FUNCTIONAL OUTCOME OF ARTHROSCOPY ASSISTED
ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION
USING BONE- PATELLAR TENDON- BONE AUTOGRAFT

A STUDY DONE AT APOLLO HOSPITALS HYDERABAD

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M.Ch (ORTHOPAEDIC SURGERY)

BY

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ORTHOPAEDIC SURGEON

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DECLARATION

I hereby declare that this dissertation titled “A study to assess the functional outcome of Arthroscopy assisted Anerior Cruciate Ligament reconstruction using Bone- patellar tendon- Bone autograft” is a bonafide work done by me during the period of July 2006 to December 2008 under the guidance and overall supervision of Dr. J. C. Pingle Professor and HOD Orthopaedics, Apollo Hospitals, Hyderabad and has not been published by me in any journal.

Dated : 16/02/2012

Dr. Romesh Gaur
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This work has come a long way with help, effort and time of many people. I wish to acknowledge all of them.

I dedicate this work to my PARENTS, SPOUSE & GUIDE.

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INTRODUCTION
INTRODUCTION

The knee joint is the most commonly injured of all joints and the anterior cruciate ligament is the most commonly injured ligament\textsuperscript{1}. The modern high speed vehicular trauma and sporting life style has led to increased ligament injuries of the knee. The anterior cruciate ligament forms the pivot in the functional congruence and stability of the knee in association with the other ligaments, capsule, muscles and bone\textsuperscript{2,3}.

The Anterior Cruciate ligament (ACL) is the primary stabilizer of the knee and prevents the knee against anterior translation\textsuperscript{4}. It is also important in counteracting rotational and valgus stress\textsuperscript{5}. After ACL injury, most patients experience recurrent episodes of instability, pain and decreased function. ACL tears have been termed as the 'Beginning of the end of the knee'. Whilst some patients can be managed non-operatively with intense physiotherapy, bracing and modification of activity, severe symptoms may require reconstruction of the injured ligament.

Reconstruction of ACL allows the patient to return to a pre trauma activity level and delays the occurrence of associated meniscal injury and onset of osteoarthritis\textsuperscript{7}. The incidence of associated cartilage damage in
acute tears is reported at 15 - 40% whereas it increases to 79% in chronic tears\textsuperscript{8}.

Reconstruction is also essential to restore the stability of the knee\textsuperscript{9}. A stable knee in turn prevents worsening of existing chondral lesions as well as occurrence of newer lesions.

Arthroscopic reconstruction of torn ACL has become the gold standard in treating ACL tears\textsuperscript{10}. The surgical reconstruction of the anterior cruciate ligament with Bone - Patellar tendon - Bone autograft represents an attempt to re-establish knee kinematics. It has the added advantage of bone to bone healing and it does not sacrifice the knee stabilizers\textsuperscript{11}.

Earlier open arthrotomy and reconstruction of the ACL was done using central third patellar tendon graft. However excessive soft tissue dissection led to complications like increased post operative pain and increased infection rate. Complaints of post surgical knee stiffness and prolonged duration of rehabilitation were other complications that led to the development of Arthroscopy assisted ACL reconstruction. The advantages were key hole incisions, less intense inflammatory response thus reducing the post op morbidity and early recovery to full range of motion and also less potential for functional imbalance. Also the posterior aspect of knee joint can be better visualized through the arthroscope
which was not possible in arthrotomy procedures.
**AIM**

Generally amidst all the anatomy, symptoms and reconstruction of the ACL, the aim of this study is to assess the functional outcome of Arthroscopic assisted anterior cruciate ligament reconstruction using Bone-patellar tendon - Bone autograft
REVIEW OF LITERATURE
REVIEW OF LITERATURE

Reconstructions of the anterior cruciate ligament are among the most frequently performed procedures in knee surgery nowadays. Looking at the history of ACL surgery, it is amazing to see how long it took for some diagnostic and management techniques to establish themselves. Long ago, the ACL was a structure that never had a scalpel come near it. However, since the early 20th century, there has been increasing awareness of and interest in, the ligament and its lesions; and since then, the former Cinderella has moved very much more centre stage.

HISTORY OF ACL RECONSTRUCTION

The description of the true nature of ACL was first set forth by Galen (Circa 170AD). He described its role as a joint stabilizer in restricting abnormal motion\textsuperscript{12}.

As far back as 1845, Amedee Bonnet\textsuperscript{13,14} wrote a treatise on joint disorders causing bloody effusions, in which he analyzed knee injuries. He described three essential signs indicative of acute ACL rupture: "In patients who have not suffered a fracture, a snapping noise,
haemarthrosis, and loss of function are characteristic of ligamentous injury in the knee”.

His statement was based upon his clinical experience, as well as on cadaver studies in which he produced knee injuries and then dissected the knee to see what lesional pattern had occurred. The paper remained unknown - after all, it was not published in English.

In 1875, Georges, K. Noulis (1849-1919), a brilliant Greek doctor wrote a thesis entitled Knee Sprains. He very accurately described the role of ACL and showed how the integrity of the ligament should be tested with the knee in extension. The test proposed by Noulis was identical with the one now known and used as the **Lachman test**.

In 1879, a Paris surgeon, Paul F. Segond, (1851-1912) wrote a most interesting study entitled "Clinical and experimental research into bloody effusions of the knee joint in sprains”, which was published in Progres Medical. For this study, Segond had repeated Bonnet’s work, producing lesions in forced extension in 90 knees. In the same paper, he described an avulsion fracture of the anterolateral margin of the tibial plateau, which he had found to be routinely associated with ACL tears. This fracture now bears his name, and is considered as a pathognomonic feature of ACL tears.

In 1895, A.W. Mayo Robson performed the first cruciate (or, as it
was then still called, crucial) ligament repair in a 41-year-old miner who was injured 36 months ago.
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<td>1963</td>
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<td>Central third of patellar tendon with wedge of patellar bone</td>
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In 1917, Ernest W. Hey Groves performed the first ACL reconstruction using an iliotibial band transplant. In 1918, Maj. S. Alwyn Smith published a paper reporting on nine cases treated with Hey Groves' technique and criticizing the incomplete nature of the construct which failed to strengthen the medial collateral ligament.

In 1920, Hey Groves reported his anatomical and physiological findings in the cruciate ligaments and described their ruptures and repair. In particular, he noted the presence of forward displacement of the

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<td>1972</td>
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tibia which the patient could induce by putting weight on one leg with the knee slightly flexed. He had found the tibia to slip forward with a jerk in some cases. Hey Groves also used the antero-posterior instability in slight flexion observed in his patients as a clinical test.

In 1935, Willis C. Campbell\textsuperscript{21} reported the first use of a tibia-based graft of the medial one-third of the patellar tendon, the prepatellar retinaculum and a portion of the quadriceps tendon. The technique did not become widespread until MacIntosh reintroduced it many years later.

In 1939, Harry B. Macey\textsuperscript{22} described the first technique using the semitendinosus tendon.

In 1963, Kenneth G. Jones\textsuperscript{23} revived the idea of using the central one third of patellar tendon graft with an attached patellar bone block. However, technique described in his paper differed from the one used nowadays. In 1966, Helmut Bruckner\textsuperscript{24} described a similar technique using the medial one-third of the patellar tendon.

In 1968, Donald B. Slocum and Robert L. Larsor\textsuperscript{25} introduced the concept of rotational instability of the knee, stressing the role of external tibial rotation in the anterior drawer at 90 degrees of flexion in medial capsuloligamentous lesions. They also noted that the test was much more positive when the ACL was injured.
The Seventies - Extra-articular Reconstructions

In 1972, D. L. Maclntosh\textsuperscript{26} went back to the phenomenon described by Hey Groves back in 1920, calling it the pivot shift. To remedy the instability, he described a technique using a fascia lata graft pedicled on the tibia. The salient feature of the technique was the extra-articular routing of the graft.

In 1975, M. Lemaire\textsuperscript{27} described his exclusively extra-articular ligament reconstruction techniques. Medially, gracilis was used for the management of the medial collateral ligament injuries; while laterally, fascia lata was employed for the reconstruction of the torn ACL. The ACL reconstruction was then referred to as the Lateral Lemaire.

In 1976, the contribution of John Lachman became known through one his students Joseph S. Torg\textsuperscript{28}, who described the test at the 1976 Annual Meeting of the LAOS at New Orleans, and called it the Lachman test in honour of his teacher. However, the principle of the test had been described earlier by Ritchey in 1960, Trillat in 1948, and, above all, by Noulis in 1875. Sadly, their contribution to the diagnosis of ACL tears went unrecognized.
In 1979, D. L. Macintosh and J. L Marshal changed the nature of the graft material used and decided to harvest the central one-third of the entire extensor mechanism with a wider portion taken from the prepatellar aponeurotic tissue that was tubed to give greater strength to what would otherwise have been a relatively thin area of the graft.

The Eighties - Synthetic Ligaments and Arthroscopy

The techniques used in the late 70s were aggressive to the soft tissues and did not produce consistently good results. This is why the new generation of surgeons went back to earlier ideas of ACL reconstruction. In the 1980s, the orthopedic sports medicine community became focused on injury to the anterior cruciate ligament (ACL) as a major cause of athletic disability. Injury to the ACL and the high frequency of subsequent knee instability which can result in further damage to the joint was more commonly diagnosed. This motivated improvements in ACL reconstruction techniques.

Ellison in 1980 reported that anterolateral rotatory instability of the knee or recurrent anterior subluxation of the lateral tibial plateau is the most common form of disabling instability for the athlete. He described the anterolateral rotatory instability test to assess deficient anterior cruciate ligament.
Losee in 1978\textsuperscript{31} independently recognized the "pivot shift" phenomenon in ACL injury but did not associate it with anterior cruciate pathology.

Galway and Macintosh in 1980\textsuperscript{32} reported that the lateral pivot shift is a special form of lateral compartment instability arising from anterior instability.

In the late 1970s and early 1980s, open autograft ACL reconstructions were thought to require protracted periods of immobilization post surgery in order to facilitate healing. This frequently resulted in joint stiffness, articular surface damage and a delayed return to athletic participation.

In 1975, Rubin, Marshall, and Wang\textsuperscript{33} had developed an experimental model of a prosthetic ACL made of Dacron. In the early 80s, there was a first wave of carbon fiber-reinforced prostheses using a material that was in vogue at the time. In 1981, D. J. Dandy was the first to implant a carbon fiber-reinforced ligament substitute, using an arthroscopic procedure. The results were rather poor\textsuperscript{34,35}.

As carbon fibre 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 reconstructions quickly, effectively and with minimal trauma. However, towards the end of the 80s, there
was an unacceptably high rate of synovitis due to host tissue response and subsequent rupture of the neoligaments. Simultaneously, advances in arthroscopic ACL surgical techniques incorporating autologous tendon grafts, as well as dramatic advances in both fixation and rehabilitation reduced surgical complications. Allogenic grafts also became a viable alternate as problems with secondary sterilization and tissue handling were recognized and overcome.

Noyes et al in 1980\textsuperscript{36} performed arthroscopy in 89 patients with acute traumatic haemarthrosis of knee and absent or negligible instability on clinical examination. They found ACL injury in 72% of knees, with partial tear in 28% and complete tear in 44% of knees. They concluded that traumatic haemarthrosis indicates a significant knee injury and that examination under anesthesia plus arthroscopy allows a more accurate diagnosis of injury to joint structures and such data are required for a rational treatment program to be outlined.

During these years some surgeons had remained faithful to the concept of autografts, the only difference being that they were now increasingly performing these procedures arthroscopically. However, the autografting community was driven by two rival philosophies. On the one hand, there were the adherents of the principle of - OUTSIDE-IN, rout-
ing the ligament into the joint through a femoral tunnel (1980: Clancy\textsuperscript{37}, 1983: Noyes\textsuperscript{38}, 1884: H. Dejour\textsuperscript{39}). On the other hand, there were the advocates of - INSIDE-OUT, routing the ligament from inside the joint into the femoral socket (1984: Rosenberg\textsuperscript{40}, 1983: Gillquist\textsuperscript{41}).

Clancy et al in 1982\textsuperscript{42} stated that their goal was to "restore functional stability to the knee joint ... possibly allowing return to some recreational activities... However, the patients were informed they should not expect to return to highly competitive sports, particularly contact sports".

Clancy performed the first surgery using free bone patellar tendon bone graft. The patellar tendon is the most commonly used graft source for ACL reconstruction because of its biomechanical strength and stiffness, the availability of bone-to-bone healing at both ends and the ability to firmly secure the graft within the tunnels, allowing for an accelerated rehabilitation program.

With this procedure, the replaced anterior cruciate ligament approximates the functions of normal anterior cruciate ligament while many of the problems of conventional anterior cruciate ligament surgery are avoided. The bone patellar tendon bone is the strongest
of the immediately available substitute. Precise location of its tissue ends influences joint kinematics. The tissue has strength, durability and elasticity. Surgically it can be accurately placed so that it performs isometrically both in its location and tension. The length of the tendon is also ideally suited for ACL reconstruction.

Placing the graft in the joint with bone at each end is advantageous because fixation is more secure and bone to bone healing occurs more rapidly than soft tissue healing.

Noyes et al 1984\textsuperscript{43} compared mechanical properties of various tissues used as grafts in and around the knee and compared them to the normal ACL. They found bone-patellar tendon-bone graft to be the strongest having 168\% strength of normal ACL. Semitendinosus had 70\% the strength of normal ACL and Gracilis had 49\% the strength of normal ACL. Weakest was the quadriceps - patellar retinaculum - patellar tendon grafts which had 21\% the strength of normal ACL.

These arguments notwithstanding, the 80s were a time when arthroscopy flourished and surgeons obtained a better understanding of the ligament attachment sites. These facts appear to have played a major role in the good results obtained over that period.
Conservative Vs Surgical Treatment

Clancy, Ray et al in 1988\textsuperscript{44} compared surgical versus conservative treatment in acute anterior cruciate ligament tears. In non-operatively treated group 50\% had excellent or good results and 50\% fair or a failure. In surgical groups all but two of the patients had excellent or good results. No result was graded as failure. They concluded that primary repair and augmentation with the patellar tendon is the treatment of choice for a patient who has an acute tear of the anterior cruciate ligament.

Barrack et al in 1990\textsuperscript{45} studied non-operative treatment in 72 patients with anterior cruciate ligament tear documented by examination under anesthesia and arthroscopy. They reported 11\% excellent, 20\% good, 15\% fair and 54\% poor results and concluded that young adults who return to a vocation requiring strenuous physical activity after complete ACL tear can only expect unsatisfactory results.

The Nineties - The Jones Procedure as the "Gold Standard"

One technique appeared to establish itself as the superior procedure, because of its simplicity and consistently good results: the free bone-tendon-bone graft of the central one-third of the patellar tendon - the so-called Jones
procedure - came to be very widely used. At the same time, metal interference screws were introduced into orthopaedic surgery. In 1987, M. Kurosaka\textsuperscript{46} 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).

The Jones procedure did however have its weak points. It could leave the patient with some stiffness, and above all, extensor mechanism (patellar and patellar tendon) problems. This is why, in 1982, Lipscom\textsuperscript{47} started using pes anserinus (semitendinosus and gracilis) tendons pedicled on the tibia for ACL reconstruction. A similar procedure using only the semitendinosus tendon had been proposed previously in 1975, by Cho\textsuperscript{48}.

In 1988, M. J. Friedman\textsuperscript{49} pioneered the use of an arthroscopically assisted four-stranded hamstring autograft technique. He was followed in 1993 (after the 1992 AAOS Annual Meeting in Boston), by R. L. Larson, S. M. Howell\textsuperscript{50}, Tom Rosenberg\textsuperscript{40}, and Leo Pinczewski\textsuperscript{51,52} who used the pes tendons (semitendinosus and gracilis) in three or four strands, with graft placement in the femoral socket. Pinczewski used an "all-inside" technique,
with a special large (8 mm) 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. Staehelin, biodegradable interference screws; L. Johnson, a staple; and others, screws and washers.

The improved diagnostic facilities with the advances in Magnetic Resonance Imaging (MRI) technology increased the probability of non-invasive but accurate diagnosis.

Lee et al in 1988 reviewed 79 MR studies of the knee and its ability to demonstrate arthroscopically proved anterior cruciate ligament tear; and also compared MR findings with the findings of two commonly applied clinical tests of ACL instability i.e. Lachman test and anterior drawer test. The sensitivity of MR imaging was 94% compared with 78% for anterior drawer test and 89% for the Lachman test. The specificity was 100% for all three.

Fischer, Fox et al in 1991 did a multicentre analysis of 1014 patients. MRI of the knee was done and injury was subsequently con-
firmed arthroscopically. The accuracy of the diagnosis from the imaging was 89% for the medial meniscus, 88% for the lateral meniscus, 93% for the anterior cruciate ligament and 99% for the posterior cruciate ligament.

Howell, Clark in 1992\textsuperscript{58} studied MRI of the ACL graft six months after reconstruction. They showed that positioning the center of tibial tunnel between 12-23 mm from the anterior edge of the tibia consistently produced graft impingement and flexion contractures. Roof impingement was voided by placing the graft more posteriorly between 22-28 mm from the anterior edge of the tibia. Stability and knee extension were significantly better when the center of the tibial tunnel was 2-3 mm posterior to the center of the normal ACL insertion.

Lemos, Albert in 1993\textsuperscript{59} evaluated 50 patients with ACL reconstruction using a bone-patellar tendon-bone autograft performed by endoscopic and two incision techniques. They were evaluated with AP and lateral X-rays. They observed that screw angles were significantly different with the two techniques. In addition, the endoscopic placement of the femoral screw had an associated divergence of the screw relative to bone plug in 9 of 25 patients compared with 0 of 25 in the open group.

Bach et al in 1990\textsuperscript{60} used KT 1000 Arthrometer to test the knees of 107
patients with tears of anterior cruciate ligament and recommended use of an Arthrometer in the clinical evaluation and follow up of the patients with ACL injury.

Beynnon et al in 1992\textsuperscript{61} published their study on knee braces and showed that the knee braces should be used to protect ACL grafts six months after operation.

**Reviews on Complications**

Paulos, Rosenberg et al in 1987\textsuperscript{62} studied infrapatellar contracture syndrome, an infrequent cause of post-traumatic knee stiffness and suggested extra articular capsular debridement and release, followed by rehabilitation as the treatment of choice.

Sachs, Daniel et al in 1989\textsuperscript{63} reviewed complications after ACL reconstruction in 126 patients and found quadriceps weakness to be the most frequent complication being present in 65\% of patients.

Shelbourne et al in 1991\textsuperscript{64} did a retrospective study of 169 acute ACL reconstructions and concluded that delaying the reconstruction by at least 3 weeks resulted in a significant decrease in the incidence of arthrofibrosis and more specially decreased the lack of full extension. Delaying surgery gave improved results when compared with those ACL that have been re-
constructed at the acute stage.

Howell, Taylor in 1993 evaluated extent of impingement of bone-patellar tendon-bone graft in relation to the tibial tunnel. In knees in which the tunnel was anterior to the slope of the intercondylar roof, there was severe impingement and graft failed whereas with tunnel placed posterior to the slope, the graft was free of impingement.
ANATOMY

AND

FUNCTION
ANATOMY & FUNCTION

EMBRYOLOGY

Embryogenically, development of knee joint can first be detected at approximately 4 weeks or 5 mm stage. It begins as a concentration of mesenchyme, the so called ‘precartilage stage’. Future femur and tibia become recognizable only when an area of mesenchyme between these two precartilage representations rarifies. Progress is rapid and by 6 weeks knee joint is discernible\(^6\). ACL itself appears as a condensation in the blastoma at about 6.5 weeks\(^7\). It appears well before joint cavitation and remains extra synovial at all times. The fact that cruciate ligament and semilunar cartilage are derived from the same blastoma tends to corroborate the theory that these structures function in concert.

ANATOMY

In a normal adult the ACL averages about 4 cm in length and 1 cm in width. The ACL is a band of regularly oriented dense connective tissue that connects the femur and tibia. The ACL is attached to a fossa on the
posterior aspect of the medial surface of the lateral femoral condyle above, and to a fossa in front of and lateral to anterior tibial spine below. It is surrounded by a mesentry like fold of synovium that originates from posterior area of the knee and completely envelopes both ACL and PCL. Thus, although the cruciate ligaments are intra articular they are also extra synovial.

The irony of ACL being crucial to the well being of the knee joint has only been recently appreciated. The axiom ‘form reflects function’ is relevant to the ACL, because of its construct and design which is directly related to its function as a constraint to joint motion.

Normal anatomy of the ACL attachments has received considerable attention because of the emphasis on reestablishing a so called ‘anatomical’ position of the insertion to attain as close to an isometric position as possible when reconstructing the ACL.

**Femoral Attachment**

The ACL is attached to a fossa on the posterior aspect of the medial surface of the lateral femoral condyle. The attachment is in the form of a segment of a circle, with the anterior border straight and posterior border convex. The long axis of femoral attachment is tilted slightly forward from the vertical, and the posterior convexity is parallel to the posterior
articular margin of the lateral femoral condyle. The origin is 16-24 mm in diameter and is located well posterior in the intercondylar notch. The centre of this origin has been noted to be 15mm from the `Over the top position'.

**TIBIAL ATTACHMENT**

Distally at its attachment on the tibia, ACL passes beneath the transverse meniscal ligament and few fascicles of ACL may blend with the anterior attachment of the lateral meniscus. The tibial attachment is somewhat broader than the femoral attachment, being 11 mm wide and 17 mm in the antero-posterior direction. Tibial attachment forms a triangle with the apex directed posteriorly.

The ACL courses anteriorly, medially and distally across the joint as it passes from the femur to tibia. It seems to turn on itself in a slight outward (lateral) spiral. The ACL is not a singular cord but a collection of individual fascicles that fan out over a broad, flattened area. Within the ligament, these fascicles are divided into

1. **Anteromedial Band (AMB)** - those fascicles originating at the proximal aspect of the femoral attachment and inserting at the anteromedial aspect of the tibial attachment.
**posterolateral Band (PLB)** - the remaining bulk of fascicles that are inserted at the posterolateral aspect of tibial attachment.

When the knee is extended, the PLB is tight and AMB is moderately lax and when the knee is flexed, the femoral attachment of the ACL assumes more horizontal orientation, causing the AMB to tighten and PLB to loosen. The insertion area of ACL at its insertion site is 3.5 times greater than the mid-substance cross sectional area. This serves to minimize stress on ligament bone interface. The ligament bone attachment is by way of an incorporation of collagen fibers of the ligament within the mineralized bone. This change from flexible ligamentous tissue to rigid bone is mediated through a transition zone of fibrocartilage.

**BLOOD SUPPLY**

Major blood supply arises from ligamentous branch of the middle artery, which is the principal arterial supply that enters in its upper third through synovial sleeve. The medial and lateral inferior genicular arteries also supply the ACL. The synovial membrane that forms an envelope around the ligament is richly endowed by blood vessels. Re-
cently a significant and more important contribution from anterior vessels in the soft tissue and synovium from the region of retro-patellar fat pad has been described. There is a minimal blood supply from femoral attachment and nothing from tibial attachment.

**NERVE SUPPLY**

The nerve supply comes from the posterior articular branch of the posterior tibial nerve. Small nerve fibers that are responsible for pain have also been observed in the substance of ACL and also serve the purpose of proprioception.

**HISTOLOGY**

The ACL is composed of fibrils of collagen measuring 150-250 nm in diameter that interlace to form complex network. Groups of collagen fibers coalesce to form subfascicles which are surrounded by a thin band of connective tissue of the endotendineum. About 3-20 sub fascicles coalesce to form visible fascicles in varying sizes. Each fascicle is surrounded by epitendineum. The whole ligament is surrounded by both paratenon and synovial sheath.

**FUNCTIONS OF ACL**
The ACL functions in concert with all other anatomical structures in and around the knee joint to control and limit the motion and to maintain both static and dynamic equilibrium.

ACL has two complementary roles:

1. Proprioception
2. Mechanical

The evidence of proprioception function comes mainly from extensive histological observations demonstrating proprioceptive nerve endings in the ACL.

The mechanical role as a tensile load carrying element has been characterized with considerable detail.

1. The ACL, principally the anteromedial band accounts for the resistance to anterior tibial translation on the femur with the knee in 90° flexion.
2. The posterolateral portion provides the principal resistance to hyperextension.
3. It provides a check to internal axial rotation and thereby affords rotatory control of the knee.
4. It is a secondary restraint resisting both valgus and varus strains in all degrees of flexion.
5. Tension in the ACL fine tunes the 'SCREW HOME' movement stabilizing the joint as it approaches terminal extension.

The cruciate ligaments perform the contrasting function of permitting motion of the articular surfaces on one hand and restraining their motion on the other by offering resistance to certain forces. Excessive restraint of mobility leads to functional disability and unphysiologic loading of the ligaments, whereas deficient restraint leads to instability.
BIOMECHANICS
A ligament exerts its function by elongating. The force produced by elongation depends upon the mechanical properties of the ligament. The ACL exerts visco-elastic properties and the strength of normal ACL ranges from 1760 N to 2160 N\textsuperscript{76}. Both cruciate ligaments perform the function of a true gear mechanism and form the nucleus of the knee joint kinematics.

In a sagittal plane the knee moves by a combination of rolling and gliding motion, which are referable to the shape of femoral condyle which in the sagittal plane, are eccentrically curved. Anteriorly the femoral condyle are flatter, posteriorly they are more curved. Rolling is predominantly in the early degree of flexion corresponding to the more oval curvature of the condyle. Gliding motion prevails in the latter degree of flexion, where the femoral condyle is more spherical and offers less surface contact with the tibial plateau.

The anteromedial fibers of anterior cruciate ligaments are tense principally in flexion while the posterolateral fibers in increasing tension as the knee is extended. The reciprocal relationship of this bun-
dle constitutes a twist within the anatomy of this single ligament and provides for stability throughout the entire arc of knee motion.  

Analysis of knee motion in a horizontal plane reveals a different type of motion, that of internal femoral condylar motion with terminal knee extension. This is called "Screw Home" mechanism which offers greater stability. This mechanism is due to the inequality of bony geometry between femoral condyle and tibial plateau.

The internal tension of anterior cruciate ligament is not constant throughout the arc of knee joint motion. It is taut in between 20 degree and 70 degree, being most lax at 40 degree of flexion. From 70 degree to 90 degree the ligament increases in tension. Anterior tibial displacement on the femur in neutral rotation and flexion cannot be elicited unless the anteromedial bundle is torn. At 30 degree and 90 degree flexion, 85% of restraining force to anterior tibial displacement is provided by anterior cruciate ligament. The Rotational, Valgus and Varus stability is a secondary function of the anterior cruciate ligament.

Thus any repair or reconstructive procedure in the anterior cruciate ligament must adhere to both anatomical and biomechanical criteria with proper isometric position and tension.
CLINICAL
EVALUATION
CLINICAL EVALUATION

The clinical evaluation of a patient with suspected ACL injury starts with a good history of the mechanism of injury. A history of twisting injury to the knee i.e. internal rotation of femur on fixed tibia is the most common history. The commonest symptom is giving way of knee which is an expression of the 'axial instability'. Hearing or feeling of a pop is highly suggestive of the injury. Patient will be unable to continue his work or his sport following the injury. The patient complains of severe pain and swelling in the knee. With associated haemarthrosis the possibility of ACL injury is around 70% (Pringle, 1917 & Lucie, 1984). Non contact injuries commonly result in ACL injury. Contact injuries are more likely to result in multiligament injuries.

When abduction, flexion and internal rotation of the femur on tibia occurs, the medial supporting structures and the tibial collateral ligament are the initial structures to be injured. If the force still continues, the ACL is also often torn. The medial meniscus may be trapped between the condyles of femur and tibia and it may be torn in its periphery, thus producing the – 'Unhappy triad of O'Donoghue'.
With adduction, flexion and external rotation of the femur on tibia, the fibular collateral ligament usually is initially disrupted and depending upon the magnitude of the trauma, the injury occurs in capsular ligament, arcuate ligament complex, the popliteus, the iliotibial band, the biceps femoris, the common peroneal nerve and one or both cruciate ligaments.

Force directed to hyperextended knee usually injures the anterior cruciate ligament and if the force continues, disruption of posterior capsule and posterior cruciate ligament may result.

**SIGNS CONFIRMING THE DIAGNOSIS OF ACL INJURY:**

**ANTEROIOR DRAWER TEST**

With the patient supine on the examining table, the hip is flexed to 45° and the knee to 90°, placing the foot on the table top, the examiner sits on the dorsum of patient's foot to stabilize it and both hands are placed behind the knee to feel for relaxing of the hamstring muscles. The proximal part of the leg is then gently pulled and pushed repeatedly anteriorly and posteriorly noting the movement of the tibia on the femur. Initially the test is performed with the tibia in neutral rotation and then tested in 30 degrees of external rotation. Internal rotation to 30 degrees may tighten the posterior cruciate enough to obliterate an other-
wise positive anterior drawer test. The degree of displacement is recorded in each position of rotation and compared with the normal knee.

In an acutely painful knee it may not be possible to perform the anterior drawer test in the conventional 90° flexed position.

This test has two fold objectives

1) To show an increase in anterior translation of tibia beneath femur

2) To show the presence of posterior longitudinal tear of meniscus.

The displacement causes a palpable and audible jump on the joint known as Finochietto's jump sign. 75% of the patients have ACL deficit.

**LACHMAN TEST**

The patient is placed supine on the examining table with the involved extremity positioned towards the examinees side. The involved extremity is kept in slight external rotation and the knee between full extension and 15 degrees of flexion. The femur is stabilized with one hand and firm pressure is applied to the posterior aspect of the proximal tibia, lifting it forward in an attempt to translate it anteriorly. The position of the exam-
Ines hands is important in performing the test properly. One hand firmly stabilizes the femur while the proximal tibia is gripped in such a manner that the thumb lies on the anteromedial joint margin. When an anteriorly directed lifting force is applied by the palm and fingers, anterior translation of the tibia in relation to the femur can be palpated by the thumb. Anterior translation of tibia associated with a soft or a mushy end point indicates a positive test.

When haemarthrosis, spasm from hamstring or torn meniscus prevent flexion of knee to 90 degree, Lachman's test is useful. In this, there is greater anterior tibial translation than in anterior drawer test, which indicates that the former is more sensitive than the latter in detecting subtle increase in the laxity following ACL injury.

**PIVOT SHIFT TEST**

The foot is lifted with the knee extended and internally rotated. Valgus stress applied to the lateral side of the leg in the region of the fibular neck with the opposite hand – and when the knee is slowly flexed while valgus and internal rotation being maintained, the tibia subluxates anteriorly. As the knee is flexed approximately 30 degrees, the iliotibial band passes posterior to the center of rotation of the knee and provides the force that reduces the lateral tibial plateau on the lateral femoral condyle.
This is synonymous with anterolateral instability. When the knee is locked due to meniscal injury, it is difficult to examine. In such situation pivot shift test can be demonstrated easily when the patient is anesthetized.

**McMURRAY’S TEST**

This is a very popular test to detect any tear either in the medial or lateral semilunar cartilage. In making the examination the patient must be recumbent and relaxed, the surgeon stands at the side of the injured limb. The foot is firmly grasped with one hand and the knee with the other hand. The knee is completely flexed, that means the heel touches the buttock. The foot is now rotated externally and the leg abducted at the knee joint. This twisting movement is done for few times and then the joint is slowly extended keeping the foot externally rotated and abducted. If the posterior end of the medial semilunar cartilage is torn the patient will complain of pain at this stage as the torn cartilage will be caught between the femur and the tibia. At the same time a definite 'click' will be felt in the knee and the patient will experience a ‘giving way’ of the knee joint simultaneously. The angle at which this occurs, indicates the position of the cartilaginous lesion. When middle of the cartilage is torn the click is felt at the middle of the extension whereas when the anterior horn is torn click is felt almost at the end of extension.
Similar exercise with the foot rotated internally and the knee adducted, if elicits pain and a ‘click’ as discussed in the previous paragraph, indicates tear in semilunar cartilage and likewise the angle of the knee at which the pain and ‘click’ will be experienced will give a clue to the position of tear.

**APLEY’S GRINDING TEST**

The patient lies prone on the table. The clinician places his knee on the patient’s thigh in order to fix the femur. The knee joint is flexed to the right angle. Now the clinician applies compression and lateral rotation to the leg from the foot i.e. grinding. If the patient complains of pain by the maneuver, there is a tear in the medial semilunar cartilage. If the patient complains of pain while the clinician compresses and internally rotates the leg, there is a tear in lateral semilunar cartilage.

**RADIOGRAPHIC SIGNS:**

**SEGOND'S fracture** is named from lateral capsular sign in which a fleck of bone is avulsed from the lateral articular surface of the tibia. The presence of notched deficit in the lateral femoral condyle is suggestive of chronic ACL injury. A cortical osseous fragment visualized anterior and superior to the tibial spine on the lateral X-
ray indicate avulsion of ACL from its tibial insertion.

CONFORMING RADIOGRAPHIC METHOD

Lateral Anterior Drawer stress test

The patient was placed on the table with knee in 90 degree flexion for anterior drawer sign. Lateral radiographs were taken before and after stress was applied. The normal anteroposterior laxity of both the tibial condyles had a maximum translation of 5 mm, beyond which it is abnormal.

Lateral Monopedal stance test

When weight bearing, every 10 degree increase in tibial slope is associated with a 6 mm increase in anterior tibial translation, both in normal knee and in those with a ruptured ACL, but the magnitude of the movement is greater in latter.

MRI IN ACL INJURY:

MR imaging offers direct, non invasive visualization of the ACL and other soft tissue structures, improving the preoperative assessment of derangement.

Satellite images are most useful for evaluation of ACL, fiber orientation of the femoral and tibial attachments.

Coronal images are useful for evaluation of the collateral ligaments and
for assessing the signal characteristics of the ACL within the intercondylar notch. The ACL appears oriented like a 'hand in pocket coursing superolateral to anterior inferomedial.

Axial views are used for assessment of ACL and posterior cruciate ligament in the notch, bone contusion, para articular fluid collections and the joint capsule.

T2 weighted water sensitive sequences are the most useful for evaluation of contusions, edema and hemorrhage seen in association with ACL tears.

**Normal ACL Appearance on MR imaging:**

ACL has "Propeller" or "fanlike" configuration gray, slightly inhomogeneous signal intensity may be seen in the normal ligament and the ligament may not be seen in its entity on a single sagittal slice.

**In injured ACL:**

In Acute ACL tears - Poor (or) Non visualization of the ACL on sagittal images, an amorphous edematous mass with focally increased Signal on T2 - weighted images, is observed.

**In chronic ACL tears:**

Although acute tears can accurately be differentiated from intact ligaments, chronic tears may have potentially confusing appearances due to bridging fibrosis, which resembles the normal ACL. The researchers found that the most useful MR imaging features for diagnosis of an
acute ACL tear was edematous soft tissue in the intercondylar notch. Non-visualization of the ACL was uncommon with chronic tears. The most useful finding in differentiating chronic tears is abnormal course and focal angulation of the ligament without edema. Focal thickening wavinar and indistinct margin are non-specific findings that may be seen with chronically torn or normal ligaments.
CLASSIFICATION
CLASSIFICATION OF KNEE INSTABILITY

The traumatic disruption of knee ligaments often result in complex instability and that if not corrected will not restore normal mechanism of the knee joint.

The vertical axis of the knee joint passes near the center of the joint. The tibial plateau is divided into four quadrants that serve as the reference points in the definition of knee instability. Any disruption in the complex of supporting structures about the knee may permit a shift in vertical axis away from the center of the tibia into one of the lateral quadrants as the tibia shifts excessively and abnormally in relation to the femur. The specific classification of each instability depends on the movement of tibia in relation to the femur during stress testing. The classification probably has its greatest usefulness in chronic instability.

The Classification is proposed by the Committee of Research and Education of the American Orthopedic Society for Sports Medicine.

A. SIMPLE / STRAIGHT INSTABILITY

B. ROTATORY INSTABILITY

C. COMBINED INSTABILITY
A. SIMPLE / STRAIGHT INSTABILITY

1. Medial
2. Lateral
3. Posterior
4. Anterior

1. **Simple medial instability** indicates disruption of tibial collateral ligament, medial capsular ligament, anterior cruciate ligament, posterior oblique ligament and posteromedial capsule.

2. **Simple Lateral Instability** indicates disruption of lateral capsular ligament, fibular collateral ligament, biceps tendon, iliotibial band, the arcuate popliteus complex, anterior cruciate ligament and posterior cruciate ligament.

3. **Simple Posterior instability** showing disruption of posterior cruciate ligament, the arcuate ligament complex and the posterior oblique ligament complex.

4. **Simple Anterior Instability** indicates disruption of anterior cruciate ligament, the lateral capsular and medial capsular ligament.
B. ROTATORY INSTABILITY

1. Anteromedial

2. Anterolateral

3. Posterolateral

4. Posteromedial

1. Anteromedial instability shows the disruption of medial capsular ligament, tibial collateral ligament, the posterior oblique ligament and the anterior cruciate ligament.

2. Anterolateral Instability shows the disruption of lateral capsular ligament, the arcuate ligament complex and anterior cruciate ligament.

3. Posterolateral Instability showing the disruption of popliteus tendon, the arcuate ligament complex, the lateral capsular ligament and posterior cruciate ligament.

4. Posteromedial Instability implies disruption of tibial collateral ligament, medial capsular ligament, the posterior oblique ligament, anterior cruciate ligament, posteromedial capsule and stretching of posterior cruciate ligament.
C. COMBINED INSTABILITY

1. Anterolateral - Anteromedial
2. Anterolateral — Posterolateral
3. Anteromedial – Posteromedial
MATERIALS AND METHODOLOGY
MATERIALS AND METHODOLOGY

MATERIAL

The prospective study consists of 40 patients who had undergone Arthroscopic ACL reconstruction using central third Bone-patellar tendon-Bone autograft at the Department of Orthopedic Surgery, Apollo Hospitals, Hyderabad.

PERIOD OF STUDY

From June 2006 to December 2008.

INCLUSION CRITERIA

- Willingness to participate and follow up
- No prior knee surgery
- Normal contralateral knee
- Clinical evaluation of instability by surgeon

EXCLUSION CRITERIA

- ACL injuries with associated intra articular fractures
- Osteoarthritic changes in X ray
INSTRUMENTATION

Specialized instruments are required for arthroscopic ACL reconstruction. The fluid medium used is Normal Saline and 3 Litre bottles are used for the purpose as it exerts more pressure and also does not need frequent changing.

The instrumentation needed is:

1. TV, Camera system & Light source
2. Shaver System
   - For debriding the joint
3. Pneumatic Tourniquet
   - For a bloodless operating area
4. Basic Arthroscopic Instruments
   - Trocar, Canula, Telescope, Probe
   - Hand Instruments
5. ACL Reconstruction Instruments
   - Tibial Guide, Guide Wire, Reamers, Graft Sizer
   - Femoral Aimer, Beath Pin, Notch Curette
6. Interference Screws — All Size.
METHODOLOGY

SURGICAL TECHNIQUE:

Under spinal or epidural anaesthesia the patient was put supine in the fracture table. The knee is examined for ligament injury using Lachman test, anterior drawer test, pivot shift test, valgus and varus stress test and posterior drawer test. After applying tourniquet the knee was extended over leg holder. Parts were cleaned and draped and a diagnostic arthroscopy was performed using standard anterolateral and anteromedial portals. The diagnosis of ACL tear confirmed arthroscopically and associated chondral lesions and meniscal tears diagnosed and treated.

HARVESTING THE GRAFT:

The skin incision made vertically from the inferior pole of the patella to superior margin of tibial tubercle. Skin flap raised to enable full visualization of the tendon width. The paratenon was dissected from the patellar tendon. The middle third of the patellar tendon measured approximately 10 mm and harvested along with patellar and tibi-
al bone plugs upto 25 mm long using oscillating saw and removed with osteotome. Just before separation two drill holes are made in the bone plug.

**GRAFT PREPARATION:**

The bone plugs are trimmed to the desired width (8mm – 11 mm). The width checked using appropriate sizer templates. The graft edges are smoothened and sutures passed through the drill holes.

**NOTCHPLASTY:**

It is done only in cases of suspected impingement and not done as a regular procedure. Graft impingement may lead to loss of terminal extension and ‘Cyclops lesion’ (large lump of scar like material). Notchplasty was done using a specialized curette and automated shaver. Care is taken not to extend the notch too far medially or superiorly as it may interfere in the patello-femoral articulation.

**TIBIAL TUNNEL PLACEMENT:**

The tibial tunnel is made using the 'Tibial Guide' (Acufex - Smith & Nephew). The angle of the guide is usually adjusted with the calculation ‘N + 7’ where N stands for the length of the patellar tendon. The tibial guide pin
is drilled and brought through at the junction of middle and posterior third of the normal ACL attachment. The tibial tunnel is reamed using cannulated drills over this guide pin upto the desired width of the bone plug. Care is taken not to form a vertical tunnel. The intra articular edges of the tunnel are smoothened using the automated shaver.

**FEMORAL TUNNEL PLACEMENT:**

The femoral tunnel is drilled through the trans-tibial approach. The knee is flexed to > 90°. The 'Femoral Aimer' is brought through the tibial tunnel and with over the top positioning to maintain the posterior cortical wall to 2 mm. The guide pin is positioned at 10' clock to 11'O clock for the right knee and 1'O clock to 2'O clock for the left knee. The 'Beath Pin' is drilled through the femoral aimer and exits at the anterolateral aspect of the thigh. The femoral tunnel is also drilled over the Beath pin to the desired width and length in proportion to the bone plug. The posterior cortex is checked for any breach of the back wall.

**GRAFT PASSAGE:**

The sutures are passed through the eye of the Beath pin and the proximal end of the pin is pulled to pass the graft through the
tibial and femoral tunnel from bottom to the top. Care is taken that no bone is allowed to protrude into the joint cavity at both tibial and femoral ends. Tibial plug protrusion can be avoided by matching the length of the graft and osseous tunnels. Small discrepancies may sometimes still exist requiring some adjustment. Shortening of the bone plugs by 2 to 3 mm or deepening of the tunnel by 3 to 5 mm can compensate for a small difference.

**GRAFT FIXATION:**

The knee is flexed to >100° and using the guide pin the femoral fixation is done using the interferential screws. Appropriate sized screws are used to get the interference fit as screw diameter is an important consideration for fixation strength. Care is taken for the screw not to protrude into articular area. Move the knee through a few cycles of motion to check for impingement. The knee is placed in extension and interference screws are placed at the cancellous side of the bone plug in tibial tunnel with the graft sutures pulled firmly under tension.

**WOUND CLOSURE:**

After irrigation of the knee joint the patellar tendon and paratenon are closed separately. The subcutaneous tissue and skin are closed over a
drain in the knee joint. Compression bandage is applied and limb immobilized in long knee brace.

**POST-OP REHABILITATION:**

Rehabilitation was started on the day after surgery under the direct supervision of the surgeon. Drain removed at 24-48 hours. The knee was immobilized in knee brace. The accelerated rehabilitation program includes the following.

<table>
<thead>
<tr>
<th>Time</th>
<th>Motion</th>
<th>Muscles Training</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Phase – I</strong></td>
<td>Aim to prevent muscle atrophy</td>
<td>Good quadriceps setting</td>
</tr>
<tr>
<td><strong>Preoperative</strong></td>
<td>Prepare patient for procedure</td>
<td>Heel slides/ SLR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Normal gait pattern emphasized</td>
</tr>
<tr>
<td><strong>Stage – II</strong></td>
<td>Aim to decrease pain &amp; swelling</td>
<td>Knee immobilized</td>
</tr>
<tr>
<td><strong>Upto 2 weeks</strong></td>
<td>Starts on day of surgery</td>
<td>Quadriceps exercise</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Foot ankle pump</td>
</tr>
<tr>
<td><strong>Stage III</strong></td>
<td>Emphasis on increasing ROM</td>
<td>Brace continued</td>
</tr>
<tr>
<td><strong>2 – 6 weeks</strong></td>
<td>Increasing weight bearing</td>
<td>Full weight bearing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No active flexion</td>
</tr>
<tr>
<td>Stage IV After 6 weeks</td>
<td>Aim in improving muscular control &amp; proprioception</td>
<td>Closed chain Kinetic Active knee flexion</td>
</tr>
<tr>
<td>------------------------</td>
<td>--------------------------------------------------</td>
<td>----------------------------------------</td>
</tr>
</tbody>
</table>

Closed chain exercises started on day one. Active SLR and static quadriceps strengthening exercises were started. Two crutch ambulation was allowed with the knee immobilized, with weight bearing as tolerated. Sutures were removed on the 14th post op day. Intermittent passive range of motion was encouraged. Weight bearing was allowed with knee brace up to 6 weeks. Active flexion was started at the end of 6 weeks. Patient was allowed active and active-assisted knee mobilization and gradual quadriceps strengthening exercises. Crutches were discontinued when quadriceps control is acquired and knee extension of 10° is achieved. Physiotherapy is continued up to 9 months post surgery.

**EVALUATION:**

Postoperative X rays (Standard Antero-posterior and Lateral views) were taken on the operated limb. The tunnel positioning and screw placement were documented. All patients were reviewed periodically at 6 weeks, 3 months, 6 months and 1 year for assessment.
The patients were evaluated using the International Knee Documentation 2000 Score (IKDC) and Lysholm & Gilquist Knee Scoring Scale. The Anterior Knee Pain (AKP) Questionnaire was also used.

The **IKDC 2000 Score** is a single page form consisting of documentation section, a qualification section and an evaluation section. The documentation section records the patient’s personal details and the history of injury. The qualification is the major part in the IKDC form and it consists of eight parameters for evaluation like – effusion, range of motion, ligament function, compartment findings, harvest site pathology, radiographic finding and functional testing. The three problem areas viz. effusions, range of motion and ligament examination are evaluated for group qualification. The worst qualification within the group gives the group qualification.

The final outcomes are documented as A, B, C & D. 'A' being 'Normal' functional outcome and 'B' as 'Nearly Normal' functional outcome. 'C' being 'Abnormal' & 'D' are 'Severely Abnormal' functional outcomes.

**The Lysholm & Gilquist Knee Scoring Scale** also comprised of eight parameters for evaluation. The parameters evaluated were– limp, use of support on walking, locking episodes, instability, pain, swelling, stair
climbing and squatting. The individual parameters were allotted specific scores depending on the functional ability of the patient. The maximum possible knee score was 100 points. Based on the outcome scores they were divided into Excellent, Good, Fair and Poor.

- **Excellent**: 95 – 100 points
- **Good**: 84 – 94 points
- **Fair**: 65 – 83 points
- **Poor**: 64 or fewer points

The AKP *Questionnaire* is evaluated by...

<table>
<thead>
<tr>
<th></th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
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<tbody>
<tr>
<td>1</td>
<td>Squatting</td>
<td>1 – 3</td>
<td>4 - 6</td>
</tr>
<tr>
<td>2</td>
<td>Stairs</td>
<td>1 – 3</td>
<td>4 - 6</td>
</tr>
<tr>
<td>3</td>
<td>Kneeling</td>
<td>1 - 3</td>
<td>4 - 6</td>
</tr>
<tr>
<td>4</td>
<td>Lotus</td>
<td>1 -3</td>
<td>4 - 6</td>
</tr>
<tr>
<td>5</td>
<td>Lotus</td>
<td>1 -3</td>
<td>4 - 6</td>
</tr>
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</table>

**Final Score**

- **Mild**: <15
RESULTS

Moderate  16-30
Severe    31-50
RESULTS

40 cases of Arthroscopy assisted ACL reconstruction were followed up for 1 year to 2.5 years. The mean follow up period was 1.5 years.

AGE DISTRIBUTION:

15 years – 45 years

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<th>PATIENTS</th>
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<td>21-25</td>
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<td>26-30</td>
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<td>41-45</td>
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SEX DISTRIBUTION:

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<td>MALE</td>
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SIDE INVOLVED:

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MODE OF INJURY:

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<td>SPORTS INJURY</td>
<td>16</td>
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<tr>
<td>RTA</td>
<td>16</td>
<td>40%</td>
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<tr>
<td>FALL</td>
<td>8</td>
<td>20%</td>
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<tr>
<td>TOTAL</td>
<td>40</td>
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DURATION OF INJURY:

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<td>UPTO 6 WEEKS</td>
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<td>32.5%</td>
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<tr>
<td>6 WKS – 3 MONTHS</td>
<td>10</td>
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</tr>
<tr>
<td>3 MONTHS – 6 MONTHS</td>
<td>9</td>
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<td>6 MONTHS – 1 YEAR</td>
<td>2</td>
<td>5%</td>
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<tr>
<td>1 YEAR</td>
<td>6</td>
<td>15%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>40</td>
<td>100%</td>
</tr>
</tbody>
</table>
SYMPTOMS AT PRESENTATION:

<table>
<thead>
<tr>
<th>SYMPTOMS</th>
<th>PATIENTS</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>KNEE PAIN</td>
<td>21</td>
<td>52.5%</td>
</tr>
<tr>
<td>INSTABILITY</td>
<td>11</td>
<td>27.5%</td>
</tr>
</tbody>
</table>
### SYMPTOMS V/S PATIENTS

- **KNEE PAIN**: 18 (45%)
- **INSTABILITY**: 22 (55%)
- **LOCKING**: 2 (5%)
- **TOTAL**: 40 (100%)

### PREOPERATIVE TREATMENT

(A aspiration, Knee immobilization):

<table>
<thead>
<tr>
<th>PATIENTS</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>18</td>
</tr>
<tr>
<td>NO</td>
<td>22</td>
</tr>
<tr>
<td>TOTAL</td>
<td>40</td>
</tr>
</tbody>
</table>

PRE OPERATIVE TREATMENT
EVALUATION
EVALUATION

All the patients at the end of 1 yr follow up were functionally evaluated based on IKDC score. Of the 40 patients 19 patients had normal result and 15 patients had nearly normal outcome. 6 of our patients had poor results (3 patients with restricted ROM and 3 with Lachmaris > 6 mm). Of the patients taken up for the study 16 patients had improved by two grades and 18 patients had improved by one grade. 3 patients did not show any improvement and 3 had worsened.

<table>
<thead>
<tr>
<th>NORMAL</th>
<th>19</th>
<th>47.5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEARLY NORMAL</td>
<td>15</td>
<td>37.5%</td>
</tr>
<tr>
<td>ABNORMAL</td>
<td>3</td>
<td>7.5%</td>
</tr>
<tr>
<td>SEVERELY ABNORMAL</td>
<td>3</td>
<td>7.5%</td>
</tr>
</tbody>
</table>

NORMAL OUTCOMES:
Of the 19 patients with excellent results 7 were operated upon the left knee and 12 in the right knee. 13 patients had improved by 2 grades. 6 patients had improved by 1 grade. The patients of this group had a normal knee on subjective assessment. They had no symptoms post surgery on the affected knee and had a full range of motion. And the ligament examinations were also normal. All the patients had posteriorly angled tibial tunnel. Of the 7 patients with left sided ACL reconstruction 6 patients had tunnel at 1'0 clock and 1 patient at 2'0 clock position. Of the 12 with right side reconstruction 8 had femoral tunnel at 10 '0 clock position and 4 patients at 11’0 clock position. In the lateral view 16 patients had a posterior femoral tunnel placement and 3 patients had an anteriorly placed tunnel.

NEARLY NORMAL OUTCOMES:

Of the 15 patients with good results 8 were operated on the left knee and 7 on the right knee. 3 patient improved by two grades and 12 patients improved by 1 grade. The patients of this group had a nearly normal knee on subjective assessment. They had minimal symptoms post surgery on the affected knee and had a minimal loss of range of motion. And the ligament examinations were also nearly normal. All the patients had posteriorly angled tibial tunnel. Of the 8 patients with left
sided ACL reconstruction 5 had femoral tunnel at 1’0 clock and 3 at 2' 0 clock position. Of the 7 patients with right sided reconstruction 4 had femoral tunnel at 10’0 clock and 3 at 11’0 clock position. In the lateral view all the patients had a posteriorly placed femoral tunnel.

**ABNORMAL OUTCOMES:**

Of the 6 patients with poor results, 3 patients did not show any improvement and 3 patients worsened from their pre operative functional status. The patients of this group had an abnormal knee function on subjective assessment. They had severe symptoms post surgery on the affected knee and had either flexion or extension deficit affecting activities of daily life. And the ligament examinations also showed excessive laxity.

Of the 3 patients who did not show any improvement 2 had a posteriorly placed tibial tunnel. Femoral tunnel was placed at 10’0 clock and anterior. They had a laxity of >6 mm. The other patient had posteriorly placed tibial tunnel and femoral tunnel at 1’0 clock and anterior in lateral view. He had a flexion deficit of 20°.

Of the 3 patients who worsened, all got worse by one grade i.e. from grade C to grade D. 1 patient had anterior tibial tunnel which was vertical and femoral tunnel at 10’ 0 clock and posterior placement at femur.
He had Lachman > 10mm. The other 2 patients also had a far anterior tibial tunnel placement and femoral tunnel at 10’0 clock and anterior placement in femur. They had a flexion deficit of >30*.

**Lysholm & Gillquist Knee Scoring Scale** was also used to evaluate functional status of our patients. We had 16 patients with excellent outcome. 19 patients with Good outcome and 5 patients had a Fair outcome.

<table>
<thead>
<tr>
<th>OUTCOME</th>
<th>PATIENTS</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXCELLENT</td>
<td>16</td>
<td>40%</td>
</tr>
<tr>
<td>GOOD</td>
<td>19</td>
<td>47.5%</td>
</tr>
<tr>
<td>FAIR</td>
<td>5</td>
<td>12.5%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>40</td>
<td>100%</td>
</tr>
</tbody>
</table>

The patients with excellent outcome had no limp and had no episodes locking or instability. Few patients had difficulty in squatting. The patients with good outcomes were able to walk without support and did not have any locking. Few patients had limp in gait and pain on severe exertion. The patients with fair outcome had marked pain on exertion and problems in squatting. One of the patients had rare episodes of locking and limp.

**The AKP Questionnaire** outcome was also evaluated in all
the cases. Most of the patients presented with anterior knee pain post surgery but went on to subside during the rehabilitation period as the bone healed and with oral analgesics.

<table>
<thead>
<tr>
<th></th>
<th>PATIENTS</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>NONE</td>
<td>29</td>
<td>72.5%</td>
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<tr>
<td>MILD</td>
<td>3</td>
<td>7.5%</td>
</tr>
<tr>
<td>MODERATE</td>
<td>5</td>
<td>12.5%</td>
</tr>
<tr>
<td>SEVERE</td>
<td>3</td>
<td>7.5%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>40</td>
<td>100%</td>
</tr>
</tbody>
</table>

ASSOCIATED INJURIES:

CHONDRAL LESIONS:

25 patients out of our 40 patients had associated Chondral lesions. 14 patients had chondral lesions at more than one site. The commonest site of presentation was the medial femoral condyle.

Medial Femoral Condyle - 40%

Lateral Femoral Condyle - 25%

Patellar Surface - 20%

Medial Tibial Plateau - 10%

MENISCAL INJURIES:
Meniscal injuries were present in 19 patients.

Medial meniscus tear 13
Lateral meniscus tear 06

Partial medial meniscectomy was done in 11 patients and partial lateral meniscectomy was done in 05 patients. Complete removal of the medial meniscus was done in 2 patients and complete removal of the lateral meniscus was done in 1 patient.

**COMPLICATIONS:**

We came across the following complications:

- In one case intra-operatively the screw guide wire broke while fixing the tibial tunnel and was removed under C-arm guidance through a small anteromedial arthrotomy.
- Five patients had paraesthesia over the anteromedial portion of tibia which settled subsequently.
- One patient had a screw back out from the tibial site at the one year follow up and the screw was removed. However his functional status was good.
- Two patient had superficial infection (stitch abscess) and it
was controlled by oral antibiotics and dressing.
DISCUSSION

The advantages of arthroscopically assisted reconstruction of the anterior cruciate ligament are that there is minimum injury to the synovial membrane of the joint and yet it achieves the goals accomplished by open operative technique. The theoretical advantage of arthroscopic surgery includes less injury to patellofemoral mechanism and possibly less frequent symptoms and contractures of the patellofemoral joint post operatively. The proper site for location of bone tunnels can be better identified by an arthroscope. In addition, the correct relationship of the graft with respect to the lateral wall of the intercondylar notch can be established.

At present the most commonly used grafts for ACL reconstructions are bone-patellar tendon-bone autograft and hamstring tendon grafts.

The central one third of the bone patellar tendon bone graft was used because of its excellent biomechanical properties. It is the strongest of the immediately available substitute. Precise location of its tissue ends influences joint kinematics. The graft can be placed accurately during the surgery for it to act isometrically both in its location and tension. Bone to bone healing is more secure and rapid when compared to other grafts. It does not
sacrifice the knee stabilizers. The bone-patellar tendon-bone graft is time tested and has lesser complications and less significant morbidity. Fu et al.\textsuperscript{80} and Ritchie\textsuperscript{81} had stated that bone-patellar tendon-bone autograft is gold standard and the first choice in anterior cruciate ligament reconstruction. Also the rigid fixation of the bone graft using interferential screws adds to the stiffness of the graft.

Otero et al. in 1993\textsuperscript{82} compared the post operative success and stability of ACL reconstruction with bone-patellar tendon-bone autograft and doubled semitendinosus/ gracilis graft. He suggested that bone-patellar tendon-bone graft provides more overall knee stability. He also stated that the method of interference screw fixation adds to stability.

Arthroscopic ACL reconstruction with autogenous central third bone patellar tendon bone graft remains the gold standard for restoring functional ACL stability with short and medium term successful results in 85.95\%\textsuperscript{42,83} of the cases. Feagin et al. in 1997\textsuperscript{84} in their long term follow up suggested that compromise of secondary restraints requires the stiffer bone patellar tendon bone construct. Beynnon in 2002\textsuperscript{85} concluded after three years follow up and comparing objective outcome of bone-patellar tendon-bone graft with hamstring graft that bone-patellar tendon-bone autograft was superior.
Anderson et al. in 1993 compared six knee ligaments rating scales in a study of seventy patients and concluded that the International Knee Documentation Committee (IKDC) scale should be used as the standardized measurements. In 2005, Betram Zarins stated that subjective informations are insufficient for evaluating the results of an operation and objective measures are needed for complete information.

Daniel O’Neill had evaluated 45 patients of arthroscopic ACL reconstruction with IKDC scoring. 92% patients had normal or nearly normal outcome and 8% had abnormal outcomes. Daniel D. Buss had 87% excellent or good results.

Fox et al. in 2002 published a meta analysis of anterior cruciate ligament reconstructions using bone-patellar tendon-bone graft and published that eight studies out of the thirteen studies had used the International Knee Documentation Committee scale for evaluation. Normal or nearly normal outcomes were seen in 39% to 96% (range) patients after reconstruction of anterior cruciate ligament. Ibrahim et al. in his study in 2005 had 87.5% patients as normal or nearly normal outcome and 12.5% patients as abnormal results as of IKDC grading.

In our study of 25 patients, 84% had normal and nearly normal outcomes and 16% patients had abnormal outcomes that were comparable
As of Lysholm and Gillquist Knee Scoring we compared our results to the results of Lysholm and Gillquist in 1997. They had studied 60 cases totally and had excellent and good results in 88%. They had 8% with fair results and 4% poor outcomes. We also had 87.5% good results. However we had 12.5% with fair outcome and we did not have any poor outcomes in our study.

Fox et al.\textsuperscript{91} published that Lysholm and Gilquist knee scoring scale was used in 12 studies and the mean score was 91 (range: 85 - 96). Ibrahim et al.\textsuperscript{92} studies have a mean Lysholm and Gilquist score of 91.6 in the reconstructions using bone-patellar tendon-bone graft. The mean score of our study was 89%.

Fox et al\textsuperscript{91}. published that anterior knee pain incidence was 3% to 17%. In three studies it was greater than 20% and in one study it was 50%. Ibrahim et al\textsuperscript{92} in 2005 has recorded anterior knee pain in 24% patients. Marder et al.\textsuperscript{93} reported anterior knee pain in 24%. In our study anterior knee pain was present in 28% of the patients.

Goldblat et al. in 2005\textsuperscript{94} did a meta analysis of articles that compared both-patellar tendon graft and hamstring graft and concluded that the bone-patellar tendon-bone autograft was preferred in terms of bet-
ter stiffness and fewer patients with loss of flexion. Corry et al\textsuperscript{95} recognized the increased laxity in the patients operated using hamstring tendon.

In another recent meta analysis, the return to pre injury level of activity for a patellar tendon ACL reconstruction was 18% greater than for a hamstring reconstruction\textsuperscript{96}. Aglietti\textsuperscript{97}, O’Neill\textsuperscript{98} and Corry\textsuperscript{95} concluded that greater activity level was attained in the patellar tendon group. In our study 85% patients had functional improvement post operatively. 40% patients had improved by 2 grades and 45% improved by 1 grade as per IKDC grading.

Anderson et al.\textsuperscript{98} concluded that anterior cruciate ligament reconstruction lowered the meniscal tear rate from 27% to 3% at 2 year follow up. 60% of our patients had associated chondral lesions and 35% had lesions at more than one site. 47.5% of our patients had meniscal injuries. These associated lesions increased with the duration of the injury. And meniscal injuries did not affect the functional stability or outcome of the knees post operatively in our short term follow up.

Howell\textsuperscript{99} had stated that in Arthroscopic anterior cruciate ligament reconstruction, tibial tunnel position dictates the femoral tunnel position to a large extent. He added that ideally tibial tunnel must be angled in medial to lateral direction and in sagittal plane it should be angled posteriorly. In an article in 2001\textsuperscript{100}, he stated that on lateral radiograph in extension, the ex-
tent of injury of the tunnel into the joint should be positioned to roof of intercondylar notch (Blumensaat’s line).

In our studies all the patients with excellent and good outcomes had angled tibial tunnel in sagittal plane. All our patients with poor outcomes had more anteriorly placed tunnel. In the antero-posterior view all the patients had tunnel placement between 35 to 45°.

Sagepa\textsuperscript{101} stated that it has been popular to place the femoral tunnel at the so called 11’0 clock position to replicate the origin of Antero-medial bundle of ACL. John C Loh\textsuperscript{102} published that the 10’0 clock position more effectively resists rotatory loads when compared to 11’0 clock position and that grafts placed at 10 or 11’0 clock position are equally effective under anterior tibial load but neither femoral tunnel was able to fully restore knee stability upto intact knee. Scoop\textsuperscript{103} in 2004 published that the best position for the femoral tunnel is between 10 and 11’0 clock in the right knee and between 1 and 2’0 clock in the left knee.

In this series of the 34 patients with excellent and good outcome 18 patients had femoral tunnel in antero posterior view at 11’0 clock or 1’0 clock position. 16 patients had tunnel placement at 10’0 clock or 2’0 clock position. Of them in lateral view 31 patients the tunnel was placed posterior and close to the posterior cortex. In 3 patients the
tunnel was anteriorly placed. All the 6 patients with poor outcomes had an anteriorly placed femoral tunnel in lateral view. All patients had the femoral tunnel in antero-posterior view within the 10'O clock and 11'O clock for the right knee and 1'O clock and 2'O clock in the left knee.

Kurt Spindler in 2005\textsuperscript{104} in their first prospective cohort study of five year outcomes after ACL reconstruction stated that weight control education and regular exercise leads to an increased functional outcome. The rehabilitation following surgical reconstruction focuses on three main goals i.e. the restoration of ligament stability, restoration of muscular strength and the restoration and improvement of general state of fitness.

David J Biau, Caroline Tournoux, Sandrine Katsahian, Peter J Schranz, Rémy S Nizard in 2006 concluded that morbidity was lower for hamstring autografts than for patellar tendon autografts. According to them evidence that patellar tendon autografts offer better stability was weak, but poor quality of the studies calls into question the robustness of the analyses.\textsuperscript{105}

Schoderbek RJ Jr, Treme GP, Miller in Clinical Sports Med. 2007\textsuperscript{106} stated “The anterior cruciate ligament (ACL) serves an important stabl-
lizing and biomechanical function for the knee. Reconstruction of the ACL remains one of the most commonly performed procedures in the field of sports medicine. Reconstruction of the ACL with bone-patella tendon-bone (BPTB) autograft secured with interference screw fixation has been the historical reference standard and remains the bench-mark against which other methods are gauged.”

Several factors have been identified as significantly influencing the biomechanical characteristics and the functional outcome of an ACL reconstructed knee joint. These factors are: (1) individual choice of autologous graft material using either patellar tendon-bone grafts or quadrupled hamstring tendon grafts, (2) anatomical bone tunnel placement within the footprints of the native ACL, (3) adequate substitute tension after cyclic graft preconditioning, and (4) graft fixation close to the joint line using biodegradable graft fixation materials that provide an initial fixation strength exceeding those loads commonly expected during rehabilitation.107

The "biological failure" of the ACL graft is a complex pathological entity whose cause is not fully understood. Failure may be initiated by early extensive graft necrosis, disturbances in revascularization, problems in cell repopulation and proliferation, and as well difficulties in the
ligamentization process.\textsuperscript{108}

L. A. Pinczewski et al\textsuperscript{109} studied the use of intra-operative landmarks and found that it resulted in reproducible placement of the tunnels and an excellent clinical outcome seven years after operation. Vertical inclination was associated with increased rotational instability and degenerative radiological changes, while rupture of the graft was associated with posterior placement of the tibial tunnel. If the osseous tunnels are correctly placed, single-bundle reconstruction of the ACL adequately controls both anteroposterior and rotational instability.

D. L. Dahm et al\textsuperscript{110} in 2008 concluded that reconstruction of the anterior cruciate ligament in carefully selected patients aged 50 years or over can achieve similar results to those in younger patients, with no increased risk of complications.

Sung-Jae Kim, Tae-Eun Kim, Doo-Hyung Lee, and Kyung-Soo Oh\textsuperscript{111} in 2008 stated that in patients who have excessive joint laxity, the two-year outcomes of anterior cruciate ligament reconstruction with bone-patellar tendon-bone grafts are better than those with four-bundle hamstring grafts in terms of both side-to-side anterior laxity and clinical results.

With the combined clinical and basic research and bet-
Understanding of the knee biomechanics, the science of anterior cruciate ligament reconstruction has advanced dramatically. The safe and effective restoration of all knees that have an injury of the anterior cruciate ligament to reach their pre-injury activity level should remain the goal of operative treatment. Due to the complex biomechanics of the knee joint following an anterior cruciate ligament tear, it is never possible to recreate a normal knee. The goal is to achieve a functional stable knee. If the primary principles of anterior cruciate ligament reconstruction are followed, one can expect consistent results with patellar tendon reconstruction. This would entail proper anatomic position of the femoral and tibial tunnels and secure fixation of the graft, which allows for a rational accelerated rehabilitation protocol.

The long term benefits of Arthroscopic anterior cruciate ligament reconstruction are not yet determined; however, short term results are encouraging. There is a clear need for prospective long term (5 to 10 years) follow-up studies with focus on objective measures of stability, functional outcome and onset of degenerative arthritis to scientifically investigate continued results of patellar tendon anterior cruciate ligament reconstruction with a focus on risk factors associated with poor outcomes.
CONCLUSION
CONCLUSION

- Anterior cruciate ligament injuries are common in younger age group individuals.
- Males are more prone for anterior cruciate ligament injuries.
- Sports injuries are the commonest cause for anterior cruciate ligament injuries.
- Associated meniscal and chondral lesions increase with duration of the injury.
- Tibial tunnel position affects the functional outcome of the patients in Arthroscopic anterior cruciate ligament reconstruction.
- Meniscal injuries do not affect the final outcome in anterior cruciate ligament reconstructed patients in short term follow up.
- Arthroscopic ACL reconstruction using bone-patellar tendon-bone autograft provides a stable knee with minimal complications.
- Arthroscopic anterior cruciate ligament reconstruction reduces
postoperative morbidity and enables early rehabilitation.

BIBLIOGRAPHY


12. Galen C: On the usefulness of the parts of the body. *Ithaca Cotnett Univer-
   Bailliere, Paris pp 1853; 354-357.


Gynecol Obstet 1936; 62: 964-968.


50. Howell S M - Arthroscopically assisted technique for preventing roof impingement of anterior cruciate ligament graft illustrated by


64. Shelbourne, Wilckeus – Arthrofibrosis in acute anterior cruci-


77. Sakane M, Fox RJ, Woo SL, Livesay GA, Li G, Fu FH – In situ forces in the anterior cruciate ligament and its bundles in response to an-


91. Jeff A Fox, Nedeff DD, Bach BR – Anterior cruciate ligament recon-


97. Aglietti P, Buzzi R, Zaccherotti G – Patellar tendon versus doubled se-
mitendinosus and gracilis tendons for anterior cruciate ligament recon-

98. Anderson C, Odensten M, Good L, Gillquist J– Surgical or non surgical
treatment of acute rupture of the anterior cruciate ligament: A
71(A): 965-974.*

99. Howell SM - Principles for placing the tibial tunnel and avoiding roof
impingement during reconstruction of a torn anterior cruciate liga-
S49-S5.*

100. Howell SM, Giffins ME, Gottlieb JE. - The relationship between the an-
gle of the tibial tunnel in the coronal plane and loss of flexion
and anterior laxity after ACL Reconstruction. *Am J Sports

101. Sagepa AA, Moyer RA, Schnech C – Testing for isometry during recon-
struction of the ACL. Anatomical and biomechanical considera-

102. John C Loh, Yukihsa Fukuda, Eiichi Tsuda – Knee Stability and graft
function following ACL Reconstruction: Comparison between
11’O and 10’O clock Femoral tunnel placement. *Arthroscopy*


**Lysholm Knee Scoring Scale**

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<th>Category</th>
<th>Description</th>
<th>Score</th>
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<tr>
<td><strong>Limp (5 points)</strong></td>
<td>None</td>
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<tr>
<td></td>
<td>Slight or periodical</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Severe and constant</td>
<td>0</td>
</tr>
<tr>
<td><strong>Support (5 points)</strong></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Stick or crutch</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Weight-bearing impossible</td>
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</tr>
<tr>
<td><strong>Locking (15 points)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>No locking and no catching sensations</td>
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</tr>
<tr>
<td></td>
<td>Catching sensations but no locking</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Locking Occasionally</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Frequently</td>
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<tr>
<td></td>
<td>Locked joint on examination</td>
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<tr>
<td><strong>Instability (25 points)</strong></td>
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</tr>
<tr>
<td></td>
<td>Never giving way</td>
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</tr>
<tr>
<td></td>
<td>Rarely during athletics or other severe Exertion</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Frequently during athletics or other</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Severe exertion (or incapable of participation)</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Occasionally in daily activities</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Often in daily activities</td>
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<tr>
<td></td>
<td>Every step</td>
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<td><strong>Pain (25 points)</strong></td>
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<td>Inconstant and slight during severe exertion</td>
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<tr>
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<td>on or after walking less than 2 Km</td>
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<tr>
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<td>5</td>
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<td></td>
<td>Marked on or after walking less than 2 Km</td>
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<td><strong>Swelling (10 points)</strong></td>
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<td>On severe exertion</td>
<td>6</td>
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<tr>
<td></td>
<td>On ordinary exertion</td>
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</tbody>
</table>
Constant 0

**Stair - Climbing (10 points)**
- No problems 10
- Slightly impaired 6
- One step at a time 2
- Impossible 0

**Squatting (5 points)**
- No problems 5
- Slightly impaired 4
- Not beyond 90° 2
- Impossible 0

The details of physical examination are given below:

<table>
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<tr>
<th>PHYSICAL EXAMINATION</th>
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<tbody>
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ABBREVIATIONS

M  -  Male
F  -  Female
R  -  Right
L  -  Left
RTA  -  Road Traffic Accident
MMT  -  Medial Meniscal Tear
MM  -  Medial Meniscus
LMT  -  Lateral Meniscal Tear
MFC  -  Medial Femoral Condyle
LFC  -  Lateral Femoral Condyle
ACLR  -  Anterior Cruciate Ligament Reconstruction
PMM  -  Partial Medial Meniscectomy
PLM  -  Partial Lateral Meniscectomy
S  -  Shaving
CMM  -  Complete Medial Meniscectomy
CLM  -  Complete Lateral Meniscectomy.