizing a guide keying on the posterior cruciate ligament to achieve posterior tibial tunnel location (group III). Recent techniques (group III) for anterior cruciate ligament reconstruction successfully achieved "posterior" tibial tunnel placement. This was associated with superior results as judged by instrumental laxity measurements. The significance of the endoscopic technique's anterior femoral tunnel location relative to that of the two-incision techniques was uncertain and warrants further study[73].

Pretensioning of the graft stretches the collagen fibers to reach its maximum extent and also provides better alignment and tensioning of the tendon sutures. Extensive tensioning may "capture" the joint resulting in difficulty in regaining motion or it may lead to articular degeneration from altered joint kinematics.

PRINCIPLES OF SUCCESSFUL ARTHROSCOPIC ACL RECONSTRUCTION

1. Small incision without disturbing uninvolved anatomic structures
2. Visual enhancement and magnification of the intra articular structures

3. Evaluation and documentation of the extent of knee pathology under anaesthesia before surgical intervention
4. Treatment of associated intra articular pathology
5. Debridement of the intercondylar notch and ligament insertion sites
6. Precise selection and placement of the osseous tunnel locations
7. Harvesting the cruciate substitute with minimal donor site morbidity
8. Tensioning and fixation of cruciate graft
9. Early post-operative mobilization and rehabilitation

The only absolute contraindication for ACL reconstruction seems to be performing a procedure in a clinical setting of acute sepsis and in a patient who has a total lack of understanding of the rehabilitation.

METHODOLOGY

This is a prospective study of 30 consecutive patients who underwent arthroscopic ACL reconstruction using quadrupled semitendinosus tendon autograft during the study period, November 2012 to April 2014, in Sri Devaraj Urs Medical College and Hospital, Tamaka, kolar.

Data was collected according to a proforma

[**Annexure I**].

Ethical committee clearance was obtained.

Inclusion criteria

All skeletally mature patients with ACL tear confirmed by Lachman test with concomitant meniscal injury that required repair were included in the study, provided that they were permitted to undergo rehabilitation after ACL reconstruction involving full weight – bearing gait and unrestricted non weight bearing range of motion.

Exclusion criteria

Patients with ACL avulsion injury.

Anterior cruciate ligament tear with Concomitant posterior cruciate ligament, collateral ligament injuries requiring surgery or posterolateral corner injury.

Anterior cruciate ligament tear associated with the bony injury around the knee. Patients undergoing revision ACL reconstruction.

Concurrent musculoskeletal condition, eg, back, hip, or ankle injury on either extremity.

Surgical technique

Initial arthroscopy

The patient receives intravenous antibiotics preoperatively. After induction of anaesthesia, the patient is positioned supine and a tourniquet applied on the upper thigh of the operative leg.

An examination under anaesthesia is performed. Diagnostic arthroscopy is performed through an anteromedial and anterolateral portals, and any chondral or meniscal procedures are performed at this time.

A minimal soft tissue notchplasty is performed for visualization purposes only.

Graft harvest and preparation

Make a 3 - 4 cm incision anteromedially on the tibia starting approximately 4 cm distal to the joint line and 3 cm medial to the tibial tuberosity.

Expose the pes anserinus insertion with subcutaneous dissection. Palpate the upper and lower borders of the Sartorius tendon, and identify the palpable gracilis and semitendinosus tendons 3 to 4cm medial to the tendinous insertion. Make a short incision in the line with the upper border of the gracilis tendon, and carry the incision just through the first layer, taking care not to injure the underlying medial collateral ligament.

With the pes retracted medially, the gracilis and semitendinosus tendons are visible on the medial side. The more proximal thicker of the two tendons is the gracilis and below it is the more horizontal semitendinosus tendon. After the tendons have been positively identified, the semitendinosus tendon is pulled forward with a curved clamp or a mixtar and snared with a braided suture. With

Metzenbaum scissors, carry the dissection proximally up the thigh. Stay in the same plane, and maintain adequate exposure by using properly placed retractors.

Then semitendinosus tendon is released from its tibial insertion. The insertion site, including the periosteum, is widely circumscribed with a knife and undermined with a periosteal elevator.

After carefully releasing the tendon from its insertion, place a double Krackow – type whipstitch with vicryl near the insertion of the tendon and release its fibrous extension to the gastrocnemius and semimembranosus muscles.

Palpate all sides of the tendon to ensure there are no fibrous extensions before releasing it with an open – end tendon stripper. If firm resistance is felt, redissect around the tendons with a periosteal elevator and Metzenbaum scissors. Release the tendon proximally by controlled tension on the tendon, while advancing the stripper proximally. The muscle should slide off the tendon as the stripper is advanced proximally.

The surgical assistant prepares the tendons on the ACL Graft master on the back table. The Graft master allows for pretensioning and control of the tendons during preparation. Residual muscle tissue is stripped from the tendon with a blunt elevator. The overall length of the tendon is measured. The tendon is cut in half to make two segments of equal length. Place a double Krackow-type whipstitch in both ends of each tendon with No. 2

Ethibond. Each segment will be looped to create a total of four strands and graft size measured with the tendon sizer. Place a running, interlocking No. 2-0 nonabsorbable Krackow-type whipstitch in each end of the loop so that the graft can be passed as a single quadruple graft. The prepared graft is then placed under tension, covered by a wet saline gauze, for 20 to 30 minutes on the graft master.

Tibial and femoral tunnel preparation

When placing the tibial guide, be aware of the intended tunnel length and direction so that the graft can be secured in a physiometric, impingement free position. Intraarticular reference points that can serve as guides include the anterior cruciate ligament stump, the inner edge of the anterior horn of the lateral meniscus, the medial tibial spine, and the posterior cruciate ligament.

Next a cannulated reamer or trephine of the appropriate diameter is advanced over the guide pin. The diameter of the reamer used for the tibial tunnel is determined by sizing the harvested hamstring graft.

With the knee flexed approximately 90 degrees, confirm the previously chosen femoral pilot hole with an Arthrex 7-mm offset femoral guide passed through the tibial tunnel. Ensure that 1 to 2mm of bone remains as a posterior wall. The starting point is at the 10:30'o clock position on the right knee (1:30-o'clock position on the left knee) approximately 8 mm lateral to the posterior cruciate ligament.

Advance a long guide wire through the guide to the chosen physiometric point on the posterolateral portion of the femoral condyle. Advance the wire so that it exits the distal anteromedial femoral cortex. Use wire plier handles to stabilize the skin and soft tissues so that the wire advances externally and does not traverse the thigh more proximally. The femoral tunnel length to be reamed is measured with a depth gauge and then calculated according to the length of the graft material. Using the appropriate diameter reamer, the femoral tunnel is reamed based on graft size. A beath pin passed into the tibial tunnel, femoral tunnel and then through the skin. The pre tensioned graft with endobutton and its threads are passed through the beath pin tibial end loop and is pulled out of the femoral tunnel. So that the endobutton thread is out of the thigh.

Under arthroscopic visualization in the joint, the threads of the endobutton is pulled using the principle of flipping the endobutton. The femoral fixation is confirmed by togging of the endobutton.

When tension is placed on the grafts, the knee is taken through approximately 15 to 20 cycles of complete flexion and extension. This helps to align the grafts and also tests for impingement between the grafts and bony structures.

The tibial side of the graft is fixed with interference screw after inserting a guide wire in tibial tunnel.

Wound Closure

Thorough lavage of the joint is done to clear off the debris. Graft harvest site is sutured in layers with no 2-0 vicryl. Skin sutured with ethilon / skin staples. Compression bandage dressing done and long knee extension brace is applied.

Figure no: 6 Graft master with attachments

Figure no: 7 ACL jig

Figure no: 8 Tendon strippers

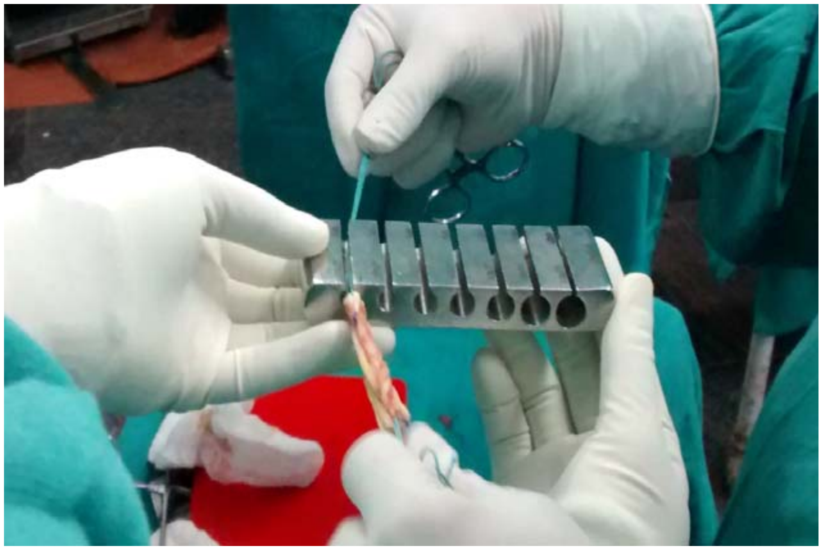


Figure no: 9 Tendon sizer

Figure no: 10 Femoral offset

Figure no: 11 Tunnel reamers

Figure no 12: interference screw

Figure No: 13 Patient positioning

Figure No: 14 Skin incision for graft harvest

Figure No: 15 Identification of Hamstring tendon

Figure No: 16 Separation of semitendinosus tendon

Figure No: 17 Tendon stripping

Figure No: 18 Release of adhesions

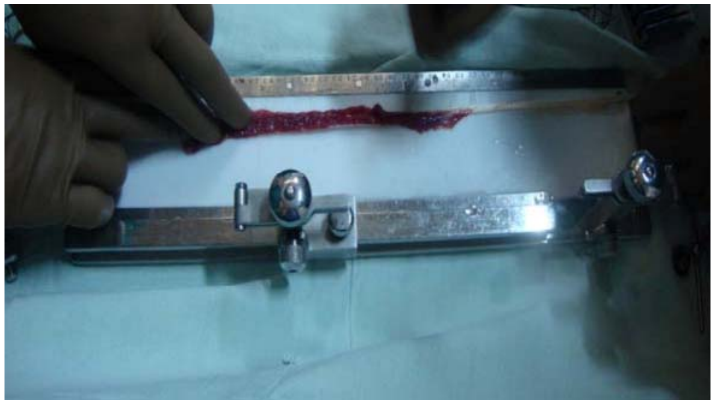


Figure No: 19 Harvested tendon

Figure No: 20 Preparation of tendon

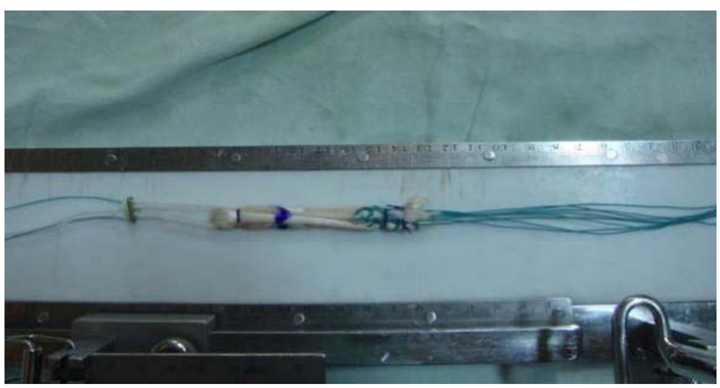


Figure No: 21 Prepared quadrupled graft with endobutton

Figure No: 22 Pre tensioning of the graft

Figure No: 23 Graft passage

Figure No: 24 Tibial tunnel interference screw fixation

Postoperative management

All patients were initiated on postoperative ACL Protocol [adapted from Wilk et al] on postoperative day 1. **[Annexure 2]**

On the operative day, after patient recovers from anaesthesia, patient is taught to do foot and ankle pump movements. The next day patient was taught static quadriceps exercises. On the 2nd post operative day, active knee bending with gradual increase of 10-20 degrees of flexion/ day was started. On the 3rd post operative day, assisted SLRT, abduction and adduction exercises of thigh and hamstring strengthening exercises were started. By the end of 1st weak, patient will be able to walk full weight bearing with long knee brace. Sutures are removed on the 10th post operative day and patient is discharged with the advice to continue exercises as per the protocol given to them in the form of a booklet.

Patients were advised to wear long knee brace for 2 months to protect the knees from getting injured. Patients were followed up every month for the first 6 months and the progresses are assessed. Patients are subject to single hop test at 4th, 5th and 6th month of post operative period and at the end of 6th month, the patients are subjected to IKDC, subjective questionnaire.

Single Hop test

The subjects performed one practice trial for each limb, followed by measured and recorded trials. The subjects were instructed to begin with the nonoperative limb. Subjects started each test with the lead toe behind a clearly marked starting line. No restrictions were placed on arm movement during testing, and no instructions were provided regarding where to look. Subjects were encouraged to wear the foot wear they would normally wear during their rehabilitation sessions.

For the hop test to be deemed successful, the landing must have been maintained for 2 sec. An unsuccessful hop was classified by any of the following: touching down of the contralateral lower extremity, touching down of either upper extremity, loss of balance, or an additional hop on landing. If the hop was unsuccessful, the subject was remainded of the requirement to maintain the landing, and the hop was repeated.

Case 1:

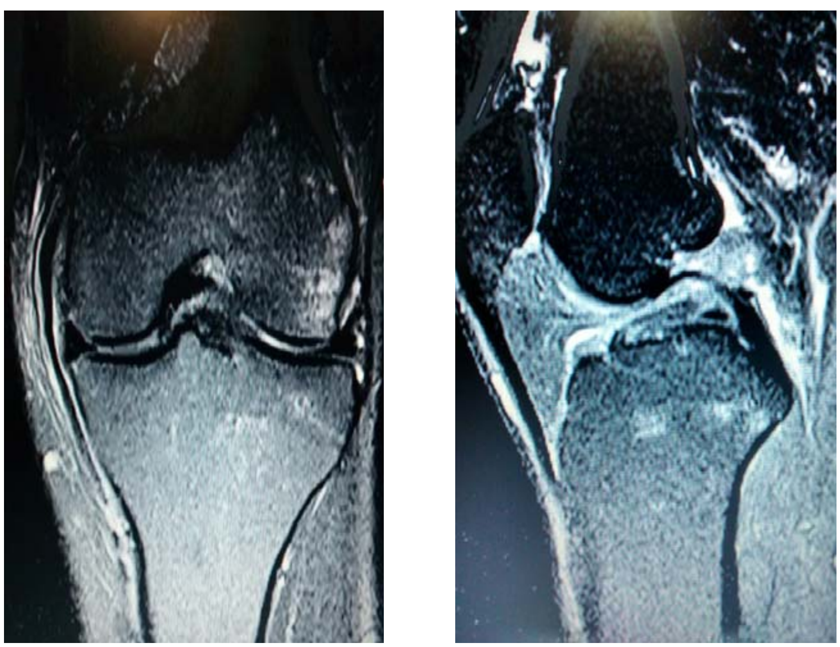
Raghuteja /27yrs/ male/Right Knee/ I.p.no:902132

Figure No: 25

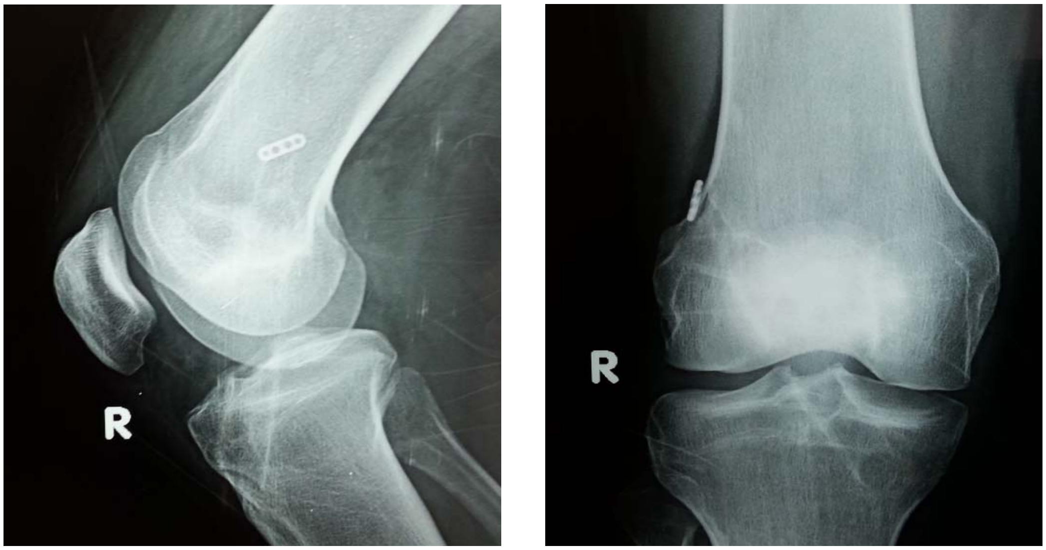
Anterior drawers test

Pivot shift test

Single hop test



MRI images



Post-operative x rays

Case no: 2

Santosh /28yrs/ male/Right Knee/ I.p.no:908422

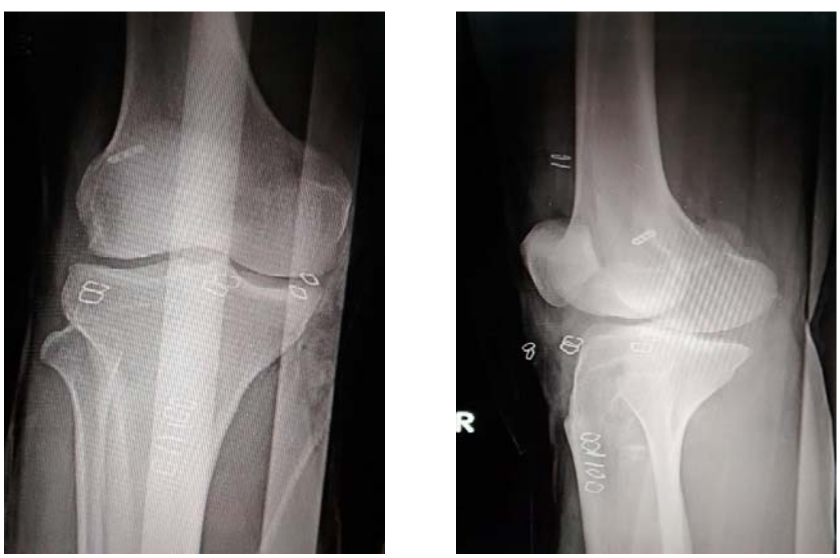
Figure No: 26

Lachman test

Anterior Drawer Test

Pivot shift test

Single hop test



POST OP X RAYS

CASE 3:

Lokesh /29yrs/ male/Right Knee/ I.p.no:895578

Figure No: 27

Lachman test

Anterior Drawer Test

Pivot shift test

Single leg hop test

Post operative x rays

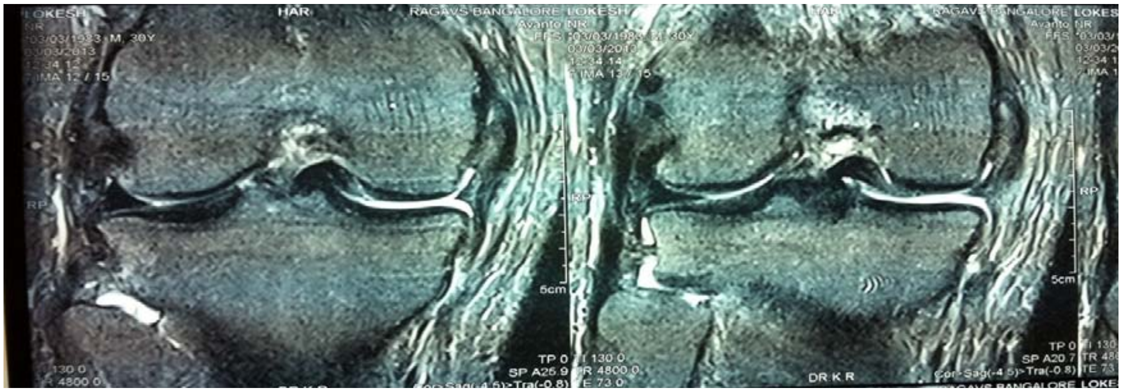
Case no 4

Faisal Pasha/27yrs/ male/Right Knee/ I.p.no: 5402

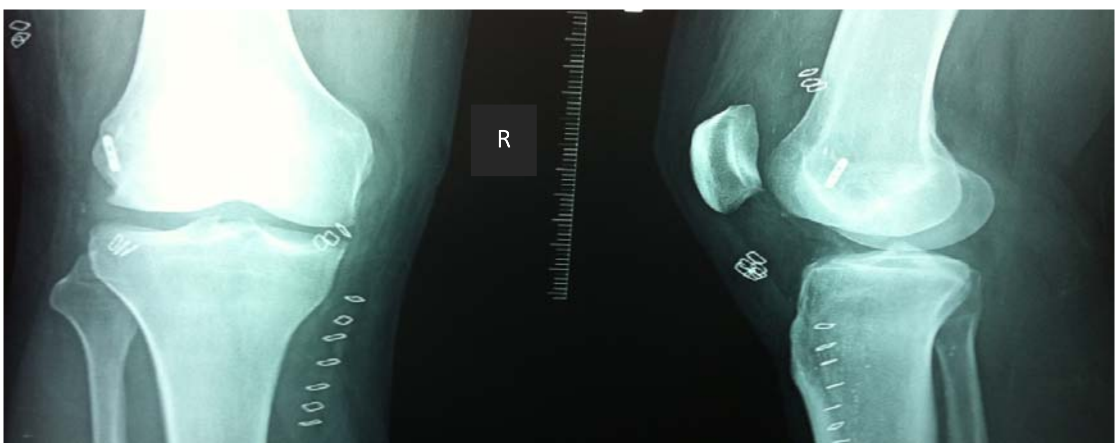
Figure No: 28

Anterior drawers test

Single hop test



MRI image



Post operative x ray

Case no 5

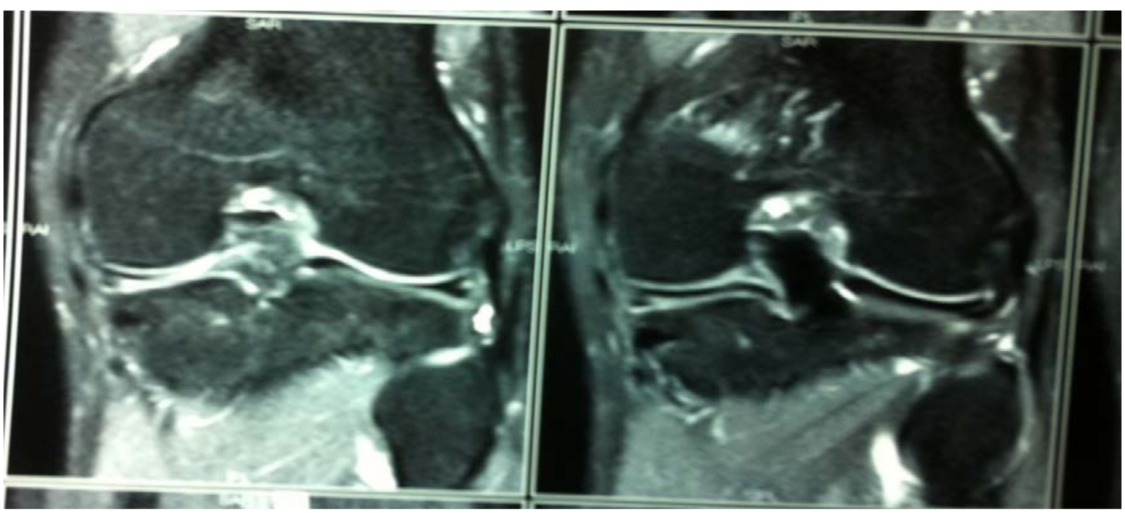
Sanjay Sarkar/25yrs/ male/Right Knee/ I.p.no: 995092

Figure No: 29

Full range of motion post operative at 6 weeks

Single hop test

Post operative x ray



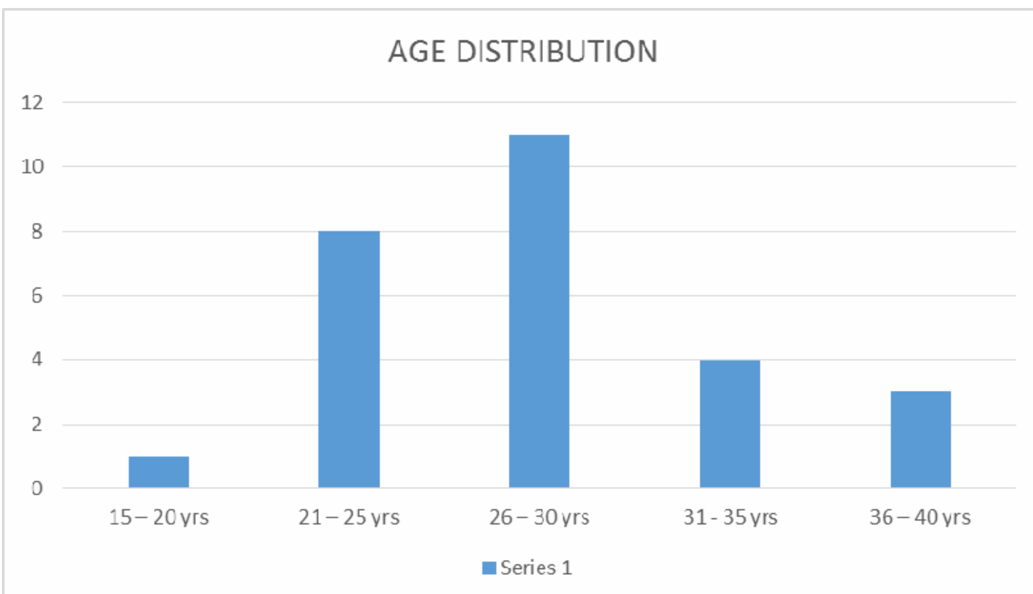
MRI images

OBSERVATIONS & RESULTS

Table No: 2 Age Distribution

Age in years	Number	Percentage
15 – 20 yrs	1	3.33
21 – 25 yrs	8	26.66
26 – 30 yrs	11	36.66
31 - 35 yrs	4	13.33
36 – 40 yrs	3	10
41 – 45 yrs	3	10
46 – 50 yrs	0	0
Total	30	100

Figure No: 30

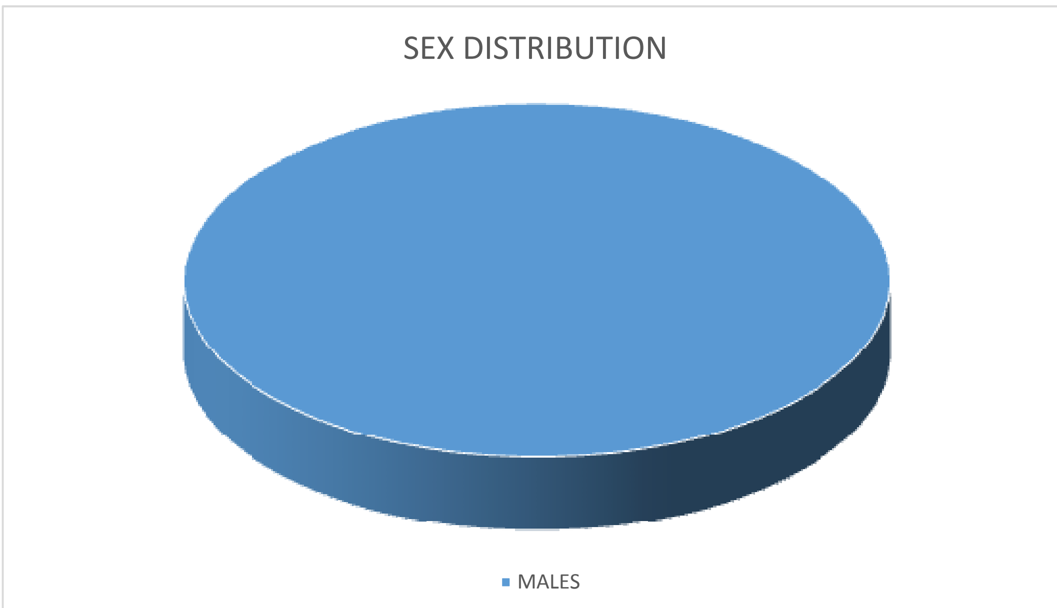


The mean age in our study was(29.6) years. The youngest patient was20 yrs and the oldest patient was 45 years old. The maximum number of patients were in the age group of 26-30yrs (36.67%) followed by the age group 21-25yrs (26.67%).

Table No: 3 Sex Distribution

	FREQUENCY	PERCENT
MALE	30	100%
FEMALE	0	0
TOTAL	30	100

Figure No: 31

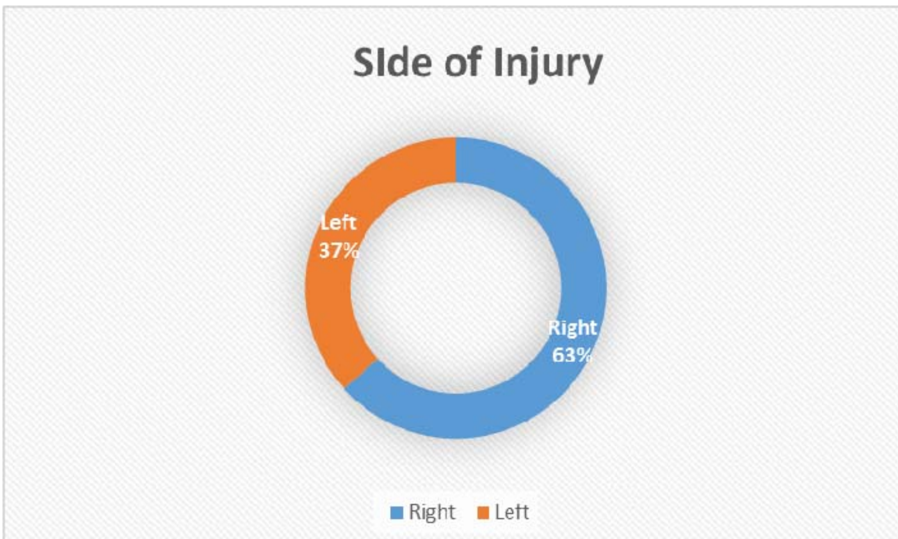


In our series of 30 patients, 30 patients (100%) were males and no female, (Male Predominance). It may be because of the involvement of males in outdoor activities like sports, farming and road traffic accidents.

Table No: 4   Side of Injury

	FREQUENCY	PERCENT
RIGHT	19	63%
LEFT	11	37%
TOTAL	30	100%

Figure No: 32

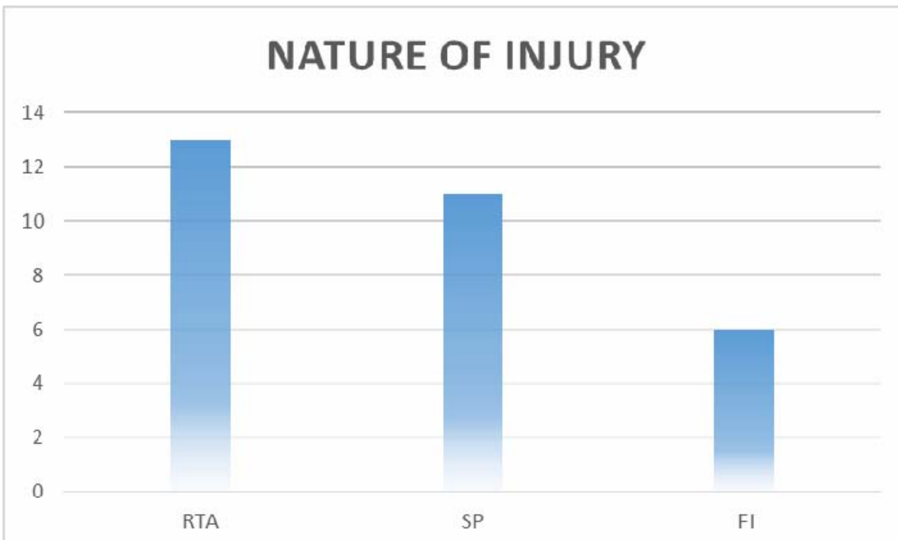


Right knee was injured in 19 patients (63%) and left knee was injured in 11 patients (37%).

Table No: 5 Nature of Injury

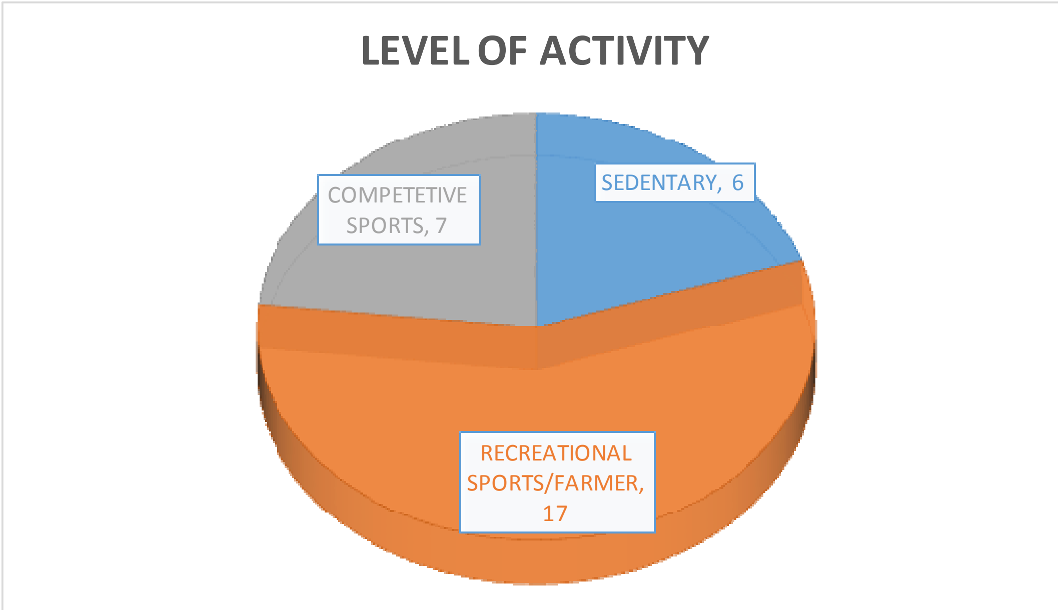
	FREQUENCY	PERCENT
RTA	13	43%
SPORTS	11	37%
FALL	06	20%

Figure No: 33 Nature of Injury



Most of the ACL tears were caused by road traffic accidents (43.33%). Next common cause was sports activities like foot ball, kabbaddi and athletics like jumping, police physical training, etc(36.66). Some patients (20%) got injured while doing daily activities like slip and fall while walking/ climbing down stairs. Twisting of the knee was noted in most of the patients (63.33%) followed by twisting in flexion (36.67%).

Figure No: 34 Patient Profile

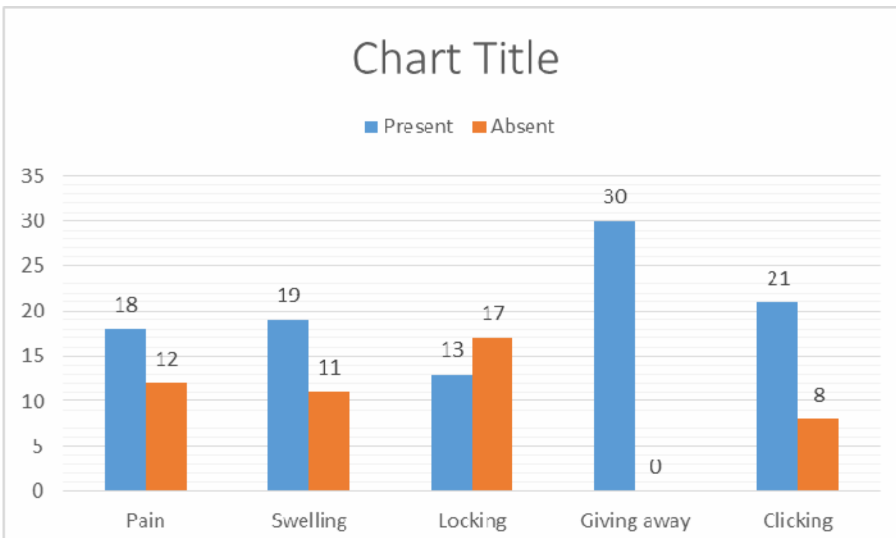


Majority of the patients17 (57%) were from farming community in our study followed by some patients 6(20%) having sedentary lifestyle and 7(23.33%) were into competitive sports.

Table No: 6 Presenting Symptoms

	FREQUENCY	PERCENT
PAIN	18	60%
SWELLIING	19	63.33%
GIVING WAY	30	100%
LOCKING	13	43.33%
CLICKING	21	72.41%

Figure No: 35 Presenting Symptoms

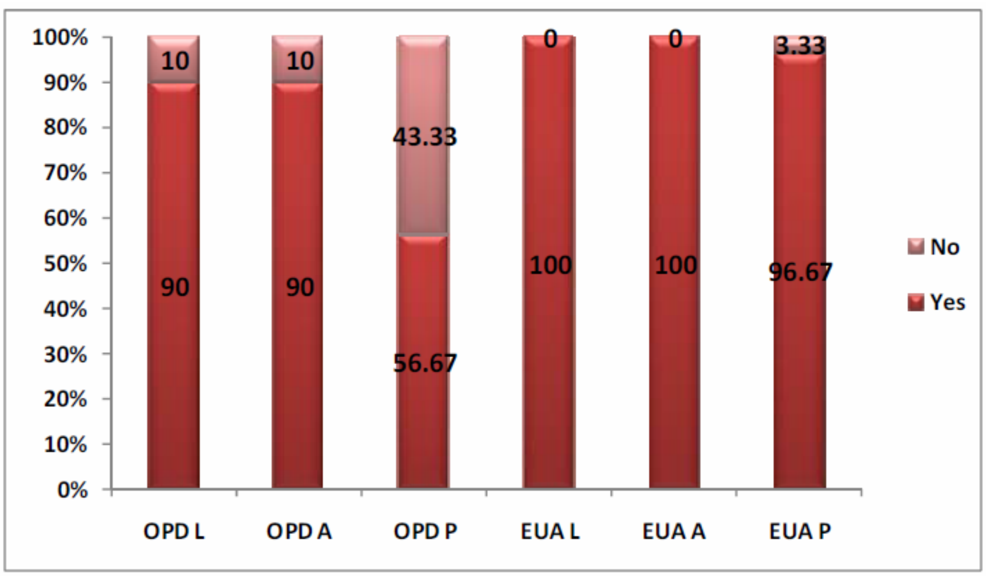


All patients presented with complaints of giving way of the knee. 72.42% of the patients were able to appreciate the clicking of knee. 63.33% cases were having swelling and 60% cases presented with complaint of pain. 43.33% gave history of locking of knee which was correlated with associated injuries in the knee.

Table No: 7 Results of clinical evaluation of laxity in OPD and under anaesthesia

	Yes		No	
	NO	&	No	%
OPD L	27	90	3	10
OPD A	27	90	3	10
OPD P	17	56.67	13	43.33
EUA L	30	100		
EUA A	30	100		
EUA P	29	96.67	1	3.33

Figure no: 36 Results of clinical evaluation of laxity in OPD and under anaesthesia



Lachman test and Anterior drawer test was found to be 90% positive which was grade 3in 46.67% and grade 4 in 53.33%, and pivot shift test, 56.67% sensitive by clinical examination which was 100% and 96.67% respectively by evaluation under anaesthsia.

Table no: 8 Frequency of associated injuries on MRI:

	Yes	%	No	%
LM (lateral meniscus)	5	16.67	25	83.33
MM (medial meniscus)	14	46.67	16	53.33

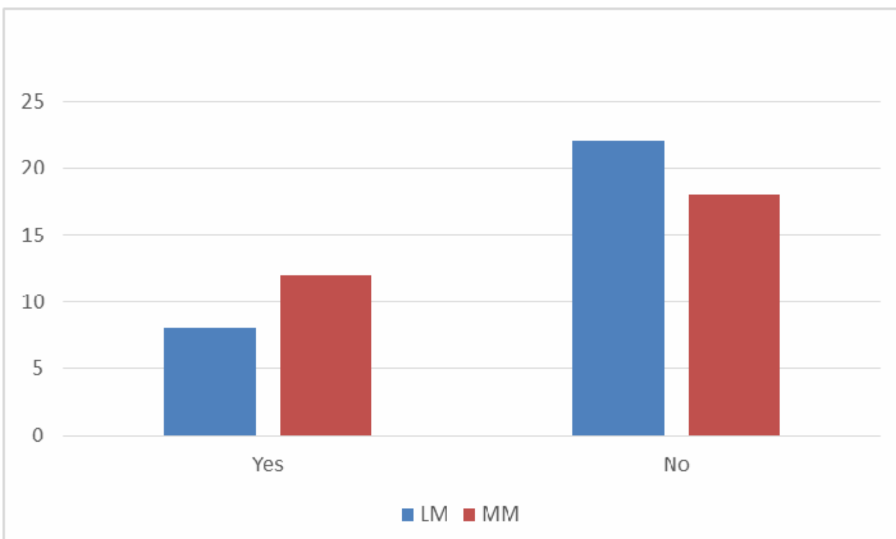
Figure no: 37 Frequency of associated injuries on MRI:

Medial meniscal tear was the commonest associated injury (46.67%) detected by MRI followed by lateral meniscus (16.67%).

Table no: 9 Results of associated injuries on arthroscopy

	Yes		No	
	No	%	No.	%
MM	12	40	18	60
LM	8	26.67	22	73.33
PCL			30	100
Isolated ACL	13	43.33	17	56.67

Figure no: 38 Results of associated injuries on arthroscopy

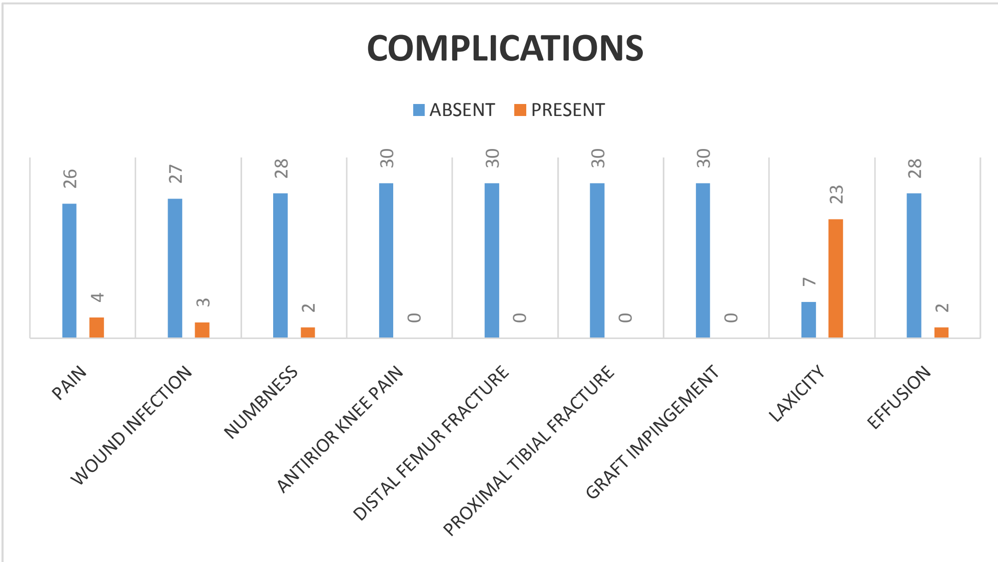


Diagnostic arthroscopy prior to ACL reconstruction confirms the medial meniscal tear in 40% cases and 26.67% lateral meniscal tear. The rest of the cases (43.33%) were isolated ACL injuries. There was no PCL injury in our study.

Table no: 10 COMPLICATIONS

	ABSENT	%	PRESENT	%
PAIN	26	86.67	4	13.33
WOUND INFECTION	28	93.33	2	6.67
NUMBNESS	29	96.67	1	3.33
ANTIRIOR KNEE PAIN	30	100	0	0
DISTAL FEMUR FRACTURE	30	100	0	0
PROXIMAL TIBIAL FRACTURE	30	100	0	0
GRAFT IMPINGEMENT	30	100	0	0
LAXICITY	7	23.33	23	76.67
EFFUSION	28	93.33	2	6.67

Figure No: 39 COMPLICATIONS

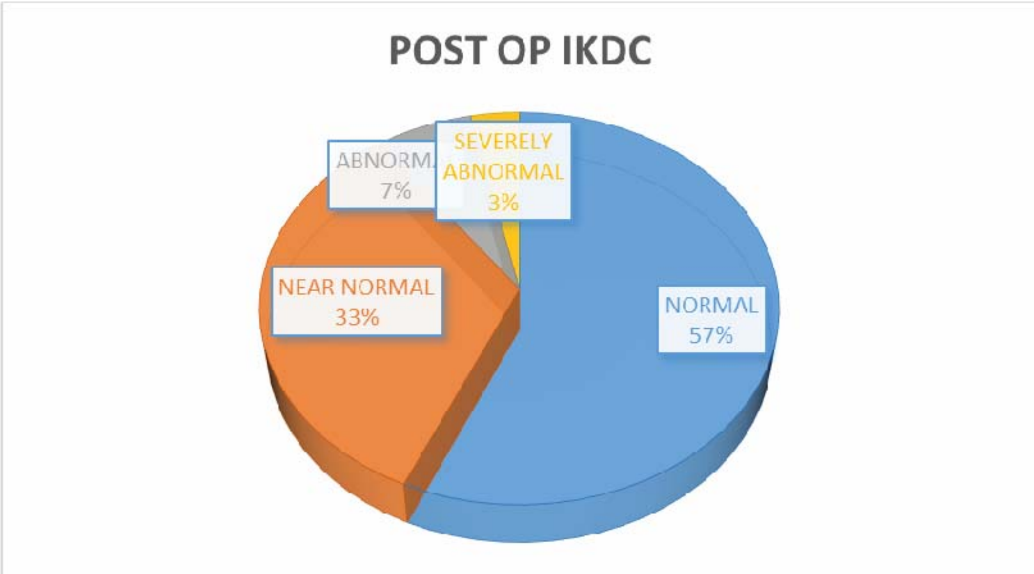


4 patients (13.33%) had pain at the graft site at the end of 6 months. Early superficial infection of the site was present in 3 cases (10%) which delayed wound healing. There was no deep infection. Majority of the patients (76.67%) were having grade I laxity at the end of 6 months but with hard end point. 1 patient (3.33%) had FFD due to noncompliant physiotherapy. 2 patients (6.67%) complaint of click but no instability.

Table no: 11 Post Operative Outcome -- IKDC Scoring

	FREQUENCY	PERCENT
NORMAL	17	56.67
NEAR NORMAL	10	33.33
ABNORMAL	2	6.67
SEVERELY ABNORMAL	1	3.33
TOTAL	30	100%

Figure No: 40 Post Operative Outcome -- IKDC Scoring



90% of the patients graded their post operative recovery as normal 57% and 33% as near normal whereas 3 patients (10%) graded recovery as abnormal according to IKDC score. The abnormal group included three patients with 1 superficial infection, 1 with laxicity and 1 with FFD.

Table no: 12 Single hop test

Limb Symmetry Index	Minimum	Maximum	Mean
Preoperative	22.72	57.14	44.355
Postoperative	66.36	93.33	83.503

Figure No: 41 Preoperative & postoperative Limb Symmetry Indices of all patients

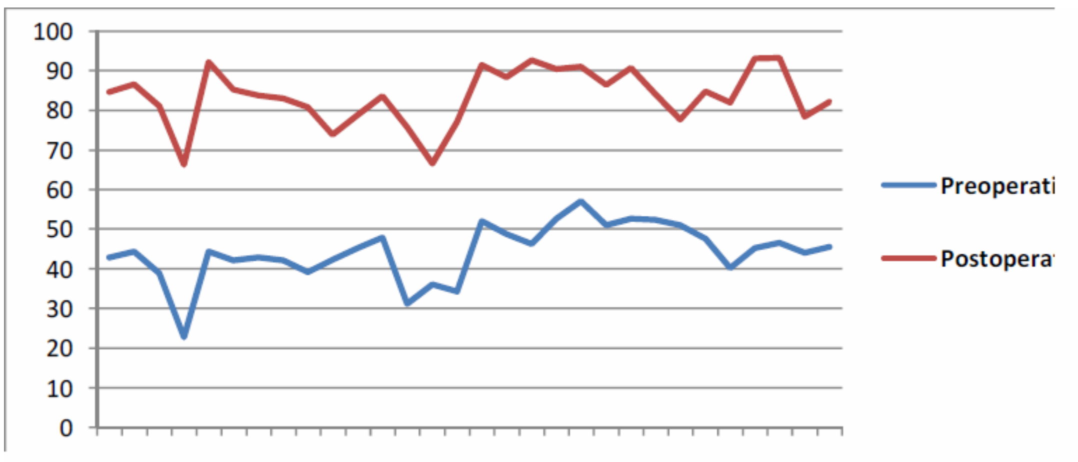
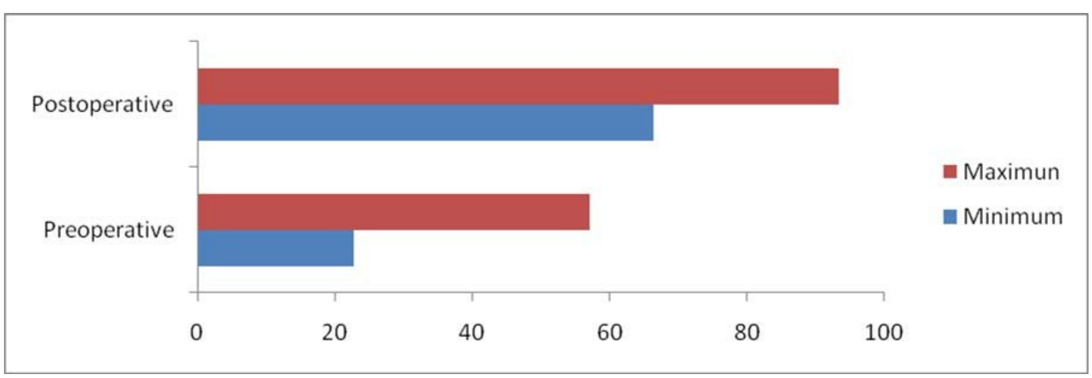
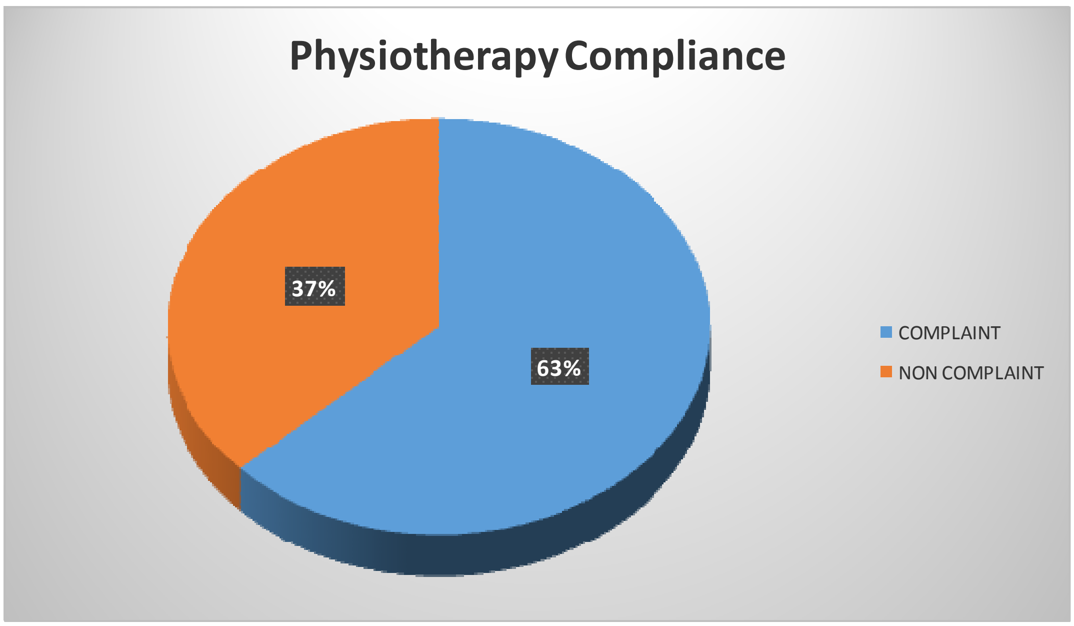


Figure No: 42 Preoperative & postoperative Mean Limb Symmetry Indices



Limb symmetry index was calculated by the percentage of affected limb over the normal limb. The preoperative index ranges from 22.72 to 57.14 with a mean of 44.355. Post operatively the index improved to a mean 0f 83.503 ranging from 66.36 to 93.33.

Figure No: 43 Physiotherapy Compliance

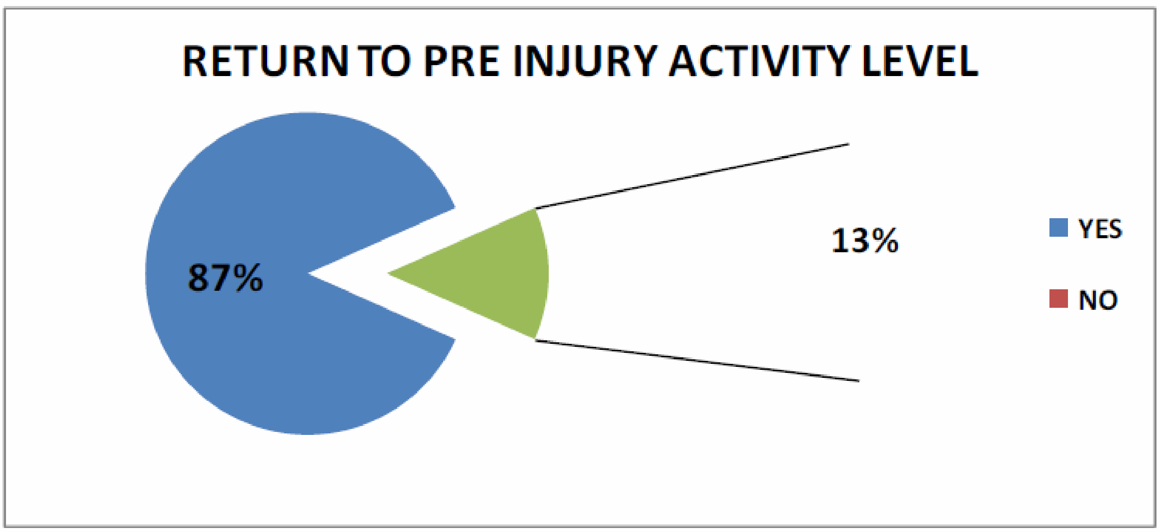


63% of the patients were complaint with the post operative rehabilitation protocol. The percentage was higher initially but with the improvement in the daily life activities, the patients gradually decreased their physiotherapy intensity and thus the final noncompliancy was 37%.

Table No: 13 Return to pre injury level of activity

	Yes		No	
	No.	**%**	**No.**	**%**
Return to pre injury level of activity	**26**	**87**	**04**	**13**

Figure No: 44 Return to pre injury level of activity



87% of the patients were able to return to their pre injury activity including farming and to competitive sports. 4 patients (10.33%) were not satisfied with physiotherapy regimen and these patients were noncompliant to the protocol.

Table No: 14 Comparison between single leg hop test and IKDC

IKDC	Normal	Near Normal	Abnormal	p value
Hop test	85.7 +/- 8.7	84.7 +/- 20.23	77.1 +/- 3.3	p >0.05

Table No: 15 Correlation between IKDC and single leg hop test

Correlations			
		IKDC	SINGLE LEG HOP
IKDC	Pearson Correlation	1	-.192
	Sig. (2-tailed)		.418
	N	30	30
SINGLE LEG HOP	Pearson Correlation	-.192	1
	Sig. (2-tailed)	.418	
	N	30	30

DISCUSSION

Anterior cruciate ligament (ACL) ruptures left untreated lead to subsequent knee disability, which can be severe with potentially devastating long term consequences. With improving results and increasingly reliable outcomes, patient and physician expectations have evolved to include the goal of return to activities and sports at normal or near normal levels.

Although there are many potential graft choices from which to choose for ACL reconstruction, hamstring autografts have over the past decade increasingly become more popular. Several studies have shown that multiple-strand hamstring tendon ACL reconstructions have higher strength, stiffness, and cross-sectional area compared with patellar tendon grafts.

Harvest of hamstring tendon autografts also yields less donor site morbidity than harvest of patellar bone- tendon- bone grafts and carries no risk of patellar fracture, however remote. Technical factors, specifically the absence of adequate fixation techniques, initially limited the use of hamstring grafts for ACL reconstruction. New techniques focus on optimizing graft strength and stiffness.

Successful ACL reconstruction using hamstring autograft requires stable initial graft fixation and, ultimately, graft- to- bone healing. Hamstring reconstruction using femoral endobutton fixation has been shown to have excellent initial mechanical properties, including pullout strength. Tibial fixation with interference screw.

In our study 31 male patients underwent ACL reconstruction using quadrupled semitendinosus tendon autograft during the study period in Sri devaraj Urs Medical College, Tamaka, kolar. All patients underwent graft fixation using endobutton in the femoral tunnel and interference screw for the tibial tunnel. Of these 31 patients, 1 patient had lost the follow up. Thus, the total number of patients in the study were limited to thirty. 30 (100%) were male patients, all aged between15 and 50 years of age. The side of injury was distributed accordingly – 63% [19 patients] to right knee while 37% [11 patients] injured their left knee. A statistical trend towards a better outcome in all three scoring systems was seen with injury to the dominant lower limb but this was not significant. Arthroscopic ACL reconstruction was done as an in-patient procedure in all patients under spinal anaesthesia.

In 2009, Brown[74] and others studied the incidence of sex and limb differences in anterior cruciate ligament injury and stated that even though females are prone for injury, due their less exposure to strainous environment makes the incidence of males more than females. They also concluded that limb differences have no influence either during injury or in the recovery period.

Among the athletes, only two were into competitive sports- the others were involved in recreational sporting activity. Majority of our patients (57%) are from farming community and the rest (23%) are having sedentary lifestyle. Once the day to day activities of walking, squatting and climbing stairs returned, after following patients according to Wilk et al,. rehabilitation protocol for 6 months during immediate post operative and follow up period, it was observed that adherence to physiotherapy gradually waned in most of the patients.

Vassilios S Nikolaou et al, in June 2008, after a retrospective analysis of MRI efficiency in diagnosing internal lesions of the knee, reported that the accuracy for tears to the medial, lateral meniscus, anterior and posterior cruciate ligaments and articular cartilage was 81%, 77%, 86%, 98% and 60% respectively[75].

They found that the clinical examination had significant lower reliability in the detection of these injuries and concluded that MRI is very helpful in diagnosing meniscal and cruciate ligament injuries. But in a countable percentage reports with false results and in chondral defects its importance is still vague. The arthroscopy still remains the gold standard for definitive diagnosis. In our study, clinical evaluation of the patients for instability was an essential component.

Lachman test and Pivot shift test was more specific in diagnosing ACL injury which were further confirmed by arthroscopy, unlike anterior drawer test which in most of the patients was inconclusive as no correlation between pre operative and examination under anaesthesia.

In 2003, Fareed H et al reported the results of a retrospective study on patients who underwent arthroscopic ACL reconstruction[76].

The purpose of their study was to evaluate their initial experience with this procedure. Between July 97 and march 2001, 29 patients underwent arthroscopic ACL reconstruction with 4 strand hamstring tendon graft. 25 were available for follow up. All patients underwent the same rehabilitative program. Patients were evaluated using the IKDC ligament evaluation system. The average follow up was 25.4 months.

Similarly Button K[77] and others, in 2005, evaluated the outcome of ACL reconstruction with semitendinosus tendon autograft with same rehabilitation protocol in 48 patients at 20 months. The results of these study were compared to our study is tabulated below.

Table no: 16 Comparison of our study with Fareed H et al And K Button & others

	Fareed H[76] et al (2003)	**K Button & Others[77] (2005)**	**Present study**
Number of patients	25	48	30
Average follow up	25.4 weeks	20 weeks	24 weeks
IKDC Normal	12 (48%)	26 (54%)	17(56.66%)
Near Normal	12 (48%)	18 (38%)	10 (33.33%)
Abnormal	01 (4%)	04 (8%)	03 (10%)

In their study, a satisfactory outcome was seen in 96% & 92% respectively while it was 90% in our study.. Quite similarly, 66.67% [20 patients] were very satisfied as per the subjective questionnaire and 30% [9 patients] were satisfied. One patient was dissatisfied. This was probably due to the laxicity and the fact that most of the patients were keen on normal day to day activities than return tosports. The two scoring systems had a very high correlation as evidenced by the Kendal- tau values ranging from 0.647 to 0.923. Statistically, this was found to be highly significant [p value 0.000-0.0001]. 87% of the patients were able to return to the pre- injury activity level.

All patients performed the hop test in the postoperative four to six months period. The mean limb symmetry index of the single hop test was 83.503. These values gradually reduced when the outcome became poorer on the two scoring systems. Statistically the hop test was more of a trend with regards to IKDC.

Andrea Reid et al, in March 2007, published their results of a series of hop tests on 42 patients, 15 – 45 years of age who had undergone ACL reconstruction[48].

The mean limb symmetry index in above study was calculated at the 22nd postoperative week against at 24th postoperative week in our study. The mean values of above study were all above 85%. In our study the mean value is around 83%. This could be due to some patients, especially the ones with a poorer outcome had much lower limb symmetry indices which was skewing the mean to the lower side. Moreover, many patients were quite apprehensive in performing the hop test, thereby increasing the disparity between the normal and the operated limb scores.

Table No: 17 Comparison of our results with Andrea reid et al & Gulick TD studies

	Andrea reid[48] et al. study,	Gulick TD[77]	Present study
Number of	42	57	30
Average age	26 years	27 years	29 years
Rehabilitation protocol	4 – 6 months	4 – 6 months	4 – 6 months
Hop test- Mean Limb Symmetry	88.2 +/- 9.5 (63.8 – 103.2)	-	83.503 +/- 3.65 (66.36–93.33) At 24 weeks
Laxity Up to Grade 1	72%	74.6%	76.67%
Return to prior	-	84%	86.67%

Time period elapsed between the injury and the ACL reconstruction ranged from 1 1/2 months to 2 1/2 years with a mean value of 6.6 months. The duration of surgery ranged from 95 minutes to 140 minutes with a mean of 112.33 minutes. 4 patients (13.33%) had pain at the graft donor site. One patient (3.33%) had numbness around the graft donor site which gradually resolved completely. 23 patients (76.67%) had laxity of up to grade 1. In spite of this, Lachman test was hard end and it is the reason for the success of the surgery.

Two patients (6.67%) had superficial skin infection resulting in delayed wound healing and thus resulting in decreased post operative scores.

Gulick TD[77] and others in 2002 studied on 57 patients and concluded that 84% of their patients returned to pre injury level of function. In our study 86.67% patients returned to their previous level of function with 63% of the patients complaint with the physiotherapy regimen.

SUMMARY

This study was conducted on 30 patients suffering from ACL deficiency during November 2012 to April 2014.

More number of patients fall in the age group of 21-40yrs with the peak incidence between 25-30yrs.

Nature of the injury in our series was road traffic accidents in 13 (44%); sports in 11 (36%) comprising 80% of the patients.

Farming is the common occupation followed by sports and others.

Giving way of the knee is the main presenting symptom (100%) in our study.

Evaluation with Lachmen test under anaesthesia equates with arthroscopic evaluation (100%).

Medial meniscus was the commonest associated injury (40%).

All the 30 cases underwent arthroscopic ACL reconstruction with quadrupled semitendinosus tendon autograft and were given Wilk et al,. rehabilitation protocol for a period of 6 months from post operative day 1. And the results were evaluated periodically at 16 wks, 20 wks and 24 wks.

On evaluation of the patients during the follow up by IKDC & single hop test, 90% of the patients had excellent to good results. 87% of the patients were able to return to pre injury level of activity.

Mild residual laxity was noted in the follow up period. Superficial infection (2 patients) was the complication encountered in our study. However, these had no contribution in the final outcome.

CONCLUSION

This study was conducted on 30 patients suffering from ACL deficiency in the age group of 20 - 45 years.

All patients had instability of knee in the form of giving way evaluated by Lachman test and confirmed by arthroscopy.

The functional outcome of anterior cruciate ligament reconstruction with quadrupled semitendinosus tendon autograft is excellent to good (90%) with mild laxity at the end of 6 months.

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<u>ANNEXURE-1</u>

Sri Devraj Urs Medical College, Tamaka Kolar

Department of Orthopaedics

Proforma anterior cruciate ligament injury

Name: Age/Sex: ____

Address: ____

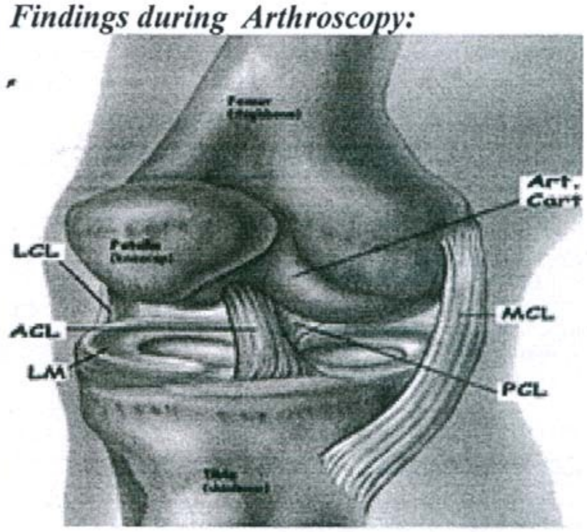
IP No.: Ward: ____

D.O.A.:D.O.O:D.O.D:____

P/ C:

History:

Findings during Arthroscopy:



Mech. of Trauma: Occupation:

Pain: Duration:

Side:

Swelling: immediate Delayed Recurrent

Locking   Giving way   Clicks

Examination:

Quadricepswasting: Synovial hypertrophy:

Patella Maltracking: Range of Movements:

Site of tenderness:

		Pre-op		Post-op		
		Right	Left	16weeks	20weeks	24weeks
Meniscal	Medial Meniscus					
ACL	Lachman test					
	Anterior Drawer					
	Pivot Shift test					
	Single Hop Test					
PCL						
MCL						
LCL						
Others						

Duration of surgery:

Rangeofmotion:

	Pre op	Post op		
		16 wks	20 wks	24 wks
Flexion Full range/Decreased				
Extension Full range/Decreased				
Extensorlag Full range/Decreased				

International Knee Documentation Committee (IKDC)	Follow up		
	16 wk	20 wk	24 wk
a) Knee symptom			
Pain			
Swelling			
Giving way			

b) Motion			
c) Stability/laxity			
d) Crepitus			
e) Morbidity at donor site			
f) Hop index			
g) Reduction of joint space on X-ray			
Normal – A, Near Normal – B, Abnormal – C, severely abnormal – D			

SubjectiveQuestionnaire		Follow up		
		16 wk	20 wk	24 wk
a) Feeling of looseness	Yes/No			
b) Swelling	Yes/No			
c) Pain	Yes/No			
d) Limitationof motion	Yes/No			
e) Giving way	Yes/No			
4 – 5—Dissatisfied, 2 – 3 --- Satisfied, 1 – Very satisfied				

Complications:

	Comment	Follow up		
		16 wk	20 wk	24 wk
Donor site morbidity				
Superficial infection	Yes/No			
Deep infection	Yes/No			
Pain	Yes/No			
Numbness	Yes/No			
Subjective opinion				
Dissatisfied				
Satisfied				

Very satisfied				
Anterior knee pain	Yes/No			
Distal femur fracture	Yes/No			
Dropped graft	Yes/No			
Posterior wall fracture	Yes/No			
Graft impingement	Yes/No			
Neuro-vascular inury	Yes/No			
Osteoarthrosis				
Others				

Rehabilitation follow up:

Phase		Follow up		
a) Immediate post op.	0 – 2 wks	16 wks	20 wks	24 wks
Achieved/not achieved				
b) Early phase	2 – 6 wks			
Achieved/not achieved				
c) Middle phase	6 – 16 wks			
Achieved/not achieved				
d) Late phase	16 – 24 wks			
Achieved/not achieved				

Single leg hop test

Limb SymmetryIndex	
Pre op	Post op

Return to pre injury level ofactivity: Yes / No

INFORMED CONSENT

I, ______________________ have been told about the study in a language that I understand (_____________). I have been told that this is for a dissertation procedure, that my participation is voluntary and I he/she reserve the full right to withdraw from the study at my own initiative at any time, without having to give any reason, and that decision to participate or withdraw from the study at any stage will not prejudice my/his/her, rights and welfare. Confidentiality will be maintained and only be shared for academic purposes.

I hereby give consent to participate in the above study. I am also aware that I can withdraw this consent at any later date, if I wish to. This consent form being signed voluntarily indicates agreement to participate in the study, until I decide otherwise.

I have signed this consent form, before my participation in this study.

Signature of the subject:

Date:

Place:

I, Dr. Udumula Ashok Reddy, Post graduate student in Department of Orthopaedics conducting a dissertation work for award of MS degree in Orthopaedics.

The study topic is "*A prospective study of outcome of arthroscopic reconstruction of anterior cruciate ligament with hamstring tendon autograft*"

I hereby state that the study procedures were explained in detail and all questions were fully and clearly answered to the above mentioned participant /his/her relative.

Investigators signature:

Date:

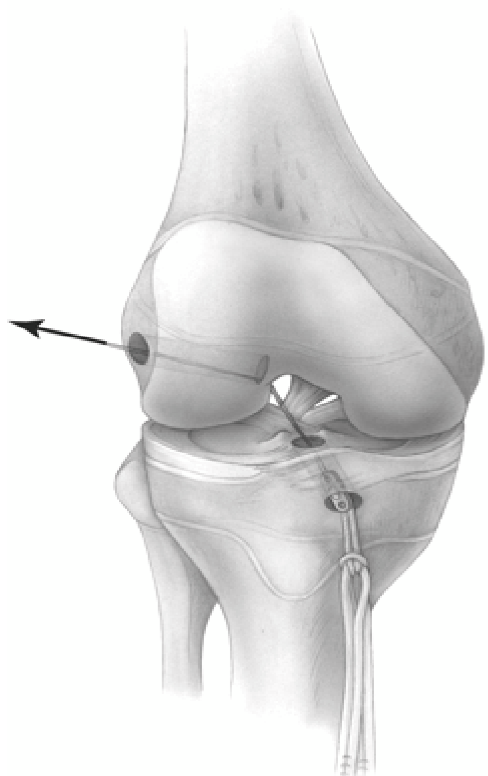
Place:

Sri Devraj Urs Medical College,
Tamaka, Kolar

Dept. of Orthopaedics

Arthroscopic Anterior Cruciate Ligament Reconstruction

Rehabilitation Protocol



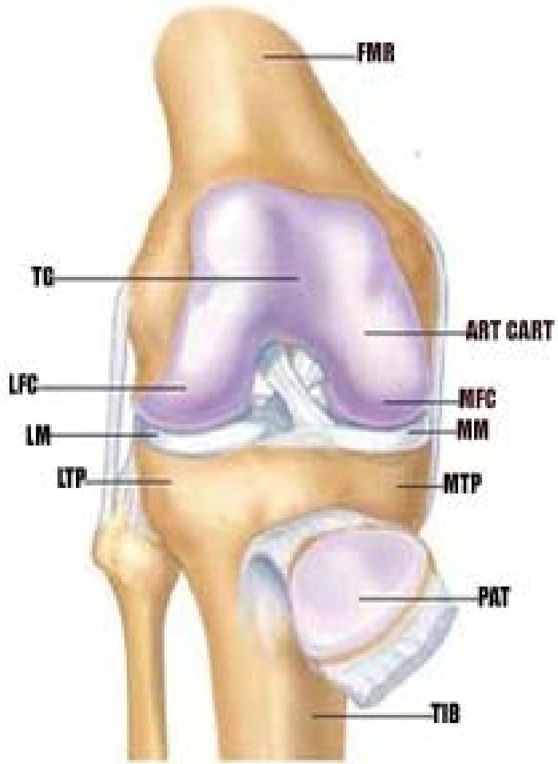
Pt. Name:

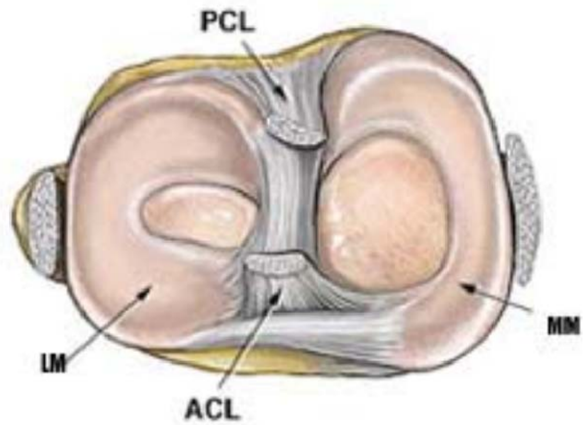
Age/Sex:

IP No.:

D.O.A. **D.O.O.** **D.O.D.**

Findings during Knee Arthroscopy & Procedure performed:





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GeneralInstructions:

Brace:Arigidkneebraceisappliedoverdressingtoprotectthenewlyreconstructed ACL.Keepbracewhilesleeping&walking. Remove brace while awake & while exercising.

Medication:Analgesics& Antibiotics.

Diet:No restriction after 24hrs of surgery.

Toilet:Bed pan till 2/3days after surgery. English toilet upto 3months after surgery.

Bath: Sponge bath for first 5days (till 1st dressing). Shower bath after dressing has changed to water proof one.

Walking:Walker/Crutch walking from 2nd/3rd day after surgery with weight bearing as tolerated. By end of 2weeks walkingwithoutwalker/crutch.

Position of leg: Keep operated leg elevated on pillows to prevent swelling of the foot & ankle.

Day 1-7:

1. Passive knee bending: Support the operated leg with both your hands/in CPM Machine & bend the knee 20-30deg. 10times, 3-4 times a day. Increase upto 40-50 deg by end of 1st week.

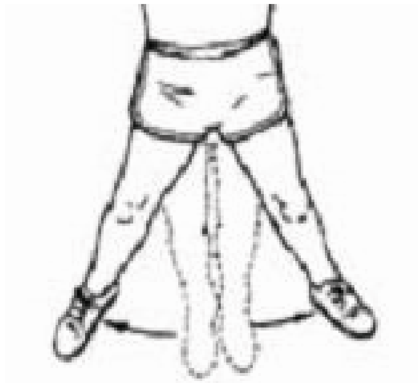
2. Isometric quadriceps: Keeping small towel below knee, keep pressing the towel with knee till 5 sec & relax.10 times,3-4 times a day.

3. Ankle pump: Move foot up/down, keeptill 5 sec in up/down. 10 times,3-4 times a day

4. Isometric hamstring: After you able to bend the knee to 30-40 deg. Bend the knee to 30-40 deg, gently press the heel to bed & pull it towards thigh for 5 sec. 10 times,3-4 times a day.

5. Assisted SLRT: Lift the operated leg straight to 45deg with help of normal leg. 20-30 times,3-4 times a day.

6. Hip adduction/abduction: Abduct n adductthe limb to 45deg in supine position. 10 times,3-4 times a day.



Day7-14 :

Continue 1-6 with Active & Passive knee bending: In addition to bend the knee with support, you may bend the same actively upto 60 deg by end of 2nd week.

Day 14-21:

In addition to above exercise. Knee bending increased to 90 deg.

1. Active SLRT: Lift the leg to 45deg without support & hold for 5 sec. 10-20 times,3-4 times a day.

2.Wall slide: Stand with your back against wall, with feet away fromwall. Bend your knees to 90deg hold for 5 sec. 10 times,3-4 times a day.

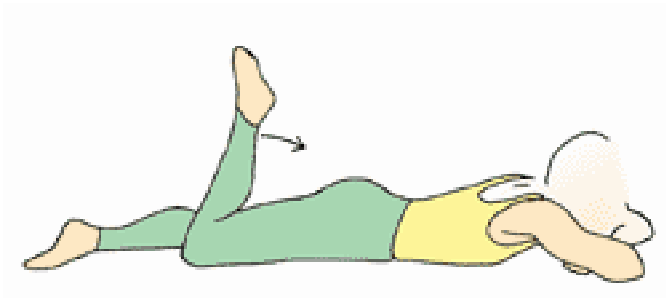
3. Half squats: Standing, hold the edgeof the table & bend your knees for 30-40deg, hold for 5 sec. 10 times,3-4 times a day.

4. Step ups: Take small stool(½ feetheight) & climb on it & descend with operated leg.10 times,3-4 times a day.

3-6 Weeks:

In addition to above exercise.

1. Knee bending: Lie prone, tell someone to bend your knee & gently press heel to thigh & hold for 5 sec. 10-20 times,3-4 times a day.



2. Hamstring pull: Sit inchair in front oftable, attach thick elastic band to table leg & take other end band around your heel. Pull gently toward chair hold for 5 sec. 10-20 times,3-4 times a day.

3. Active hip adduction/abduction, flexion/extension in supine, lateral & prone position. Hold in movement for 5 sec. 10-20 times,3-4 times a day.

4. Stationary bicycle used with increasing resistance.

6 weeks-6 months:

In addition to above exercise.

1. Knee quadriceps/hamstrings, Hip adduction/abduction/flexion/extension with weight cuffs starting with 1kg at the end of 6weeks (With 2 kg stated at 8-9thweek).

2. Swimming twice weekly started after 12th week.

3. Driving car at end of 3 months.

<u>3months-6months:</u>

In addition to above exercise.

1. Light jogging.

2. Driving two wheeler at end of 6months.

Summary

Arthroscopic ACLR Rehabilitation Protocol

Day 1-7

1. Passive knee bending.
2. Isometric quadriceps.
3. Ankle pump.
4. Isometric hamstring.
5. Assisted SLRT.
6. Hip adduction/abduction.

Day7-14

Continue 1-6 with Active & Passive knee bending.

Day 14-21

In addition to above exercise

1. Active SLRT.
2.Wallslide.
3. Half squats.
4. Step ups.

3-6 Weeks

In addition to above exercise

1. Knee bending.
2. Hamstring pull.
3. Active hip adduction/abduction, flexion/extension in supine, lateral& prone position.
4. Stationarybicycle.

6 weeks-6 months

In addition to above exercise.

1. Knee quadriceps/hamstrings, Hip add/abd/flx/ext with weight cuffs.
2. Swimming.
3. Driving car at end of 3 months.

3months-6months

In addition to above exercise.

1. Light jogging.
2. Driving two wheeler at end of 6months

KEY TO MASTER CHART

M	:	Male
R	:	Recreational sports/Farmers
S	:	Sedentary
C	:	Competitive sports
Lt	:	Left
Rt	:	Right
RTA	:	Road Traffic Accident
Fl	:	Fall
Sp	:	Sports
P	:	Present
A	:	Absent
LM	:	Lateral Meniscus
MM	:	Medial Meniscus
OPD	:	Out patient department
OPD L	:	OPD Lachman test
OPD A	:	OPD Anterior drawers
OPD P	:	OPD Pivot shift test
EUA L	:	Evaluation under anesthesia Lachman test
EUA A	:	Evaluation under anesthesia anterior drawers
EUA P	:	Evaluation under anesthesia Pivot shift test
SABN	:	Severely abnormal

ABN	:	Abnormal
NN	:	Neo normal
N	:	Normal
IKDC	:	International knee documentation committee
C	:	Complaint
NC	:	Non complaint
F	:	Full range
D	:	Decreased moments
n	:	no
y	:	yes
LSI	:	Limb symmetry index

																													Single Hop test follow u					GRAFT SITE												
S. No.	Names	AGE	SEX	I.P No.	D.O.O	level of activity	Side	Nature of injury	Duration of Pain	Pain	Swelling	Locking	Giving away	Clicking	Quadriceps wasting	OPD L	OPD A	OPD P	EUA L	EUA A	EUA P	Associated injuries on MRI	Associated Injuries on arthroscopy	IkDC	Single Hop test - Normal	Single hop test- affected	LS I- Preop	Duration of Surgery	16 weeks	20 weeks	24 weeks	LSI- Postop	Physiotherepy compliance	Pain	Wound Infection	Numbness	Antirior Knee pain	Distal Femur Fracture	Proximal Tibial Fracture	Graft Impingement	Laxicity	Effusion	ROM Pre	ROM - post op	Clicking Post op	Return to preinjury activity
1	krishnamurthy	24 Yrs	M	822575	5/11/2012	R	Lt	RTA	1Yr	P	P	P	P	P	1.5cms	3+	3+	P	3+	3+	P	LM+MM	LM+MM	SABN	105 cm	45 Cms	42.9	135 Min	52 cms	65 cms	89 cms	84.76	C	P	A	A	A	A	A	A	P	A	F	F	A	n
2	nagaraj	36yrs	M	813716	3/6/2013	S	Rt	Fl	6mn	P	A	A	P	P	1.5cms	4+	4+	P	3+	3+	P	MM	MM	NN	90 cm	40 cms	44.4	135 Min	46 cms	57 cms	78 cms	86.67	NC	A	A	A	A	A	A	A	P	A	D	F	A	y
3	krishnamurthy m	28 Yrs	M	902767	4/8/2013	R	Rt	RTA	4Mn	P	A	P	P	P	1.5cms	3+	3+	P	4+	4+	P	LM	LM	N	90 cm	35 cms	38.9	110 Min	42 cms	51 cms	73 cms	81.11	C	A	A	A	A	A	A	A	P	A	F	F	A	y
4	prakash	39yrs	M	934324	6/12/2013	S	Lt	Fl	1Yr	P	P	A	P	P	1.5cms	3+	3+	N	4+	4+	P	MM	MM	N	110 cm	25 cms	22.7	130 Min	34 cms	52 cms	73 cms	92.22	NC	A	A	A	A	A	A	A	A	A	F	F	A	y
5	santosh	28yrs	M	908422	5/10/2013	C	Rt	Sp	2mn	A	P	A	P	A	1.5cms	3+	4+	P	3+	3+	P	LM		NN	90 cm	40 cms	44.4	135 Min	52 cms	67 cms	83 cms	66.36	C	P	A	A	A	A	A	A	P	A	D	D	A	y
6	lokesh	29 Yrs	M	895578	2/4/2013	C	Rt	Sp	2mn	P	P	P	P	A	1cms	4+	4+	P	4+	4+	P	MM	MM	N	95 cm	40 cms	42.1	95 Min	51 cms	68 cms	81 cms	85.26	C	A	A	A	A	A	A	A	P	A	D	F	A	y
7	kumar	21 Yrs	M	901512	3/5/2013	R	Lt	RTA	6mn	P	A	A	P	P	1.5cms	4+	3+	N	3+	3+	P			NN	105 cm	45 cms	42.9	100 Min	57 cms	73 cms	88 cms	83.81	NC	A	A	A	A	A	A	A	P	A	F	F	A	y
8	raghuteja	27 Yrs	M	902132	6/27/2013	C	Rt	Sp	8mn	P	A	P	P	P	1cms	4+	3+	P	4+	4+	P		LM	N	95 cm	40 cms	42.1	100 Min	49 cms	62 cms	79 cms	83.15	C	A	A	A	A	A	A	A	P	A	F	F	A	y
9	venkatachalapathi	23yrs	M	915956	7/20/2013	R	Rt	RTA	2mn	P	P	A	P	P	1cms	4+	4+	N	4+	4+	P	MM		N	115 cm	45 cms	39.1	110 Min	58 cms	75 cms	93 cms	80.87	C	A	A	A	A	A	A	A	P	A	D	F	A	y
10	shivappa	28yrs	M	90285	9/7/2013	R	Rt	RTA	2mn	P	P	A	P	A	1cms	4+	4+	P	3+	3+	P			N	130 cm	55 cms	42.3	110 Min	67 cms	81 cms	96 cms	73.85	C	A	A	A	A	A	A	A	P	A	D	F	A	y
11	yaseen	27 Yrs	M	901989	8/25/2013	S	Rt	Fl	6mn	P	A	P	P	P	1.5cms	3+	4+	P	4+	4+	P	MM+LM	MM	NN	128 cm	58 cms	45.3	140 Min	70 cms	83 cms	101 cms	78.91	NC	P	A	A	A	A	A	A	A	A	D	D	A	n
12	venkatesh	28yrs	M	937091	8/25/2013	C	Lt	Sp	7mn	A	A	A	P	P	1.5cms	4+	4+	N	3+	3+	P	MM		N	123 cm	59 cms	48	100 Min	73 cms	87 cms	103 cms	83.74	C	A	A	A	A	A	A	A	P	A	F	F	A	y
13	gowtham kumar	40yrs	M	945726	9/16/2013	S	Rt	RTA	2.5yrs	P	P	A	P	P	1.5cms	4+	4+	P	3+	3+	P			N	112 cm	35 cms	31.3	120 Min	49 cms	66 cms	85 cms	75.89	C	A	A	A	A	A	A	A	P	A	D	F	A	y
14	moula	23 Yrs	M	946545	9/20/2013	R	Rt	Sp	2yrs	P	P	P	P	P	1cms	4+	4+	P	4+	4+	P	MM	LM+MM	NN	144 cm	52 cms	36.1	95 Min	67 cms	80 cms	96 cms	66.67	NC	A	A	A	A	A	A	A	A	A	F	F	A	y
15	suresh	25yrs	M	955189	10/18/2013	R	Lt	RTA	6mn	P	A	A	P	P	1cms	3+	4+	N	4+	4+	P	MM	MM	N	105 cm	36 cms	34.3	100 Min	50 cms	64 cms	81 cms	77.14	C	A	A	A	A	A	A	A	P	A	D	F	A	y
16	gopal	31 Yrs	M	902696	7/14/2013	C	Rt	Sp	3mn	A	P	A	P	P	1cms	4+	4+	P	3+	3+	P			N	71 cm	37 cms	52.1	105 Min	46 cms	58 cms	65 cms	91.55	C	A	A	A	A	A	A	A	A	P	F	F	A	y
17	chandra	35yrs	M	921467	12/11/2013	R	Rt	Sp	2mn	P	P	P	P	A	1cms	3+	4+	N	3+	3+	P			N	86 cm	42 cms	48.8	105 Min	52 cms	64 cms	76 cms	88.37	C	A	A	A	A	A	A	A	P	A	F	F	A	y
18	pradeep	24yrs	M	959742	11/19/2013	R	Rt	Sp	6mn	P	A	P	P	P	1cms	4+	4+	N	4+	4+	P		LM	N	69 cm	32 cms	46.4	110 Min	42 cms	51 cms	64 cms	92.75	C	A	A	A	A	A	A	A	P	A	F	F	P	y
19	ashoka	22yrs	M	641244	5/17/2013	R	Lt	RTA	3mn	A	P	P	P	P	1cms	4+	4+	N	4+	4+	P	MM	MM	NN	74 cm	39 cms	52.7	110 Min	46 cms	57 cms	67 cms	90.55	NC	A	P-s	A	A	A	A	A	P	A	D	F	A	y
20	vijay kumar	20yrs	M	914923	6/18/2013	R	Rt	Fl	2mn	A	P	A	P	A	1cms	4+	4+	P	4+	4+	P			N	56 cm	32 cms	57.1	125 Min	39 cms	45 cms	51 cms	91.07	NC	P	A	A	A	A	A	A	A	A	D	D	A	y
21	umeulla	27 Yrs	M	972962	12/27/2013	R	Lt	RTA	4mn	A	A	A	P	P	1.5cms	3+	4+	P	4+	4+	P			N	96 cm	49 cms	51	115 Min	59 cms	63 cms	83 cms	86.46	C	A	A	A	A	A	A	A	P	A	D	F	A	y
22	suresh babu	41 Yrs	M	981926	3/2/2014	S	Rt	Fl	3mn	A	P	A	P	P	1.5cms	3+	4+	N	4+	4+	P	MM	LM+MM	N	76 cm	40 cms	52.6	115 Min	56 cms	60 cms	69 cms	90.97	C	A	A	A	A	A	A	A	A	A	F	F	P	y
23	anjanappa	26yrs	M	982450	3/2/2014	S	Lt	RTA	3mn	A	P	A	P	A	1.5cms	3+	4+	P	3+	3+	N			ABN	82 cm	43 cms	52.4	135 Min	51 cms	57 cms	69 cms	84.15	NC	A	P-s	A	A	A	A	A	P	A	D	F	A	n
24	shankar	33yrs	M	976203	3/1/2014	R	Rt	sp	2mn	p	p	A	P	A	1.0 cms	3+	4+	N	3+	3+	P			NN	92cm	47cms	51.1	110 Min	49cms	56cms	73cms	77.77	C	A	A	P	A	A	A	A	P	A	F	F	A	y
25	sanjay sarkar	25 Yrs	M	995092	3/24/2014	R	Rt	RTA	2 mn	A	P	P	P	P	1.5 cm	4+	4+	P	4+	4+	P	MM	MM	NN	86 cms	41 cms	47.7	110 Min	47 cms	56 cms	73 cms	84.88	C	A	A	A	A	A	A	A	P	P	D	F	A	y
26	srinivas	29 Yrs	M	1011306	7/5/2014	S	Lt	RTA	1.5 mn	P	P	A	P	P	1.0 cms	3+	4+	P	3+	3+	P		LM	ABN	67 cms	27 cms	40.3	115 Min	34 cms	43 cms	55 cms	82.09	NC	A	A	A	A	A	A	A	P	A	D	D	A	n
27	somashekar	45yrs	M	63658	5/2/2014	R	Rt	Fl	3 mn	A	P	P	P	P	1.5 cms	3+	4+	N	3+	3+	P	MM	MM	NN	73 cms	33 cms	45.2	100 Min	40 cms	51 cms	68 cms	93.15	NC	A	A	A	A	A	A	A	A	A	D	F	A	y
28	faisal pasha	27 Yrs	M	5402	5/15/2014	R	Rt	RTA	1.5 mn	P	P	P	P	A	1 cms	3+	4+	N	4+	4+	P	LM	LM	N	60 cms	28 cms	46.7	105 Min	34 cms	45 cms	56 cms	93.33	C	A	A	A	A	A	A	A	P	A	F	F	A	y
29	manjunath	34 Yrs	M	6243	6/29/2014	C	Lt	Sp	2 yrs	A	A	A	P	P	1 cms	3+	4+	N	4+	4+	P			N	93 cms	41 cms	44.1	100 Min	46 cms	57 cms	73 cms	78.49	C	A	A	A	A	A	A	A	P	A	F	F	A	y
30	ramesh m	43 Yrs	M	1018265	5/14/2014	R	Lt	Sp	6 mn	A	A	P	P	A	1 cm	4+	4+	P	4+	4+	P	MM	MM	NN	79 cms	36 cms	45.6	95 Min	42 cms	53 cms	65 cms	76.85	NC	A	A	A	A	A	A	A	P	A	D	D	P	y