FUNCTIONAL OUTCOME OF ARTHROSCOPIC ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION WITH BONE PATELLAR TENDON BONE GRAFT
INTRODUCTION

Anterior cruciate ligament ruptures are “the beginning of the end of Knee”

Anterior cruciate ligament (ACL) is an intra-articular, extrasynovial structure present in the central complex of the knee joint which along with other structures in and around knee joint controls, limits motion and maintains static and dynamic equilibrium of knee joint.

ACL is commonly injured in athletic activities and in road traffic accidents example: when a sudden loading or tension is placed on the ligament as when a running athlete plants a foot to suddenly decelerate or change direction.

Anterior knee instability associated with rupture of ACL is a disabling clinical problem in general and especially in athletic individuals. ACL has a poor capacity of healing. The need for surgical correction of ACL injuries arises because, untreated complete injury to the ligament leads to progressive symptomatic instability leading to recurrent injury and damage to the menisci and articular cartilage thus resulting in early osteoarthritis. Arthroscopic guided ACL Reconstruction (ACLR) has multiple advantages over open ACLR.

- Smaller surgical incision
- Less extensor mechanism trauma.
- Improved viewing of intercondylar notch for tunnel placement
- Less post operative pain, fewer adhesion and earlier mobilization.
Numerous authors have described successful reconstruction of ACL (ACLR) with use of autografts (e.g. Patellar tendon, hamstring tendons, distally based ilio tibial band (ITB), fascia late etc) and allografts (e.g. Achillis tendon, tibialis anterior, patellar tendon, hamstring tendons etc)\(^8,9,10,11&12\).

The Bone-Patellar tendon-Bone autograft the most commonly used autograft for reconstruction\(^13-17\). The bone-patellar tendon-bone autograft has been widely accepted as the gold standard for ACL reconstruction with a high success rate\(^17-20\). The bone–patellar tendon–bone graft usually is an 8- to 11-mm-wide graft taken from the central third of the patellar tendon, with its adjacent patella and tibial bone blocks. This graft's attractive features include its high ultimate tensile load (approximately 2300 N), its stiffness (approximately 620 N/mm), and the possibility for rigid fixation with its attached bony ends and early incorporation. However, donor site morbidities and extensor mechanism problems associated with the use of the bone-patellar tendon-bone are the two most commonly encountered problems.

In our study we have analyzed the results of Arthroscopic ACL reconstruction using autologous ipsilateral bone patellar tendon bone graft.
AIMS AND OBJECTIVES

THE AIM OF THE STUDY

Evaluation of the results of arthroscopic guided anterior cruciate ligament reconstruction using autologous BPTB graft.

OBJECTIVES

1. To know the functional outcome of arthroscopic guided anterior cruciate ligament reconstruction using BPTB graft using Lysholm knee score
2. To list and evaluate the complications encountered with anterior cruciate ligament reconstruction using bone-patellar tendon-bone graft
3. To analyze the results and compare the same with standard published data in literature.
Knee joint is a triaxial joint consisting of two articulations, the patello-femoral joint and the tibio-femoral joint. This joint is exposed to forces in excess of five times the body weight per step. The normal range of motion can be from 10 degrees of hyperextension to 130 degrees of flexion with 8 to 10 degrees of rotation through the entire arc.  

Fig. 1 anatomy of knee joint
SUPERIOR VIEW OF THE KNEE JOINT

Fig. 2 superior view of knee joint

ANTERIOR CRUCIATE LIGAMENT

Credit of discovery of ACL has been attributed to Galen in 170 A.D.\textsuperscript{21}

In adults the ACL is about 38 mm long (Range 25-42 mm) and about 1 cm thick at the middle (range 7-12mm). It is entirely intra-articular, but it is extrasynovial, with its synovial envelope.

It is proximally attached to the posterolateral corner of the intercondylar surface of the lateral femoral condyle. The attachment is 15-20mm long in the form of an arc of a circle and anteriorly it is relatively straight and posteriorly it is obliquely convex.
The area of attachment is 23mm distal to the level of adductor tubercle and 12mm anterior to the junction of the roof of the intercondylar notch and posterior surface of the lateral femoral condyle. The attachment is usually an interdigitation of collagen fibers and rigid bone through a transitional zone of fibrocartilage and mineralized fibrocartilage.

To posterior fibers are parallel to the articular surface of lateral femoral condyle. It passes downwards, forwards and medially to the anterior intercondylar area of the tibia and gets attached to the slope of the tibial spine.22.

**Clinical relevance:**

The relationship of the ACL graft to intercondylar notch is critical. Proper graft positioning will allow full extension and avoids impingement of the graft. Howl et al identified increased signals on MRI scans in ACL grafts that are impinging against the intercondylar roof in extension.23

Additionally, biomechanical studies show that in order to relieve graft stress in extension, the tibial hole should be placed posteriorly an average of 42% of tibial sagittal depth24. This concept has been supported by clinical evidence that loss of full extension is directly associated with anterior placement of the tunnel.25

A pre-operative lateral radiograph with the injured knee in maximum hyperextension is helpful in calculation of the appropriate tibial tunnel position based on the intersection of a line drawn parallel to the intercondylar roof with the tibial surface.
Interstitial anatomy

ACL consists of 2 bundles that are evident only when the synovial coverings are removed. They are the anteromedial bundle (AMB) and posterolateral bundle (PLB). The nomenclature of these bundles is based on the relationship of the attachments of the bundles on the tibial surface.

ANATOMY OF ANTERIOR CRUCIATE LIGAMENT

Fig. 3 Arthroscopic picture showing bundles of ACL (AMB=Antero medial bundle) (PLB=Postero lateral bundle) (LFC= Lateral femoral condyle)
The tibial attachments form a triangle with the apex directed posteriorly. The anteromedial bundle inserts on the medial aspect of the intercondylar area of the tibia and forms the medial corner of the triangle. The posterolateral bundle represents the posteriorly directed apex of the triangle, with its attachments just lateral to the midline of the intercondylar eminence. None of the bundle attach to the tubercles of the tibial spine. The AMB attaches to the femur posteriorly and superiorly on the medial surface of the lateral femoral condyle. The PLB attaches anteriorly and inferiorly on the lateral femoral condyle.

ATTACHMENTS OF INDIVIDUAL BUNDLES ON FEMUR AND TIBIA

Fig 4 Attachment of bundles of ACL (AMB=Anteromedial bundle)
(PLB=Posterolateral bundle)
This orientation of the bundles allows a portion of the ACL to be taut during all portions of the range of motion. In flexion the fibers of AMB are tightened whereas the PLB is slack. The fibers of the PLB which are of a greater bulk and length come under increasing tension as the knee extended. At about 60 degrees of knee flexion the ACL is maximally loaded.

The reciprocal relationship of the AMB and the PLB constitute of four-bar linkage within the anatomy of this single ligament and provides for stability throughout the entire arc of the knee joint motion.

It has been shown that the fibers of the ACL are not parallel but show an external torsion of 46 degrees in full extension and 105 degrees in 90 degrees of knee flexion. It has been suggested that the fibers of the ACL are arranged more along the lines of scissors lattice, which is a more efficient arrangement in terms of coping with changing fiber tensions. If the arrangement is strictly parallel, potential disruptive tensile forces could develop within the ligament.

The important concepts of the normal ACL are:

1. Each fiber has a unique point of origin and insertion.
2. That fibers are not parallel and do not have the same length.
3. That the fibers are not under the same tension at any one point in space.
Microstructure of ACL

The ACL is composed of fibrils of collagen of 150 to 250 nanometer in diameter that interlace to form complex networks. Multiple networks of fibrils form individual fibers of 1.20 micron in diameter that tends to parallel the axis of the ligament. Multiplex of collagen fibers coalesce to form subfascicular units 100-250 microns in diameter. The subfascicular unit is surrounded by a thin band of loose connective tissue the endotendineum. Three to twenty subfascicular units coalesce to form visible fasicles of varying sizes. Each fasiculus is surrounded by epitendineum. The epitendineum is more loosely and randomly oriented than the fasicles. The entire ligament is surrounded by both a paratenon and a synovial sheath \(^\text{26}\).

Clinical relevance

Thus the reconstruction of ACL deficient knee must attempt to reproduce not only the normal anatomy by using the isometric points within the femoral origin and tibial insertion of the original ligament but also to reproduce the function by using a substitute of appropriate material properties.
Vascularity of the ACL

The synovial membrane which forms an envelope about the ligament is richly endowed with blood vessels that originate predominantly from the ligamentous branches of the middle genicular artery and a few smaller terminal branches of the lateral and medial inferior genicular arteries. The synovial vessels arborize to form a web like network of pre ligamentous vessels that ensheathe the entire ligament. These pre-ligamentous vessels then give rise to smaller connecting branches that penetrate the ligaments transversely and anastamose with a network of endoligamentous vessels. These vessels along with their supporting connective tissues are oriented in a longitudinal direction and lie parallel to the collagen bundles within the ligament.[27]

Clinical relevance

Clinical studies have reported a favorable prognosis for most partial tears. An isolated disruption of AMB usually occurs of the femoral origin. Since the blood supply to the remaining portion of ligament is intact, these injuries do well. In a hyperextension injury where the PLB is torn there may be a concomitant disruption of the blood supply. Therefore the fate of the remaining ligament is compromised.
ARTERIAL SUPPLY OF ANTERIOR CRUCIATE LIGAMENT

Fig. 5 showing arterial supply of ACL

(IMG=Infero medial genicular artery) (ILG=Inferolateral genicular artery)
The ACL is the primary restraint to the anterior translation of the tibia but its function is much more than that of a simple checkrein. Along with the PCL, the ACL determines the blend of gliding and sliding between the tibia and femur that characterizes normal knee kinematics. Noyes et al (1976), in a landmark article, reported an ultimate tensile load approaching 1,700+/- 660 N with the human femur-ACL tibia complex (FATC), in the younger age group (16-26 yrs). However Woo et al (1991) have shown significantly higher values 2,160+/-157N, which is dependent on the orientation of the tensile force. Lower values being quoted with the tensile force in line with the tibia (tibial orientation), rather than along the axis of the ACL (anatomical orientation), which in theory involves more of the ACL fiber bundles. Interestingly Woo et al quote a figure of 1,602+/-167N, close to Noyes results, with the force applied in the tibial orientation. The stiffness was quoted as 242+/-28 N/mm and 218+/-27 N/mm in anatomical and tibial orientation respectively in Woo et al paper and 182+/-56 N/mm by Noyes et al. Increasing the flexion of the knee has been shown to reduce the ultimate tensile load and stiffness of the ACL in the tibial orientation (Figgie et al 1986). Of particular importance is that increasing age had a significant effect on
reducing the structural properties of the bone –ACL – bone complex, as shown in Table 1. In addition, the study by Woo et al (1991) found most of the younger age group failed at the bone ligament interface unlike mid-substance tears with the older group, particularly when the tensile force was applied in the tibial orientation.

**TABLE NO.1**

Effect of age on ACL structural properties

<table>
<thead>
<tr>
<th></th>
<th>23-35 yrs</th>
<th>40-50 yrs</th>
<th>60-97 yrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>UTL (N)</td>
<td>2,160+/-157</td>
<td>1,503+/-83</td>
<td>658+/-129</td>
</tr>
<tr>
<td>Stiffness(N/mm)</td>
<td>242+/-28</td>
<td>220+/-24</td>
<td>180+/-25</td>
</tr>
<tr>
<td>Mean Energy to failure N-m</td>
<td>11.6</td>
<td>6.1</td>
<td>1.8</td>
</tr>
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UTL-Ultimate Tensile Load
KNEE JOINT KINEMATICS

In the sagittal plane the knee moves by a combination of rolling and gliding movements due to the shape of the femoral condyles and corresponding tibial plateau. In the sagittal plane the femoral condyles are eccentrically curved, being flatter anteriorly and describe an oval posteriorly, they are more curved. Rolling occurs in the initial stage of the flexion while gliding at the later stages due to less surface contact with the tibia. Muller\textsuperscript{33} likened this changing axis of rotation to a crossed four-bar link with a fixed vertical limb (Figure.6). The crossed bars correspond to the course of the cruciate ligaments and the fixed limb representing their femoral bony origin in the intercondylar notch. However, there is increasing dissatisfaction with this theory. Amis has been stated true ACL isometricity does not exist and similarly the PCL shows non-isometry (Amis 1997)\textsuperscript{34}. Thus these crossed bars are not made of rigid construct as Muller has hypothesized.

In the horizontal plane, on reaching terminal extension, internal femoral condyle rotation (or external tibial rotation) is seen i.e. “the screw home mechanism”. This was due to the large medial femoral condyle with its corresponding concave tibial plateau. The smaller lateral tibial plateau is slightly convex. This configuration affords greater medial femoral- tibial contact, facilitating internal femoral rotation on terminal extension (Ellison and Berg 1985)\textsuperscript{35}.
FOUR BAR LINKAGE SYSTEM

Fig.6. A. with the knee in extension the anteromedial and posterolateral femoral insertions are oriented vertically and the bundles are parallel.

B. with the knee in flexion the anteromedial and posterolateral insertions are oriented horizontally and bundles are crossed.

The absence or the deficiency of the ACL following injury leads not only to an episodic instability but also a consistently altered joint mechanics. This results in asynchronous movement of the knee in loading, leading to functional instability and unphysiological loading of articular cartilage, secondary meniscal tears, subchondral trabecular fractures and ultimately results in accelerated osteoarthritis of the knee joint.
The goal of ACL reconstruction should be to prevent symptomatic instability, restoration of normal knee kinematics and prevention of premature degenerative joint disease.

FUNCTIONS OF ACL

They are

1. The ACL is the primary restraint to anterior tibial translation on femur in flexion (clinically assessed by the anterior drawer test). With the ACL resisting 86% of the total resisting forces on the anterior drawer test.
2. Preventing the hyperextension of the knee.
3. Checking the internal axial rotation of tibia and thereby it affords rotatory knee control acting as a secondary restraint to prevent excessive valgus and varus.
4. Fine tuning of the screw home stabilization of the knee joint as it approaches terminal extension.
5. Proprioceptive properties.

The internal tension of the ACL is not constant in all areas of knee joint motion. It is maximally tensed at about 60 degrees of knee flexion. Anterior tibial displacement on the femur (anterior drawer sign) con not be elicited the AMB is torn.
Butler and co-workers\textsuperscript{33} found that at 30 degrees flexion (Lachman sign), 85\% of the restraining force of anterior tibial displacement was provided by ACL. Forced hyperextension concentrates stress in mid-substance of the ligament. Cutting of the ACL can produce genu recurvatum\textsuperscript{20}.

ACL tightens maximally on internal rotation of the tibia and sectioning of ACL allows 8 degrees of excessive internal rotation in full extension. Pivot shift is a reversal of screw home movement where the lateral tibial plateau is allowed to subluxate in internal rotation in extension.

The ACL offers a secondary restraint to excessive varus and valgus stresses, significant only after collateral ligament compromise. In this function both cruciates tend to act in concert through all ranges of motion. They offer a greater resistance to valgus force than varus force.

\textbf{Proprioceptive function of ACL}

Neural receptors or stretch receptors are found within the ACL. These neural elements are primarily found within invaginations in the ligament near the tibial insertion of ACL. Neural structures are also found in the synovial tissues\textsuperscript{20}.

These receptors were identified as fusiform nerve endings consisting of a single axon wrapped in a fibrous capsule, similar to the golgi tendon organ\textsuperscript{38}. The long axis of the structure being parallel to the ligament, where they can register the greatest potential
changes in the stresses associated with flexion and rotational movement of the joint. These receptors influence the activity of the synergist of ACL. All proprioceptive studies of ACL indicate that this ligament has more than purely mechanical stabilizing function, and that it additionally performs an important function of proprioceptive control.

The rupture of the ACL leads not only to a loss of stability with the disintegration of the rolling–gliding mechanism but also to a loss of its proprioceptive protective function. This has important clinical relevance for ACL reconstruction because its proprioceptive functions are permanently lost and cannot be restored by any therapeutic procedure.

**MECHANISM OF INJURY**

ACL and PCL injuries are significant events that can occur with virtually any mechanism of injury, if the force is sufficient to cause permanent deformation. As a rule ligaments can stretch to 10-25% of the usual resting length.

Mechanism of injury can either be direct or indirect. Palmer described four mechanisms of injury to the ligament[39].

1. Abduction, Flexion and Internal rotation of femur on tibia.
2. Abduction, Flexion and External rotation of femur on tibia.
3. Hyperextension.
4. Antero-posterior displacement.
Abduction, flexion and internal rotation is the commonest mechanism and if the injury is severe it can result in the “O’DONOGHUE” triad i.e. an injury to ACL, MCL and medial meniscus\textsuperscript{40}. Hyperextension is the second most common mechanism of injury to the ACL. Disagreements still exist about the incidence of isolated tears. All supporting structures about the knee function in concert and probably no single ligament can be disrupted without sustaining some degree of injury to the other supporting structures. The injury to the supporting structure may be minimal and may heal with conservative measures leaving what is apparently and isolated injury of the ACL on clinical examination.

**Clinical evaluation of ACL injuries**

Despite advances in the technology the mainstay in the proper diagnosis and treatment remains the ability to accurately evaluate the patient’s complaints and perform a thorough clinical examination.

The typical history of an ACL rupture is:

- History of twisting or hyperextension injury
  - Pop in the knee at the time of injury
  - Inability to continue the previous activity.

De Haven\textsuperscript{41}, Noyes et al have indicated that the ACL is injured in approximately 70% of all knees with acute haemarthrosis. Development of post – traumatic effusion
occurs within the first 12-24 hours. Patient with chronic ACL tears present with swelling of the knee with or without effusion, history of giving way, recurrent falls and locking.

**Lachman test**

**Described by Torg et al**

It is the most sensitive maneuver for eliciting the ACL disruption in an acute setting, when the knee is swollen and painful, in which considerable knee motion is too painful to be tolerated.

The patient is supine with the knee flexed to 15-20 degrees. The femur is stabilized with one hand and a 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 examining hand is important in performing the test properly. One hand should firmly stabilize the femur while the other grips the proximal tibia in such way that the thumb lies on the anteromedial joint line. When an anteriorly directed lifting force is applied by the palm and fingers anterior translation of the tibia on the femur can be palpated by the thumb. Anterior translation of the tibia with a soft or mushy end indicates a positive test. When viewed from the lateral aspect, silhouette of the inferior pole of the patella, patellar tendon, and the proximal tibia shows a slight concavity with the disruption of the ACL the anterior translation of the tibia obliterates the patellar tendon slope.
Grading of the test

0…………… Normal laxity
1+ …………. Anterior translation of less than 0.5 cm
2+…………… Anterior translation of 0.5-1 cm
3+…………….. Anterior translation of 1-1.5 cm
4+ …………. Anterior translation more than 1.5 cm

In patients with large thigh, if the examiners hand con not encompass 50% of the thigh the test is not reliable. In this situation, the examiner uses his thigh as a bench for performing the test. One hand stabilizes the patient’s femur of the examinees thigh while the other hand applies the stress.
LACHMAN TEST

Small degrees of anterior translation of the tibia on the femur may be better detected in a relatively extended position, where the door stopper effect of the posterior horn of the meniscus is obliterated\textsuperscript{42}.
Anterior drawer Test.

It is carried out with the patient supine, hip flexed to 45 degrees and the knee flexed to 90 degrees with the foot on the top of the table. The examiner sits on the dorsum of the foot to stabilize it and places both the hand behind the knee to feel for the relaxation of the hamstrings. The proximal part of the leg is then pushed anteriorly and posteriorly gently to note the movement of the tibia on the femur with foot in neutral position\textsuperscript{39}.

An anterior draw of 6-8 mm. greater than the opposite side indicates a torn ACL. However before applying anterior stress the examiner must make sure that the tibia is not sagging posteriorly due to a laxity of the PCL. If a positive anterior drawer is not accompanied by a pivot shift phenomena, PCL insufficiency exists unless proven otherwise.

Sometimes there is a discrepancy between the lachman test and the anterior drawer test. This has been attributed to a differential injury to the anteromedial and the posterolateral bundle of the ACL. A negative Lachman test indicates an intact posterolateral bundle while a positive anterior drawer test indicates a torn anteromedial bundle.
ANTERIOR DRAWER TEST

Demonstration of anterior drawer test

Anterior drawer test A, In resting position, tibial plateau is held in normal position by intact posterior cruciate ligament. B and C with anterior cruciate insufficiency, tibia can be pulled forward against force of gravity and tone of flexors.
A, With knee flexed to 90 degrees for classic anterior drawer sign, medial meniscus, being attached to tibia, abuts against acutely convex surface of medial femoral condyle and has “doorstop” effect, preventing or hindering anterior translation of tibia. B, With knee extended, relationships are changed. Comparatively flat weight bearing surface of femur does not obstruct forward motion of meniscus and tibia when anterior stress is applied

**Slocum Rotatory Anterior Drawer Test** 43

Slocum has shown that varying the rotation of the tibia on the femur as the anterior drawer test is performed is valuable in determining the rotator instability of the knee. The degree of anterior displacement of the tibia on the femur is noted as the test is performed in 15 degree of internal rotation and 30 degree of external rotation. A positive anterior drawer test in neutral rotation is accentuated when the test is performed in 30 degrees of external rotation and reduced in 15 degrees of internal rotation indicates an anteromedial rotatory instability. The opposite indicates an anterolateral rotatory instability.
Jerk Test of Hughston and Losee\textsuperscript{44,45}

This is performed with the patient supine and the examiner supporting the lower extremity flexing the knee to 90 degrees and internally the tibia. When the right knee is being examined, the foot is grasped with the right hand and the tibia is internally rotated while exerting a valgus force with the left hand over the proximal tibia. Then the knee is extended gradually maintaining the internal rotation and valgus stress, when the test is positive, the lateral tibia spontaneously subluxes forwards in the form of a sudden jerk at approximately 30 degrees of flexion.

Lateral Pivot shift test of Macintosh\textsuperscript{46}

The foot is lifted with the knee extended (dislocation phase), leg is internally rotated and a valgus stress is applied to the lateral side of the leg in the region of the fibular neck with the opposite hand. The knee is then slowly flexed while the valgus and internal rotation is maintained. This leads to a tilting of the posterior border of the tibia, a rise of tension in the iliotibial tract and impingement of the posterior tibia border on the lateral femoral condyle (tension phase). If the test is positive then a reduction of the tibia occurs at approximately 30 degrees of flexion. At 30 degrees of flexion the iliotibial tract 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 (reduction phase).

The factors contributing to the occurrence of the pivot shift phenomena are:
Illiotibial tract.

Convex shape of the lateral tibial plateau

Action of the biceps femoris and the popliteus

An isolated tear of the ACL produces only a small subluxation, greater sublaxation occurs when lateral capsular complex or the semimembranosus corner is deficient. Severe valgus instability may make the test difficult to elicit because of lack of medical support.

Lateral pivot shift test
Slocum Modification\textsuperscript{43}.

The patient is placed in a lateral decubitus with the affected side up. Roll the patient’s pelvis 30 degrees posteriorly and place the medical side of the foot on the firm examining table with the knee in full extension. This position eliminates the rotation effect of the hip and allows the knee to fall into a valgus position and internally rotates the tibia on the femur. The hands are placed with the thumb on each of the femoral and tibial sides and the index finger across the joint. The knee is then gently pressed forward into flexion. A positive test is present when the reduction occurs as the knee passes 25-40 degrees of flexion.
Flexion Rotation Drawer Test

Described by Noyes it tests the functions of the ACL in two planes. The antero-posterior and femoral rotation, and it is positive when other test of ACL are negative. It combines the features of the Lachmann test and the Hughstons pivot shift test.

With the patient supine and the knee at 0 degrees, lift the leg upwards allowing the femur to fall back and externally rotate. This results in anterolateral tibial sublaxation as the starting point of the test. While the knee is flexed, the tibia moves backwards and the femur rotate internally causing the joint to reduce when the test is positive. Mild valgus stress and anterior pressure on the calf with the examiners hand may be applied to elicit a positives test.

For an acutely injured knee lachman Test is the Primary test as the patient is unable to flex the knee beyond 30 degree without considerable discomfort.

On physical examination, patient with chronic ACL tear will more often have a positive anterior drawer and pivot shift phenomena than patients with an acutely injured knee. The presence of joint line tenderness should alert one to the possibility of meniscal tears or joint fibrosis.

Those patients whose main complaints are episodes of instability and whose feeling of instability is re-created when the pivot shift maneuver is performed will benefit from ACL reconstruction.
In those, whose, symptoms are from meniscal tears, patello-femoral pain, or joint arthrosis, decision making is more difficult. If signs and symptoms of clear cut giving way are the most prominent complaints, this group will benefit from ACL reconstruction even if they have some joint fibrosis. If the main complaint is pain and degree of instability has diminished because of the arthritic process, treatment should be directed towards the cause of pain and not towards ACL deficiency.

**Quantitative evaluation of ACL laxity:**

Quantitative evaluation of laxity can be done using stress arthrometers such as KT-1000 or UCLA portable instrumented clinical knee testing apparatus or Radiographic Laxiometry. In radiographic Laxiometry, the distance between the most posterior points of the tibial condyle and the corresponding femoral condyle is measured. In a normal stable knee, both points should lie in the same line, but if a pathological drawer displacement is present, the lines will be separated by a measurable distance.
**IMAGING STUDIES**

Most often x rays are normal, but occasionally one will see a SEGOND sign, also known as the lateral capsular sign, where a small fleck of bone is raised from the lateral tibial plateau. This is pathognomonic for an ACL tear.

MRI is very good for demonstrating the status of the ACL and the menisci, but there is little reason to use it to determine the status of the ACL, since one should be able to do this on physical examination.

The radiographic changes include:

- Avulsion, prominence or spurring of intercondylar spines
- Narrowing of intercondylar notch
- Notching of lateral femoral condyle
- Arthritic changes, initially in lateral compartment
TREATMENT OPTIONS

The management goal of the ACL – injured patients is to prevent recurrent knee injury while allowing the patient to return to his desired work and level of sports participation. Some patients are able to cope with their inquiry without sustaining further injuries. Younger, more active individuals who are unwilling to modify their activity level should be considered for surgical management.

NON–OPERATIVE

- INDICATIONS
  - Those with isolated injury, intrinsic damage or partial tear who are willing to modify their activities that cause pain, swelling and instability

- AIM
  - Resolve inflammation
  - Restore range of motion
  - Regain muscle power
  - Protecting knee from further injury

OPERATIVE METHODS

1. Direct repair
2. Repair with augmentation
3. Reconstruction – Extra – articular
   - Macintosh
   - Modified Macintosh
   - Andrews
SURGICAL MANAGEMENT OF ACL INJURIES

REVIEW OF LITERATURE

Galen first described the structure of Anterior Cruciate Ligament in a cadaver knee in 170.A.D\textsuperscript{47}

In Europe Professor Amedee Bonnet\textsuperscript{56} in France described ACL rupture in 1845 with a description of Bracing by J Stark from Edinburgh in 1850. The first primary repairs in Britain were performed by Mayo Robertson in 1895 and WH Battle in 1900, who used a silk suture to repair an ACL which was avulsed from its femoral origin in association with a medical collateral ligament injury in a 50 years old woman at St. Thomas’s Hospital, London. In Europe the first prosthetic reconstruction occurred in Germany by Fritzlanger in 1903 using silk and in Britain E Corner in 1914 used silver wire\textsuperscript{56}.

In 1917, Hey Groves reported on methods for reconstructing the ACL\textsuperscript{48}. His techniques consisted of routing a proximally based strip of Iliotibial band through a femoral and tibial tunnel to reconstruct the ACL. This technique was successful in treating a patient who had been injured by a horse. In 1920 Hey Groves modified his technique by using a distally based strip of Iliotibial band to reconstruct the ACL and using the semitendinosus and Gracilis tendons to reconstruct the PCL\textsuperscript{49}. In this paper, he described the anatomy, mechanism of injury, and method of diagnosing cruciate ligament injuries. Of the 14 patients who were operated on only 4 showed no benefit. The Hey Groves operation has formed the basis for modern techniques of intraarticular cruciate ligament reconstruction.
The concept of intra articular stabilization of the ACL deficient knee became popular during the 1920s and 1930s. In 1936 Campbell described an operation for reconstruction of the ACL using a distally based graft formed by the medial portion of the Patellar tendon, capsule, and quadriceps tendon routed through femoral and tibial tunnels. He reported excellent results of ACL reconstruction on nine knees. Campbell advocated ligament reconstruction in young athletes in whom conservative treatment was unsuccessful.

In 1938, Palmer reported work in knee ligament injuries, which laid the foundation for our current knowledge of knee ligament surgery. He discussed the anatomy, biomechanics, and physiology of knee ligaments and methods for their surgical repair of cruciate ligaments, including a drill guide. He stressed the importance of early diagnosis and repair of acute knee injuries.

In 1956, Augustine described a technique for dynamic ACL reconstruction. His procedure called for releasing the semitendinosus distally and then directing it through the back of the knee and forward through a tibial tunnel. Inherent to his technique was the need for the patient strengthening in order to obtain good results.

During the 1950s, O’Donoghue did much to advance the study of the knee. In 1950 he reported on his experience in treating the actively injured knee and went on to describe the classic “unhappy triad”, consisting of rupture of the ACL and Medical Collateral ligament and tear of the Medical Meniscus. He emphasized, early diagnosis and prompt layer by layer operative repair.
In 1963, O’Donoghue reported a method for reconstruction of the ACL using a distally based strip of iliotibial band routed through the Tibal tunnels. In 1963, Jones introduced the concept of using the central third of the Patellar tendon to reconstruct the ACL. His technique involved leaving a distally based strip of patellar tendon with an attached block of bone form the Patella, which was routed through the lateral femoral condyle. The femoral tunnel was placed anterior to the anatomic site of the ACL origin because of the shortness of the graft. In light of this, most of his patients were unable to regain full range of knee motion, but most were able to return to sports.

In 1968, Lam modified the Jones procedure and placed the graft in a more anatomic locations. A comparative study of the two procedures showed that Lam’s technique achieved a better range of motion.

In 1973, Nicholas described the five in one procedure for repairing of anteromedial rotatory instability of the knee. The procedure included total meniscectomy, advancement of the femoral attachments of the medial collateral ligament, distal and forwards advancement of the posteromedial capsule, advancement of the Vastusmedialis and pes anserinus transfer. Although symptoms and stability improved in most of Nichols’s patient, stability was not completely restored. Of 52 patients who underwent operation, 43 were able to return to sports, but since Nicholas’s study no further series have substantiated his results.
Cho in 1975 sparked interest in using a distally base semitendinosus tendon as graft of ACL reconstruction\textsuperscript{53} in the late 1970s, other investigators developed techniques for using the central third of the patellar tendon based on the early work of Campbell and jones. Eriksson, using a modification of the Jones procedure, achieved stability in 80 percent of the knee he studies\textsuperscript{54}.

In 1981, Insall et al described ACL reconstruction using a proximally based strip of lliotibial band, with a block of bone from the tibial tubercle transferred through the intercondylar notch and attached to the anterior aspect of the tibia.\textsuperscript{55}

Much of the other work done in the 1980s centered around the development of prosthetic ligaments, Jenkin and Mckibbin, Rusthton et al and others used carbon fiber as ligament replacement and to augment reconstruction. This material induced fragmentation and synovitis. Park et al Rodkey et al., Rubbin etal, and Ubbu tested Dacron. Woods et al and James used Proplast as a cruciate ligament stent with limited success: and Kennedy et al, successfully used a polypropyle device to augment an intra-articular ACL reconstruction. Bolton and bruchman have developed a polytetrafluoroethylene (Govortex) prosthetic ACL\textsuperscript{56,57,58}

In 1983, Clancy and colleagues published a series of 80ACL reconstruction using the medial third of the patellar tendon\textsuperscript{11}. They advanced the medical third of the patellar tendon through a tunnel in the anterior tibia and harvested the proximal
portion of the graft with block of patellar bone to permit bony union between the proximal end of the graft and the tunnel in the lateral femoral condyle. Clancy further modified his technique by detaching the distal end of the graft from the tibial tubercle. This established the bone tendon-bone graft, which has become the standard for patellar tendon reconstruction of the ACL. Clancy obtained excellent or good results in 47 of 50 patients 33 months after surgery.

With early work by Noeyes showing semitendinosus to have 50% of strength of ACL, Lipscomb in 1982 described a combined semitendinouses and gracilis (STG) tendon graft with good results. In 1980 Puddu described the method of ACL Reconstruction using semitendinosus tendon and in 1988 Friedman first described the 4 stranded double looped STG format for Arthroscopy guided ACLR. Dr. Tom Rosenberg, Salt Lake City, Utah, has popularized the use of four stranded semitendinosus graft using the endo–button technique.

The most recent advance in ACL reconstruction is the development of the single–incision, or endoscopic technique and Computer Assisted ACL Reconstruction as described by Rosenberg, Olson et al., and Paulo’s et al. These endoscopic techniques are an attempt to reduce the morbidity of ACL reconstruction further by avoiding a lateral femoral incision and its associated dissection.

Freedman et al. (Freedman 2003) found in a Meta analysis that patellar tendon autografts had a significantly lower rate of graft failure and resulted in better static knee stability and increased patient satisfaction compared with hamstring tendon autografts.
ACL reconstruction using bone patellar tendon bone graft

The bone-patellar tendon-bone is the most commonly used autograft for reconstruction\textsuperscript{19}. The bone-patellar tendon-bone autograft has been widely accepted as the gold standard for ACL reconstruction with a high success rate\textsuperscript{21}. The bone–patellar tendon–bone graft usually is an 8- to 11-mm-wide graft taken from the central third of the patellar tendon, with its adjacent patella and tibial bone blocks. This graft's attractive features include its high ultimate tensile load (approximately 2300 N), its stiffness (approximately 620 N/mm), and the possibility for rigid fixation with its attached bony ends and early incorporation. However, donor site morbidities and extensor mechanism problems associated with the use of the bone-patellar tendon-bone are the two most commonly encountered problems.

Morbidity associated with the Harvest of bone patellar tendon bone graft

Harvest Site Morbidity:

The main disadvantage of the patellar tendon graft is the harvest site morbidity. The problems produced by the harvest are patellar tendonitis, quadriceps weakness, anterior knee pain\textsuperscript{62,63,64}. Persistent tendon defect, patellar fracture, patellar tendon rupture, patellar entrapment, and arthrofibrosis. The common long-term problem is kneeling pain.

Kneeling Pain

The most common complaint after patellar tendon harvest is kneeling pain. This can be reduced by harvesting through two transverse incisions.

This reduces the injury to the infrapatellar branch of the saphenous nerve.
Patellar Tendonitis

Pain at the harvest site will interfere with the rehabilitation program. The strength program may have to be delayed until this settles. The problem is usually resolved in the first year, but it can prevent some high performance athletes from resuming their sport in that first year.

Quadriceps Weakness

The quadriceps weakness may be the result of pain and the inability to participate in a strength program. If significant patellofemoral symptoms develop, the athlete may be unable to exercise the quads.

Persistent Tendon Defect

If the defect is not closed, there may be a persistent defect in the patellar tendon. This results in a weaker tendon.

Patella Entrapment

If the defect is closed too tight, the patella may be entrapped, and patellar infera may result. This will certainly result in patellofemoral pain, because of an increase in patellofemoral joint compression.

Tendon Rupture This may occur if a very large graft is taken from a small tendon. Mechanical cause is the most possible reason for this complication.
Graft Fixation

In the early weeks after surgery, the weakest links in reconstruction are the fixation sites, not graft tissue itself.

Fixation of replacement grafts can be classified into direct and indirect methods.

Direct fixation devices include interference screws, staples, washers, and cross pins

Indirect fixation devices include polyester tape–titanium button and suture-post.

In our study we have used titanium interference screw for both tibial side and for femoral side fixation

INTERFENCE SCREW ensures tibial and femoral fixation of the graft.
Biology of graft healing:

Biology of integration based upon histological study, the ACL graft is seen to undergo four phases of integration. In the early, acute inflammatory process, ischemic necrosis occurs. With cell recruitment and chronic inflammation there is revascularization, cell proliferation and finally collagen remodeling.

The pattern of change within the body of autograft tendon when it is transplanted into a human recipient has been classically described as ‘ligamentisation’.

This reflects the morphological changes within the tendon, which shows an increase in fibroblast ingrowth and MRI changes which may represent enhanced shear resistance and increased vascularity.

Histologically, there is predominantly fibroblastic ingrowth for the first two months, followed by graft remodeling with neovascularity and areas of necrosis over the next ten months.

Finally, there is steady maturation of the graft over the next two years. The transplanted graft has been found to undergo a process of complete metaplasia to a ligamentous structure within three years of implantation\textsuperscript{66}.
MATERIALS AND METHODS

Between July 2009 to June 2011 all patients who underwent arthroscopic assisted ACL reconstructions using the bone-patellar tendon-bone autograft in the Department of Orthopaedics and Traumatology, Katuri Medical College, China Kondrupadu, Guntur, Andhra Pradesh is the material in our study.

No. of Cases : 30 cases

Duration of study: July 2009 to June 2011.

Inclusion Criteria

All patients with ACL Tear…

Who are in the age groups between 18 to 45 years.

With history of repeated & episodic knee instability (ACL tear)

With no evidence of clinical and radiological degenerative change in the knee joints

Exclusion criteria included

Patients with ACL tear in age groups less than 18 and greater than 45 years

Patients with ACL tears with associated injuries of tibial or femoral condyles

Patients with ACL tears with Tricompartmental osteo-arthritis of knee joint

Contralateral ACL deficiency

Bilateral ACL reconstruction

Revision ACL surgery
Previous knee operation

Concomitant extra-articular reconstruction

Concomitant medical illness or geographic constraints that precluded follow up evaluations.

METHODS

After the patient is clinically and radiologically (magnetic resonance imaging) diagnosed to have tear, and after meeting inclusion criteria, the patients were taken up for ACL reconstruction. All the patients were followed up at regular interval i.e. 3 months, 6 months, 12 months and 18 months and 24 months (prospective study).

In our study we have used autologous, ipsilateral bone-patellar tendon-bone graft in all the patients for ACL reconstruction. In all the patients the graft is fixed with titanium interference on femoral and tibial sides.
EVALUATION OF RESULTS

All the patients were evaluated periodically at 3 months, 6 months, 12 months, 18 months and 24 months. The minimum period of follow up was 6 months.

The standard protocol of Lysholm knee scoring system is used for evaluation of the results of the surgery during follow up. At each follow up along with subjective evaluation, the following clinical examinations were also done.

- Ligament laxity was assessed using Lachman’s test, anterior drawer’s test and pivot shift test.
- Range of motion of the operated knee was noted and compared with the opposite knee.
- Knee extension or straight leg raising (quadriceps power) was assessed.

SURGICAL TECHNIQUE

The anterior cruciate ligament was reconstructed with a single-incision, arthroscopic assisted techniques. Prophylactic antibiotic was given prior to the skin incision. The portals used for arthroscopy included the anteromedial portal and anterolateral portal. We used to do diagnostic arthroscopy prior to harvesting of the graft and any meniscal pathology will be addressed.

The bone-patellar tendon-bone autograft was harvested via a longitudinal incision (usually 4-5 cm in length) over the patellar tendon. The graft was prepared
into a bone-patellar tendon-bone construct with the leading suture on the patellar side\textsuperscript{67-70}.

The notch was prepared using a curette and motorized shaver until the over-the-top position and femoral ACL footprint were clearly demonstrated.

The tibial stump was cleaned leaving a short amount of stump for reference and covering the graft. The tibial guide pin was inserted to the posterior half of the remnant using the Acufex-elbow-tipped tibial guide and tibial tunnel reamed according to the size of the graft. With the knee flexed at 90 degrees, a guide pin was passed through the tibial tunnel to the femoral tunnel position. The femoral tunnel was reamed according to the size of the graft.

Using a suture passing pin, the graft was passed through the tibial tunnel into the femoral tunnel and the suture passing pin passing out distal to the anterolateral skin of the thigh.

The fixation method for patellar tendon graft was a cannulated interference screw usually 9 × 30 mm. The femoral site was fixed at 120 degrees knee flexion with the screw guide pin passed through the tibial tunnel. After femoral fixation, tension was applied to the tibial bone block suture and the knee passed through several cycles of flexion-extension to pretension the graft. The tibial site was fixed at 20 degrees knee flexion.

After the procedure, an intra-articular vacuum drain was placed into the joint. The drain was removed at 24-48 hours postoperatively. The knee was placed in a compressive dressing and hinge knee brace locked in full extension.
INTRAOPERATIVE PHOTOGRAPHS

Position and Making portals of Arthroscopy

Arthroscopic view of complete Graft harvested

ACL tear

After harvesting Inserting the Tibial Screw Arthroscopic view

BPTB Graft BPTB Graft
Staging of Rehabilitation:

PHASE I (0-2 weeks)

Immediate postoperative goals

- Full extension
- Flexion > 90
- Full weight bearing

Activities

- Prone heel hangs
- Passive ROM
- Quadriiceps sets
- Straight leg raises
- Patellar mobilization exercises

PHASE II (2-6 weeks)

Early phase

GOALS

- Normal gait
- Normal full range of motion
- Achieve normal gait

**ACTIVITIES**

- Above exercises +
- Formal physical therapy
- Closed chain knee extension
- Prone open chain knee flexion
- Stair steeper
- Stationary bike

**PHASE III (6 weeks – 4 months)**

**Middle phase**

**GOALS**

- Maximize strengthening and endurance
- Increase sport specific activities and improve confidence in knee

**ACTIVITIES**

- Continue strengthening
- Begin running
- Slide board
Functional testing

Stage IV (4 months – 8 months)

LATE PHASE

GOALS

- If no pain, swelling or instability returned to sport

ACTIVITIES

- Return to sport
- Continue strengthening to >80% of strength
CASE # 1

Name: M kurminaidu  
IP No.: 09187  
Age/Sex: 23/Male  
D.O.A.: 29/03/2010  
Occupation: Student  
D.O.S.: 12/04/2010  
ADDRESS: Nellimarla vzm  
Side: Left  

PRESENTING COMPLAINTS

TYPES OF INJURY

Twisting YES

Hyperextension

NATURE OF INJURY

Sports YES

motor vehicle work

other

Pain (yes/no) YES

Effusion immediately (yes/no)

hours after injury (yes/no) YES

able to get up and walk (yes/no) YES

local treatment take (yes/no) NO

massage (yes/no)

splintage (yes/no)

aspiration (yes/no) NO

contents blood/nil

CLINICAL EXAMINATION

Swelling and effusion (yes/no) NO

Tenderness over joint line (yes/no) NO
Lachman test  +VE  Anterior drawer test  +VE
Posterior drawer test  -VE
Pivot shift test  +VE  McMurray’s test  -VE
Varus instability test  -VE  Valgus instability test  -VE

ARTHROSCOPY
Date:  12-04-2010

Findings
Supra patellar pouch:  NORMAL
Patellar tracking:  NORMAL
Lateral compartment:  NORMAL
Medial compartment:  NORMAL
Anterior cruciate ligament:  COMPLETELY TORN
Posterior cruciate ligament:  NORMAL
Loose bodies :  NO

POST OPERATIVE FOLLOW UP*  Exercises done regularly
(yes/no):  YES

*follow up done at regular interval and noted LYSHOLM SCORE, ANTERIOR
DRAWER TEST, PIVOT SHIFT TEST, QUADRICEPS STRENGTH.
showing complete ACL tear

x-ray Left knee AP and Lateral view

Per Operative Graft Preparation

Arthroscopic picture showing complete ACL tear
Post operative rehabilitation

post operative on knee brace

Post op 3rd month follow up
CASE # 2

Name: N apparao               IP No.: 14799
Age/Sex: 31/Male               D.O.A.: 15/06/2009
Occupation: constable          D.O.S.: 02/07/2009
ADDRESS: grivi vzm             Side: Right

PRESENTING COMPLAINTS

TYPES OF INJURY

Twisting   YES
Hyperextension

NATURE OF INJURY

Sports YES
motor vehicle work
other

Pain (yes/no) YES
Effusion immediately (yes/no)

hours after injury (yes/no) YES
able to get up and walk (yes/no) YES
local treatment take (yes/no) NO
massage (yes/no)
splintage (yes/no)
aspiration (yes/no) NO
contents blood/nil

CLINICAL EXAMINATION

Swelling and effusion (yes/no) NO
Tenderness over joint line (yes/no) NO
<table>
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<tr>
<th>Test</th>
<th>Result</th>
<th>Test</th>
<th>Result</th>
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<tr>
<td>Lachman test</td>
<td>+VE</td>
<td>Anterior drawer test</td>
<td>+VE</td>
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<td>Posterior drawer test</td>
<td>-VE</td>
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<td>Pivot shift test</td>
<td>+VE</td>
<td>McMurray’s test</td>
<td>+VE</td>
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<td>Varus instability test</td>
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<td>Valgus instability test</td>
<td>-VE</td>
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<td>Grinding test</td>
<td>+VE</td>
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**ARTHROSCOPY**

Date: 02-07-2009

**Findings**

- Supra patellar pouch: NORMAL
- Patellar tracking: NORMAL
- Lateral compartment: NORMAL
- Medial compartment: NORMAL
- Anterior cruciate ligament: COMpletely TORN
- Posterior cruciate ligament: NORMAL
- Femoral condyle: NORMAL
- Tibial condyles: NORMAL
- Loose bodies: NO

**POST OPERATIVE FOLLOW UP**

Exercises done regularly

(Yes/No): YES

*Follow up done at regular interval and noted Lysholm score, anterior drawer test, pivot shift test, quadriceps strength.
Pe - operative graft preparation  post operative x ray photograph

Post-operative rehabilitation  Post-operative straight leg raising

Post Operative squatting  post operative ACL laxity testing
CASE # 3

Name: M prasad
IP No.: 12981
Age/Sex: 31/Male
D.O.A.: 08/05/2010
Occupation: teacher
D.O.S.: 19/05/2010
ADDRESS: Nellimarla
Side: LEFT

PRESENTING COMPLAINTS

TYPES OF INJURY

Twisting         YES
Hyperextension

NATURE OF INJURY

Sports
motor vehicle work YES
other

Pain (yes/no) YES

Effusion                     immediately (yes/no)

hours after injury (yes/no)  YES
able to get up and walk (yes/no)  YES
local treatment take (yes/no)  NO

massage (yes/no)  
splintage (yes/no)  
aspiration (yes/no)  NO
contents         blood/nil

CLINICAL EXAMINATION

Swelling and effusion (yes/no)  NO
Tenderness over joint line (yes/no)  NO
Lachman test +VE  Anterior drawer test +VE
Posterior drawer test -VE
Pivot shift test +VE  McMurray’s test -VE
Varus instability test -VE  Valgus instability test -VE
Grinding test -VE

ARTHROSCOPY
Date: 19-05-2010

Findings
Supra patellar pouch: NORMAL
Patellar tracking: NORMAL
Lateral compartment: NORMAL
Medial compartment: NORMAL
Anterior cruciate ligament: COMPLETELY TORN
Posterior cruciate ligament: NORMAL
Femoral condyle: NORMAL
Tibial condyles: NORMAL
Loose bodies : NO

POST OPERATIVE FOLLOW UP*  Exercises done regularly
(Yes/no): YES

*follow up done at regular interval and noted LYSHOLM SCORE, ANTERIOR DRAWER TEST, PIVOT SHIFT TEST
Post operative x-ray photograph

Arthroscopic picture  Post operative knee flexion

Post operative straight leg raising
CASE # 4

Name: M satish  
IP No.: 04266
Age/Sex: 20/Male  
D.O.A.: 10/02/2010
Occupation: student  
D.O.S.: 14/02/2010
ADDRESS: rajam, sklm  
Side: Right

PRESENTING COMPLAINTS

<table>
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<tr>
<th>TYPES OF INJURY</th>
<th>NATURE OF INJURY</th>
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<tbody>
<tr>
<td>Twisting</td>
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<tr>
<td>Hyperextension</td>
<td>motor vehicle work</td>
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</table>

Pain (yes/no) YES
Effusion immediately (yes/no) YES
hours after injury (yes/no) YES
able to get up and walk (yes/no) YES
local treatment take (yes/no) NO

massage (yes/no) splintage (yes/no) aspiration (yes/no) NO
contents blood/nil

CLINICAL EXAMINATION

Swelling and effusion (yes/no) NO
Tenderness over joint line (yes/no) NO
Lachman test  +VE    Anterior drawer test  +VE
Posterior drawer test  +VE
Pivot shift test  +VE    McMurray’s test  -VE
Varus instability test  -VE    Valgus instability test  -VE
Grinding test  -VE

ARTHROSCOPY
Date:  14-02-2010

Findings
Supra patellar pouch:  NORMAL
Patellar tracking:  NORMAL
Lateral compartment:  NORMAL
Medial compartment:  NORMAL
Anterior cruciate ligament:  COMPLETELY TORN
Posterior cruciate ligament:  NORMAL
Femoral condyle:  NORMAL
Tibial condyles:  NORMAL
Loose bodies :  NO

POST OPERATIVE FOLLOW UP*    Exercises done regularly
(yes/no):  YES

*follow up done at regular interval and noted LYSHOLM SCORE, ANTERIOR DRAWER TEST, PIVOT SHIFT TEST, QUADRICEPS STRENGTH
Post operative rehabilitation

Post operative photographs showing complete flexion and cross leg sitting
CASE # 5

<table>
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<tr>
<th>Name:</th>
<th>V nookaraju</th>
<th>IP No.:</th>
<th>12727</th>
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<tr>
<td>Age/Sex:</td>
<td>24/Male</td>
<td>D.O.A.:</td>
<td>30/04/2010</td>
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<td>Occupation:</td>
<td>Conductor</td>
<td>D.O.S.:</td>
<td>10/05/2010</td>
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<td>ADDRESS:</td>
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PRESENTING COMPLAINTS

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<th>TYPES OF INJURY</th>
<th>NATURE OF INJURY</th>
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<tr>
<td>Twisting</td>
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<tr>
<td>Hyperextension</td>
<td>Sports, motor vehicle work, YES, other</td>
</tr>
</tbody>
</table>

Pain (yes/no)       YES
Effusion immediately (yes/no)

hours after injury (yes/no)   YES
able to get up and walk (yes/no)   YES
local treatment take (yes/no)   NO
massage (yes/no)               
splintage (yes/no)             

aspiration (yes/no) NO
contents blood/nil

CLINICAL EXAMINATION

Swelling and effusion (yes/no) NO
Tenderness over joint line (yes/no) NO
Lachman test  +VE       Anterior drawer test  +VE
Posterior drawer test -VE
Pivot shift test  +VE       McMurray’s test        +VE
Varus instability test -VE       Valgus instability test -VE
Grinding test    +VE

ARTHROSCOPY

Date:  10-05-2010

Findings

Supra patellar pouch:   NORMAL
Patellar tracking:      NORMAL
Lateral compartment:    NORMAL
Medial compartment:     NORMAL
Anterior cruciate ligament:   COMPLETELY TORN
Posterior cruciate ligament:   NORMAL
Femoral condyle:        NORMAL
Tibial condyles:        NORMAL
Loose bodies :          NO

POST OPERATIVE FOLLOW UP*   Exercises done regularly

(yes/no):  YES

*follow up done at regular interval and noted LYSHOLM SCORE, ANTERIOR DRAWER TEST, PIVOT SHIFT TEST, QUADRICEPS STRENGTH
x-ray Right Knee AP and Lateral view

Post operative photographs of knee flexion and straight leg raising

Post operative flexion photograph
CASE # 6

Name: Chanda Mabubi  IP No. 09384
Age/Sex: 26/Female  D.O.A.: 30/03/2010
Occupation: House Wife  D.O.S.: 07/04/2010
ADDRESS: Nakarikallu, Guntur  Side: Right

PRESENTING COMPLAINTS

TYPES OF INJURY  NATURE OF INJURY
Twisting YES  Sports
Hyperextension  motor vehicle work

Pain (yes/no) YES
Effusion immediately (yes/no)
hours after injury (yes/no) YES
able to get up and walk (yes/no) YES
local treatment take (yes/no) NO
massage (yes/no)
splintage (yes/no)
aspiration (yes/no) NO
contents blood/nil

CLINICAL EXAMINATION
Swelling and effusion (yes/no) NO
Tenderness over joint line (yes/no) NO
Lachman test +VE  Anterior drawer test +VE
Posterior drawer test -VE
Pivot shift test -VE  McMurray’s test +VE
Varus instability test -VE  Valgus instability test -VE
Grinding test +VE

**ARTHROSCOPY**

Date: 07-04-2010

**Findings**

Supra patellar pouch: NORMAL
Patellar tracking: NORMAL
Lateral compartment: NORMAL
Medial compartment: NORMAL
Anterior cruciate ligament: COMPLETELY TORN
Posterior cruciate ligament: NORMAL
Femoral condyle: NORMAL
Tibial condyles: NORMAL
Loose bodies : NO

**POST OPERATIVE FOLLOW UP**

Exercises done regularly

(yes/no): YES

*follow up done at regular interval and noted LYSHOLM SCORE, ANTERIOR DRAWER TEST, PIVOT SHIFT TEST, QUADRICEPS STRENGTH*
x-ray Right knee AP and Lateral view

MRI showing ACL tear

Post-operative photograph

Post operative cross leg sitting

Post operative ACL laxity testing

Post operative ACL laxity testing
CASE # 7

<table>
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<th>Name:</th>
<th>Y nagaraju</th>
<th>IP No.:</th>
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<td>D.O.A.:</td>
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<td>Occupation:</td>
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<td>ADDRESS:</td>
<td>denkada, vzm</td>
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**PRESENTING COMPLAINTS**

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<th>NATURE OF INJURY</th>
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<tr>
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</tr>
<tr>
<td>Hyperextension</td>
<td>Sports YES</td>
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Pain (yes/no) YES

Effusion immediately (yes/no) YES

hours after injury (yes/no) YES

able to get up and walk (yes/no) YES

local treatment take (yes/no) NO

massage (yes/no) splintage (yes/no) aspiration (yes/no) NO

contents blood/nil

**CLINICAL EXAMINATION**

Swelling and effusion (yes/no) NO
Tenderness over joint line (yes/no)  NO

Lachman test  +VE  Anterior drawer test  +VE

Posterior drawer test  -VE

Pivot shift test  +VE  McMurray’s test  +VE

Varus instability test  -VE  Valgus instability test  -VE

Joint & Tendon test  +VE

**ARTHROSCOPY**

Date:  05-10-2009

**Findings**

Supra patellar pouch:  NORMAL

Patellar tracking:  NORMAL

Lateral compartment:  NORMAL

Medial compartment:  NORMAL

Anterior cruciate ligament:  COMPLETELY TORN

Posterior cruciate ligament:  NORMAL

Femoral condyle:  NORMAL

Tibial condyles:  NORMAL

Loose bodies:  NO

**POST OPERATIVE FOLLOW UP***  Exercises done regularly

(Yes/no):  YES

*follow up done at regular interval and noted LYSHOLM SCORE, ANTERIOR DRAWER TEST, PIVOT SHIFT TEST, QUADRICEPS STRENGTH
x-ray Right knee AP and Lateral view

Arthroscopic Picture  Surgery Photograph

Post operative photograph showing complete flexion and straight leg raising
CASE # 8

Name:  s santosh  IP No.:  07937
Age/Sex:  24/Male  D.O.A.:  17/03/2010
Occupation:  Home Guard  D.O.S.:  30/03/2010
ADDRESS:  cheepurupalli, vzm  Side:  Right

PRESENTING COMPLAINTS

TYPES OF INJURY
Twisting  YES
Hyperextension

NATURE OF INJURY
Sports YES
motor vehicle work

Pain (yes/no)  YES
Effusion  immediately (yes/no)
hours after injury (yes/no)  YES
able to get up and walk (yes/no)  YES
local treatment take (yes/no)  NO
massage (yes/no)
splintage (yes/no)
aspiration (yes/no)  NO
contents  blood/nil

CLINICAL EXAMINATION

Swelling and effusion (yes/no)  NO
Tenderness over joint line (yes/no)  NO
Lachman test Anterior drawer test +VE
Posterior drawer test -VE
Pivot shift test -VE McMurray’s test +VE
Varus instability test -VE Valgus instability test -VE
Grinding test +VE

ARTHROSCOPY

Date: 30-03-2010

Findings

Supra patellar pouch: NORMAL
Patellar tracking: NORMAL
Lateral compartment: NORMAL
Medial compartment: NORMAL
Anterior cruciate ligament: COMPLETELY TORN
Posterior cruciate ligament: NORMAL
Femoral condyle: NORMAL
Tibial condyles: NORMAL
Loose bodies: NO

POST OPERATIVE FOLLOW UP* Exercises done regularly
(yes/no): YES

*follow up done at regular interval and noted LYSHOLM SCORE, ANTERIOR DRAWER TEST, PIVOT SHIFT TEST, QUADRICEPS STRENGTH
x-ray Right knee AP and Lateral view

Arthroscopic Picture

Arthroscopic Picture

MRI Film showing ACL Tear

Post operative squatting and knee flexion
CASE # 9

Name: G Shankararao  
IP No.: 15928  

Age/Sex: 27/Male  
D.O.A.: 27/06/2009  

Occupation: Bus driver  
D.O.S.: 01/07/2009  

ADDRESS: Vadlapadu, Guntur  
Side: Left  

PRESENTING COMPLAINTS

TYPES OF INJURY                  NATURE OF INJURY

Twisting   YES                 Sports

Hyperextension                  motor vehicle work YES

Pain (yes/no) YES

Effusion immediately (yes/no)

hours after injury (yes/no) YES

able to get up and walk (yes/no) YES

local treatment take (yes/no) NO

massage (yes/no)

splintage (yes/no)

aspiration (yes/no) NO

contents blood/nil

CLINICAL EXAMINATION

Swelling and effusion (yes/no) NO
Tenderness over joint line (yes/no)  NO

Lachman test  +VE  Anterior drawer test  +VE
Posterior drawer test  -VE
Pivot shift test  -VE  McMurray’s test  +VE
Varus instability test  -VE  Valgus instability test  -VE
Grinding test  +VE

**ARTHROSCOPY**

Date:  01-07-2009

**Findings**

Supra patellar pouch:  NORMAL
Patellar tracking:  NORMAL
Lateral compartment:  NORMAL
Medial compartment:  NORMAL
Anterior cruciate ligament:  COMPLETELY TORN
Posterior cruciate ligament:  NORMAL
Femoral condyle:  NORMAL
Tibial condyles:  NORMAL
Loose bodies :  NO

**POST OPERATIVE FOLLOW UP***  Exercises done regularly
(yes/no):  YES

*follow up done at regular interval and noted LYSHOLM SCORE, ANTERIOR DRAWER TEST, PIVOT SHIFT TEST, QUADRICEPS STRENGTH
x-ray Right knee AP and Lateral view

Arthroscopic Picture

Post-operative complete extension and complete flexion
CASE # 10

Name: pydiraju  IP No.: 17943
Age/Sex: 24/Male  D.O.A.: 16/06/2010
Occupation: teacher  D.O.S.: 22/06/2010
ADDRESS: rajam, sklm  Side: Right

PRESENTING COMPLAINTS

TYPES OF INJURY                      NATURE OF INJURY
Twisting  YES                      Sports YES
Hyperextension

Pain (yes/no)  YES
Effusion  immediately (yes/no)

hours after injury (yes/no)  YES
able to get up and walk (yes/no)  YES
local treatment take (yes/no)  NO
massage (yes/no)  

Clintage (yes/no)
aspiration (yes/no)  NO

CLINICAL EXAMINATION

Swelling and effusion (yes/no)  NO
Tenderness over joint line (yes/no)  NO

Lachman test  +VE  Anterior drawer test  +VE
Posterior drawer test  -VE
Pivot shift test  +VE  McMurray’s test  +VE
Varus instability test  -VE  Valgus instability test  -VE
Grinding test  +VE

ARTHROSCOPY
Date:  22-06-2010

Findings
Supra patellar pouch:  NORMAL
Patellar tracking:  NORMAL
Lateral compartment:  NORMAL
Medial compartment:  NORMAL
Anterior cruciate ligament:  COMPLETELY TORN
Posterior cruciate ligament:  NORMAL
Femoral condyle:  NORMAL
Tibial condyles:  NORMAL
Loose bodies :  NO

POST OPERATIVE FOLLOW UP*  Exercises done regularly
(yes/no):  YES

*follow up done at regular interval and noted LYSHOLM SCORE, ANTERIOR DRAWER TEST, PIVOT SHIFT TEST, QUADRICEPS STRENGTH
x-ray Right knee AP and Lateral view

MRI showing ACL tear

Harvesting graft

Suture removal

Post operative squatting

Testing for ACL laxity
CASE # 11

Name: kiran kumar  
IP No.: 34210
Age/Sex: 26/Male  
D.O.A.: 28/12/2009
Occupation: photographer  
D.O.S.: 01/01/2010
ADDRESS: palakonda, sklm  
Side: Right

PRESENTING COMPLAINTS

<table>
<thead>
<tr>
<th>TYPES OF INJURY</th>
<th>NATURE OF INJURY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Twisting</td>
<td>Sports</td>
</tr>
<tr>
<td>Hyperextension</td>
<td>motor vehicle work</td>
</tr>
<tr>
<td></td>
<td>other</td>
</tr>
</tbody>
</table>

Pain (yes/no) YES
Effusion immediately (yes/no)

hours after injury (yes/no) YES
able to get up and walk (yes/no) YES
local treatment take (yes/no) NO
massage (yes/no)
splintage (yes/no)
aspiration (yes/no) NO
contents blood/nil

CLINICAL EXAMINATION

Swelling and effusion (yes/no) NO
Tenderness over joint line (yes/no) NO
Lachman test  +VE  Anterior drawer test  +VE
Posterior drawer test  -VE
Pivot shift test  +VE  McMurray’s test  +VE
Varus instability test  -VE  Valgus instability test  -VE
Grinding test  +VE

ARHTHROSCOPY

Date:  06-09-2008

Findings

Supra patellar pouch:  NORMAL
Patellar tracking:  NORMAL
Lateral compartment:  NORMAL
Medial compartment:  NORMAL
Anterior cruciate ligament:  COMPLETELY TORN
Posterior cruciate ligament:  NORMAL
Femoral condyle:  NORMAL
Tibial condyles:  NORMAL
Loose bodies :  NO

POST OPERATIVE FOLLOW UP*

Exercises done regularly

(yes/no):  YES

*follow up done at regular interval and noted LYSHOLM SCORE, ANTERIOR DRAWER TEST, PIVOT SHIFT TEST, QUADRICEPS STRENGTH
MRI showing ACL tear

post operative x ray photograph

Arthroscopic Picture

post operative complete flexion photograph

Post-operative Photograph

post operative complete extension
CASE # 12

Name: naveen IP No.: 16230
Age/Sex: 35/Male D.O.A.: 29/06/2009
Occupation: Painter D.O.S.: 05/07/2009
ADDRESS: phoolbaugh, vzm Side: Right

PRESENTING COMPLAINTS

TYPES OF INJURY NATURE OF INJURY
Twisting YES Sports YES
Hyperextension motor vehicle work
other

Pain (yes/no) YES
Effusion immediately (yes/no)

hours after injury (yes/no) YES
able to get up and walk (yes/no) YES
local treatment take (yes/no) NO
massage (yes/no)
splintage (yes/no)
aspiration (yes/no) NO
contents blood/nil

CLINICAL EXAMINATION

Swelling and effusion (yes/no) NO
Tenderness over joint line (yes/no) NO
Lachman test  +VE  Anterior drawer test  +VE
Posterior drawer test  +VE
Pivot shift test  -VE  McMurray’s test  +VE
Varus instability test  -VE  Valgus instability test  -VE
Grinding test  +VE

**ARTHROSCOPY**

Date: 05-07-2009

**Findings**

Supra patellar pouch:  NORMAL
Patellar tracking:  NORMAL
Lateral compartment:  NORMAL
Medial compartment:  NORMAL
Anterior cruciate ligament:  COMPLETELY TORN
Posterior cruciate ligament:  NORMAL
Femoral condyle:  NORMAL
Tibial condyles:  NORMAL
 Loose bodies :  NO

**POST OPERATIVE FOLLOW UP***

Exercises done regularly

(yes/no):  YES

*follow up done at regular interval and noted LYSHOLM SCORE, ANTERIOR DRAWER TEST, PIVOT SHIFT TEST, QUADRICEPS STRENGTH
MRI showing ACL tear

Arthroscopic picture

x-ray Right knee AP and Lateral view

Per operative graft harvest

Immediate Post-operative Photograph

post operative cross leg sitting

post operative complete flexion
OBSERVATIONS AND RESULTS

In our study of Arthroscopic Cruciate Ligament reconstruction using autologous bone-pattellar tendon-bone graft, a total of 30 cases were operated and followed up. Minimum follow up period was six months and maximum follow up period was twenty four months period.

1. AGE DISTRIBUTION

Majority of patients i.e. 13 (43.34%) patients in our study were in the age group of 18-24 years, 9 (30%) were in the age group of 25-31 years, 4 (13.33%) were in the age group of 32-38 and 4 (13.33%) were in the age group of 39-45.

TABLE NO. 2: AGE GROUP (n=30)

<table>
<thead>
<tr>
<th>AGE GROUP (YRS)</th>
<th>NO. OF PATIENTS</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-24</td>
<td>13</td>
<td>43.34%</td>
</tr>
<tr>
<td>25-31</td>
<td>09</td>
<td>30.00%</td>
</tr>
<tr>
<td>32-38</td>
<td>04</td>
<td>13.33%</td>
</tr>
<tr>
<td>39-45</td>
<td>04</td>
<td>13.33%</td>
</tr>
</tbody>
</table>
2. SEX DISTRIBUTION

Male predominance was found in our study. 29 (96.6%) patients were males and 1 (3.4%) patient was female. This probably because males are more frequently involved in sports and road traffic accidents.

**TABLE NO. 3: SEX DISTRIBUTION (n=30)**

<table>
<thead>
<tr>
<th>Sex</th>
<th>No. of PTS</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>29</td>
<td>96.6%</td>
</tr>
<tr>
<td>Female</td>
<td>1</td>
<td>3.4%</td>
</tr>
</tbody>
</table>
FIGURE 8: BAR Diagram showing the SEX DISTRIBUTION

FIGURE 9: PIE Diagram showing the SEX DISTRIBUTION
3. LATERALITY

Left knee were affected in 12 (40%) patients and Right knee were affected in 18 (60%) patients. There was not much difference in lateralization of the injury.

TABLE NO. 4: LATERALITY (n=30)

<table>
<thead>
<tr>
<th>SIDE</th>
<th>No. of PTS</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left</td>
<td>12</td>
<td>40%</td>
</tr>
<tr>
<td>Right</td>
<td>18</td>
<td>60%</td>
</tr>
</tbody>
</table>

FIGURE 10: Column diagram showing the LATERALITY
4. ASSOCIATED INJURIES

Twelve patients in our study had isolated ACL tears and rest had associated injuries to menisci in ipsilateral knee. Two patients had associated lateral meniscal tears, sixteen patients had medial meniscal tears.

TABLE NO. 5: ASSOCIATED INJURIES (n=30)

<table>
<thead>
<tr>
<th>STRUCTURES INVOLVED</th>
<th>No. of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISOLATED ACL TEAR</td>
<td>12</td>
</tr>
<tr>
<td>ACL+LM TEAR</td>
<td>2</td>
</tr>
<tr>
<td>ACL+MM TEAR</td>
<td>16</td>
</tr>
</tbody>
</table>
AVERAGE LYSHOLM SCORE

We have used the Lysholm score for subjective evaluation of all our patients at each follow up. The following are the parameters and the maximum points given for each. Parameters (100 points)

1) Limp (5 points)
2) Support (5 points)
3) Stair climbing (10 points)
4) Squatting (5 points)
5) Instability (30 points)
6) Pain (30 points)
7) Swelling (10 points)
8) Atrophy of thigh (5 points)

In our study Lysholm score was done at 3 months, 6 months, 1 year, 18 months and 2 years. Average Lysholm score at 3 months was 81.6, at 6 months 84.43, at 1 year 94.9, 18 months 93.33 and at 2 years 95.

GRADING OF LYSHOLM SCORE

<table>
<thead>
<tr>
<th>Grade</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
<td>&lt;65 points</td>
</tr>
<tr>
<td>Fair</td>
<td>66 to 81 points</td>
</tr>
<tr>
<td>Fair to good</td>
<td>82 to 92 points</td>
</tr>
<tr>
<td>Good to excellent</td>
<td>93 to 97 points</td>
</tr>
<tr>
<td>Excellent</td>
<td>98 to 100 points</td>
</tr>
</tbody>
</table>
TABLE NO. 6: AVERAGE LYSHOLM SCORE (n=30)

<table>
<thead>
<tr>
<th>DURATION</th>
<th>AVERAGE LYSHOLM SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 months (n=30)</td>
<td>81.6</td>
</tr>
<tr>
<td>6 months (n=30)</td>
<td>84.43</td>
</tr>
<tr>
<td>1 year (n=20)</td>
<td>94.9</td>
</tr>
<tr>
<td>18 months (n=6)</td>
<td>93.33</td>
</tr>
<tr>
<td>2 years (n=5)</td>
<td>95</td>
</tr>
</tbody>
</table>

Other parameters were also used to evaluate the patients clinically

i. Instability was assessed using anterior drawer test, Lachman test and pivot shift test.

ii. Range of motion of the knee was compared with the contra lateral side.

iii. Quadriceps muscle strength was assessed by using MRC grading for muscle.

5. ANTERIOR DRAWER TEST

At 3 months follow up 28 (93.33%) patients had negative anterior drawer test. 2 (6.67%) patients had 1+ laxity. This is due to poor post-operative rehabilitation.
TABLE NO. 7: ANTERIOR DRAWER TEST AT 3 MONTHS FOLLOW UP (n=30)

<table>
<thead>
<tr>
<th>TEST RESULT</th>
<th>NO. OF PATIENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEGATIVE</td>
<td>28 (93.33)</td>
</tr>
<tr>
<td>1+</td>
<td>2 (6.67%)</td>
</tr>
</tbody>
</table>

TABLE NO. 8: ANTERIOR DRAWER TEST AT 6 MONTHS FOLLOW UP (n=30)

<table>
<thead>
<tr>
<th>TEST RESULT</th>
<th>NO. OF PATIENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEGATIVE</td>
<td>29 (96.6%)</td>
</tr>
<tr>
<td>1+</td>
<td>1 (3.4%)</td>
</tr>
</tbody>
</table>

At 6 months follow up 29 (96.6%) patients had negative anterior drawer test, 1 (3.4%) patients had mild (1+) laxity.
Anterior drawer test was negative in 29 (96.6%) patients. These patients had no instability at 1 year follow up during activities like running or climbing up and down stairs. 1 patient (3.4%) had 1+ laxity. These patients had no instability while walking. None of the patients had pivot shift test positive.

6. **RANGE OF MOTION OPERATED KNEE**

In our study of 30 patients, at 3 months follow up 27 (90%) patients had normal range of motion of the operated knee, at 6 months follow up 28 (93.34%) patients had equal range of motion compared to normal contra-lateral side, at 1 year follow up 29 (96.67%) patients had equal range of motion compared to contra-lateral side.
<table>
<thead>
<tr>
<th>DECREASED ROM</th>
<th>NO. OF PATIENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Decreased ROM</td>
<td>27 (90%)</td>
</tr>
<tr>
<td>Up to 10 degree</td>
<td>3 (10%)</td>
</tr>
</tbody>
</table>

**TABLE NO. 11: RANGE OF MOTION (ROM) OF OPERATED KNEE AT 6 MONTHS OF FOLLOW UP (n=30)**

<table>
<thead>
<tr>
<th>DECREASED ROM</th>
<th>NO. OF PATIENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Decreased ROM</td>
<td>28 (93.34%)</td>
</tr>
<tr>
<td>Up to 10 degree</td>
<td>1 (3.33%)</td>
</tr>
<tr>
<td>&gt;20 degree</td>
<td>1 (3.33%)</td>
</tr>
</tbody>
</table>
TABLE NO. 12: RANGE OF MOTION (ROM) OF OPERATED KNEE AT 1 YR FOLLOW UP (n=30)

<table>
<thead>
<tr>
<th>DECREASED ROM</th>
<th>NO. OF PATIENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Decrease ROM</td>
<td>29 (96.67%)</td>
</tr>
<tr>
<td>&gt;20 degree</td>
<td>1 (3.33%)</td>
</tr>
</tbody>
</table>

7. QUADRICEPS POWER

At 3 months follow up only 20 patients (66.67%) had grade of 5/5 (MRC) power in Quadriceps muscles this is because of poor rehabilitation. At 6 months 23 patients (76.67%) had grade 5/5 power. At 1 year follow up all the 16 patients (76.20%) had grade 5/5 power. This shows that there was significant improvement in Quadriceps muscle strength at long term follow up with good rehabilitation program.
TABLE NO. 13: QUADRICEPS POWER (MRC GRADE) AT 3 MONTHS (n=30)

<table>
<thead>
<tr>
<th>GRADE</th>
<th>NO. OF PATIENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/5</td>
<td>3 (10%)</td>
</tr>
<tr>
<td>4/5</td>
<td>7 (23.33%)</td>
</tr>
<tr>
<td>5/5</td>
<td>20 (66.67%)</td>
</tr>
</tbody>
</table>

TABLE NO. 14: QUADRICEPS POWER (MRC GRADE) AT 6 MONTHS (n=30)

<table>
<thead>
<tr>
<th>GRADE</th>
<th>NO. OF PATIENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/5</td>
<td>2 (6.67%)</td>
</tr>
<tr>
<td>4/5</td>
<td>5 (16.66%)</td>
</tr>
<tr>
<td>5/5</td>
<td>23 (76.67%)</td>
</tr>
</tbody>
</table>
TABLE NO. 15: QUADRICEPS POWER (MRC GRADE)
AT 1 YEAR (n=21)

<table>
<thead>
<tr>
<th>GRADE</th>
<th>NO. OF PATIENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/5</td>
<td>5 (23.80%)</td>
</tr>
<tr>
<td>5/5</td>
<td>16 (76.20%)</td>
</tr>
</tbody>
</table>

8. VARIOUS COMPLICATIONS

TABLE NO. 16: COMPLICATIONS

<table>
<thead>
<tr>
<th>COMPLICATIONS</th>
<th>NO. OF CASES</th>
<th>TREATMENT GIVEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior knee pain</td>
<td>03</td>
<td>NSAIDS</td>
</tr>
<tr>
<td>Infection (Superficial)</td>
<td>01</td>
<td>Intravenous antibiotics</td>
</tr>
<tr>
<td>Infection (Deep)</td>
<td>01</td>
<td>IV ANTIBIOTICS + debridement finally hardware removal</td>
</tr>
<tr>
<td>Extensor Lag</td>
<td>01</td>
<td>Rehabilitation</td>
</tr>
</tbody>
</table>
In the present study four complications were noted i.e.

1. Stiff knee and deep infection in one patient leading to graft morbidity and hard ware removal
2. Anterior knee pain
3. Superficial infection
4. Extensor Lag

Out of 30 patients, three patients developed anterior knee pain during first 3 months.

Treatment received in the form of Non Steroidal Anti Inflammatory Drugs and physical therapy and modified rehabilitation program to avoid any concentric – resisted quadriceps exercises, patients are relieved of pain by 6 months.

1 patient out of 30 developed superficial infection at tibial site and received treatment in the form of intravenous Ceftriaxone 1 gm twice a day for 10 days thereby infection subsequently subsided.

In the present study one case presented with stiff knee and deep infection for which debridement done and continuous suction and irrigation kept for 48 hours and intravenous antibiotics were kept. Patient had not regained range of motion and underwent another surgery for hardware removal.

In the present study one patient had Extensor lag and advised vigorous rehabilitation program.
DISCUSSION

The present study of Arthroscopic guided anterior cruciate ligament reconstruction using BPTB graft tendon grafts done during the period of July 2009 to June 2011, at Katuri Medical College & Hospital, Chinna Koduru Guntur District.

Outcome was measured using Lysholm knee score, Anterior drawer test, Range of motion of the knee joint and Quadriceps power of ipsilateral knee. And result of the present study was compared with studies of Patel et al. 2000, Jomha et al. 1999 and Bach et al. 1998.
<table>
<thead>
<tr>
<th>Author &amp; Year of Publisher</th>
<th>Graft used</th>
<th>Technique</th>
<th>Femoral Fixation</th>
<th>Tibial Fixation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patel 2000</td>
<td>Ipsilateral autogenous BPTB</td>
<td>Arthroscopic single incision</td>
<td>Interference screw</td>
<td>Interference screw</td>
</tr>
<tr>
<td>Jomha 1999</td>
<td>Ipsilateral autogenous BPTB</td>
<td>Arthroscopic single incision</td>
<td>Interference screw</td>
<td>Interference screw</td>
</tr>
<tr>
<td>Bach 19998</td>
<td>Ipsilateral autogenous BPTB</td>
<td>Arthroscopic single incision</td>
<td>Interference screw</td>
<td>Interference screw</td>
</tr>
<tr>
<td>Our Study</td>
<td>Ipsilateral autogenous BPTB</td>
<td>Arthroscopic single incision</td>
<td>Interference screw</td>
<td>Interference screw</td>
</tr>
</tbody>
</table>
### TABLE NO. 18: PATIENT VARIABLES

<table>
<thead>
<tr>
<th>Author &amp; Year of Publisher</th>
<th>No. of Patients</th>
<th>Follow up</th>
<th>Mean age at surgery</th>
<th>Mean Follow up interval (mo)</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patel 2000</td>
<td>32</td>
<td>73%</td>
<td>33 Years</td>
<td>70</td>
<td>75% Male</td>
</tr>
<tr>
<td>Jomha 1999</td>
<td>59</td>
<td>74%</td>
<td>26 Years</td>
<td>84</td>
<td>73% Male</td>
</tr>
<tr>
<td>Bach 1998</td>
<td>103</td>
<td>81%</td>
<td>25 Years</td>
<td>26</td>
<td>63% Male</td>
</tr>
<tr>
<td>Our Study</td>
<td>30</td>
<td>85%</td>
<td>28 Years</td>
<td>15</td>
<td>96.6% Male</td>
</tr>
</tbody>
</table>

Average age at surgery in the present study group was 28 years and that of Patel et al. 2000 was 33 years and that of Jomha et al. 1999 was 26 years and Bach et al. 1998 was 25 years.

Average duration of follow-up of the present study was 15 months with a minimum follow-up period 6 months and maximum follow-up period was 24 months. Average duration of follow-up Bach et al. 1998 was 26 months.
### TABLE NO. 19: REHABILITATION PROTOCOL

<table>
<thead>
<tr>
<th>Author &amp; Year of Publisher</th>
<th>Post-operative Weight Bearing</th>
<th>Post-operative CPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patel 2000</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Jomha 1999</td>
<td>NWD × 4 WEEKS</td>
<td>Used</td>
</tr>
<tr>
<td>Bach 19998</td>
<td>WBAT</td>
<td>Used</td>
</tr>
<tr>
<td>Our Study</td>
<td>NBW × 4 WEEKS</td>
<td>Not Used</td>
</tr>
</tbody>
</table>
### TABLE NO. 20: LYSHOLM KNEE SCORE

<table>
<thead>
<tr>
<th>Author &amp; Year of Published</th>
<th>Average LYSHOLM Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patel 2000</td>
<td>89</td>
</tr>
<tr>
<td>Jomha 1999</td>
<td>94</td>
</tr>
<tr>
<td>Bach 19998</td>
<td>90</td>
</tr>
<tr>
<td>Our Study</td>
<td>90</td>
</tr>
</tbody>
</table>

The measured Lysholm score of Patel et al. 2000 at the end of the study was 89, Jomha et al. 1999 at the end of the study was 94, Bach et al. 1998 at the end of the study was 90 and our study average Lyshom score at the end of the study is 90.
## TABLE NO. 21: COMPLICATIONS AND REOPERATION

<table>
<thead>
<tr>
<th>Author &amp; Year of Publisher</th>
<th>MUA</th>
<th>Deep Infection</th>
<th>HWR</th>
<th>No. of patients having complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patel 2000</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>N/A</td>
</tr>
<tr>
<td>Jomha 1999</td>
<td>8</td>
<td>2</td>
<td>12</td>
<td>31</td>
</tr>
<tr>
<td>Bach 19998</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>Our Study</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>6</td>
</tr>
</tbody>
</table>

**MUA** - Manipulation Under Anesthesia

**HWR** - Hard Ware Removal
TABLE NO. 22: MENISCAL DISEASE AT RECONSTRUCTION & HOW IT IS ADDRESSED

<table>
<thead>
<tr>
<th>Author &amp; Year of Publisher</th>
<th>Patients with Meniscal Tears(%)</th>
<th>Meniscal Tears treated by PMM(%)</th>
<th>Meniscal Tears treated by PLM(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patel 2000</td>
<td>40</td>
<td>77</td>
<td>23</td>
</tr>
<tr>
<td>Jomha 1999</td>
<td>N/A</td>
<td>31</td>
<td>25</td>
</tr>
<tr>
<td>Bach 19998</td>
<td>52</td>
<td>34</td>
<td>42</td>
</tr>
<tr>
<td>Our Study</td>
<td>60</td>
<td>89</td>
<td>11</td>
</tr>
</tbody>
</table>

PMM - Partial Medial Menisectomy
PLM - Partial Lateral Menisectomy

TABLE 23: Pivot Shift Examination

<table>
<thead>
<tr>
<th>Author and Year Published</th>
<th>Postoperative Grade (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Patel 2000</td>
<td>91</td>
</tr>
<tr>
<td>Jomha 1999</td>
<td>76</td>
</tr>
<tr>
<td>Bach 1998</td>
<td>91</td>
</tr>
<tr>
<td>Our Study</td>
<td>100</td>
</tr>
</tbody>
</table>

In the present study no patient had Pivot Shift Test positive Post-operatively
SUMMARY

The present study was conducted at Katuri Medical College & Hospital, Chinna Kondrupadu, Guntur, Andhra Pradesh. During the period of July 2009 to June 2011 and the title of the study is “Surgical Outcome following Anterior Crucitate Ligament Reconstruction using Autologous Ipsilateral Bone-Patellar Tendon-Bone Graft.

All the patients were selected into the study based on inclusion and exclusion criteria. The type of surgery was arthroscopic guided anterior cruciate ligament reconstruction with BPTB Graft. The fixation of the graft is achieved with canulated interference screw both proximally (femoral) and distally (tibial). All the patients were follow-up periodically 3 months, 6 months, 1 year, 18 months and 2 years.

In the present study, a total number of 30 patients underwent anterior cruciate ligament reconstruction with BPTB tendon grafts. Out of this 29 patients were male and 1 patient was female.

All the patients were kept on postoperative ACL rehabilitation protocol. Outcome was measured using Lysholm knee score, Anterior drawer test, Range of motion of the knee joint and Quadriceps power of ipsilateral knee.

The average Lysholm score in this present study group at various follow up periods were 81.6 at 3 months, 84.43 at 6 months, 94.9 at 1 year, 93.33 at 18 months and 95 at 2 years.

It is observed that anterior drawer test was negative in 93.33% of patients at 3 months, 96.6% of patients at 6 months and at 1 year 96.6% of patients had negative anterior drawer test.

Full range of motion attained in 90% of patients at 3 months, 93.34% of patients at 6 months and at 1 year 96.67% of patients. Postoperatively no patient in our study had pivot shift positive
CONCLUSIONS

- Majority of study subjects were males i.e., 29 out of 30 and female was one.
- Mean age was 27.9 years
- Only Thirteen patients had isolated ACL injury, remaining Seventeen patients had ACL associated injuries.
- Right side was affected in eighteen patients and left side in twelve patients.
- Most common mechanism of injury was activity of Road Traffic Accident twelve patients. Daily living accident in nine patients and sporting activity in nine patients.
- In our study there is much difference in the incidence of medial and lateral meniscal tears.
- In our study 20 percent of patients various complications like Anterior Knee Pain, Superficial infection and Deep infection
- Autologous ipsilateral bone patellar tendon bone graft is a good graft choice in arthroscopic ACL reconstruction
- The proximal and distal titanium interference screw provided good primary ACL graft fixation, which enabled immediate negation of anterior drawer and pivot shift tests.


ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION –

EVALUATE PROFORMA

Name : Proforma No. :

Age : O.P. No. :

Sex : I.P. No. :

Address :

PRESENTING COMPLAINTS

TYPES OF INJURY NATURE OF INJURY

Twisting Sports

Hyperextension Motor Vehicle

Work

Other

Pain

Effusion Immediately

Hours after injury (yes/no)

Able to get up and walk Yes/No

Local treatment take Yes/No

Massage Yes/No

Splintage Yes/No
Aspiration  Yes/No
Hours after injury
Contents  Blood/Nil
Analgesics  Yes/No
Advice Given  Details

CLINICAL EXAMINATION

Swelling and Effusion  :
Tenderness Over Joint Line  :
Patellar Tracking  :
Range of Movements  :
Lachman Test  :
Anterior Drawer Test  :
Posterior Drawer Test  :
Pivot Shift Test  :
McMurray’s Test  :
Medial Meniscus  :
Lateral Meniscus  :
Varus Instability Test  :
Valgus Instability Test  :
Girth of Thigh  :
Right  Left  :
Muscle wasting  :
Plain radiography  :
Stress radiography  :
MRI

ARTHROSCOPY

Date:
Interval between Injury and Arthroscopy :
Findings :
Supra patellar Pouch :
Patellar Tracking :
Lateral Compartment :
Medial Compartment :
Associated MCL Laxity : Yes/No
Repair Done : Yes/No
Anterior Cruciate Ligament : Yes/No
Repair Done : Yes/No
Anterior Cruciate Ligament :
Posterior Cruciate Ligament :
Femoral Condyles :
Tibial Condyles :
Loose Bodies :
Exercise Done Regularly :
**PHYSIO EVALUATION JUST BEFORE SURGERY**

**Date:**

<table>
<thead>
<tr>
<th>Parameter</th>
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</thead>
<tbody>
<tr>
<td>Swelling</td>
<td></td>
</tr>
<tr>
<td>Patellar Mobility</td>
<td></td>
</tr>
<tr>
<td>Range of Motion</td>
<td></td>
</tr>
<tr>
<td>Anterior Drawer</td>
<td></td>
</tr>
<tr>
<td>Posterior Drawer</td>
<td></td>
</tr>
<tr>
<td>Medical/Lateral Instability</td>
<td></td>
</tr>
<tr>
<td>Rotary Instability</td>
<td></td>
</tr>
<tr>
<td>Quadriceps Power</td>
<td></td>
</tr>
<tr>
<td>Hamstring Power</td>
<td></td>
</tr>
<tr>
<td>Stationary Bicycle</td>
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</table>
# LYSHOLM KNEE SCORE

<table>
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<tr>
<th>FOLLOW UP</th>
<th>3M</th>
<th>6M</th>
<th>1Y</th>
<th>18M</th>
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</table>

**LIMP**

<table>
<thead>
<tr>
<th>Description</th>
<th>3M</th>
<th>6M</th>
<th>1Y</th>
<th>18M</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Slight and / or Periodical</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Constant</td>
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</table>

**SUPPORT**

<table>
<thead>
<tr>
<th>Description</th>
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<th>6M</th>
<th>1Y</th>
<th>18M</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Stick or crutch</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Weight bearing impossible</td>
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</tbody>
</table>

**ATROPHY OF THIGH**

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<thead>
<tr>
<th>Description</th>
<th>3M</th>
<th>6M</th>
<th>1Y</th>
<th>18M</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>1-2 cm</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
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<tr>
<td>&gt;2 cm</td>
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</tbody>
</table>

**INSTABILITY**

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<tr>
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<th>6M</th>
<th>1Y</th>
<th>18M</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Giving Way</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
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<tr>
<td>Rarely During a Athletics or other Heavy</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Frequently During a Athletics or other Heavy</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
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<tr>
<td>Exertion</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Occasionally During Daily Activities</td>
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<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Often in Daily Activities</td>
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<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>At every Step</td>
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</table>

**PAIN DURING WALKING, RUNNING, JUMPING**

<table>
<thead>
<tr>
<th>Description</th>
<th>3M</th>
<th>6M</th>
<th>1Y</th>
<th>18M</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Activity</td>
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<tr>
<td>-------------------------------------------------------------------------</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inconstant and slight during heavy Exertion</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marked on giving way</td>
<td>20</td>
<td></td>
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</tr>
<tr>
<td>Marked During Heavy Exertion</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marked on or after walking more than 2 kms</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marked on or after walking less than 2 kms</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Constant</td>
<td>0</td>
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<tr>
<td><strong>SWELLING DURING WALKING, RUNNING, JUMPING.</strong></td>
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</tr>
<tr>
<td>None</td>
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<tr>
<td>With giving way</td>
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<tr>
<td>On Heavy Exertion</td>
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<td>On Normal Exertion</td>
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<tr>
<td>Constant</td>
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<tr>
<td><strong>STAIR CLIMBING</strong></td>
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<tr>
<td>No problems</td>
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<tr>
<td>Slightly Impaired</td>
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</tr>
<tr>
<td>One step at a time</td>
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<tr>
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<tr>
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<tr>
<td>Slightly impaired</td>
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</tr>
<tr>
<td>Not beyond 90</td>
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</tr>
<tr>
<td>Impossible</td>
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<tr>
<td><strong>Total</strong></td>
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<td>---------------------------</td>
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</tr>
<tr>
<td><strong>Fixed Flexion Deformity</strong></td>
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</tr>
<tr>
<td><strong>Range of Motion Compared with Opposite knee Extension</strong></td>
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<tr>
<td><strong>Equivalent</strong></td>
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<tr>
<td>&lt;10</td>
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<tr>
<td>&gt;10</td>
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</tr>
<tr>
<td>&gt;20</td>
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</tr>
<tr>
<td><strong>Lachman 0-30</strong></td>
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</tr>
<tr>
<td><strong>Anterior Drawer 60-90</strong></td>
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</tr>
<tr>
<td><strong>Varus/Valgus Instability</strong></td>
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</tr>
<tr>
<td><strong>Pivot Shift</strong></td>
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</tr>
<tr>
<td><strong>Quadriceps Strength (MRC Grading)</strong></td>
<td></td>
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</tr>
<tr>
<td><strong>anterior knee pain</strong></td>
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