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Study Of Arthroscopic Fixation Of Posterior Cruciate Ligament Tibial Avulsion Fractures Using Tightrope Like Device

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ABBREVEATIONS

Sr.No	Abbreviation	Full Form
1	AL	Anterolateral
2	ACL	Anterior cruciate ligament
3	BMI	Body Mass Index
4	CT	Computerized tomography
5	CDC	Centre for Disease Control
6	IKDC	International Knee Documentation Committee
7	KSS	Knee Society Score
8	MRI	Magnetic resonance imaging
9	PCL	Posterior cruciate ligament
10	PM	Posteromedial

11	WHO	World Health Organization

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INTRODUCTION

Avulsion fractures of the tibial insertion of the posterior cruciate ligament (PCL) are an infrequent injury in the Western world. The incidence this of fractures is much higher in countries like India or China because of two wheeler related injuries.[1]

"The posterior cruciate ligament (PCL) is an important stabilizer of the knee joint. PCL injury is less common and surgery on the PCL has seen to be less popular compared with other knee ligaments. The recent advances in understanding of PCL anatomy, biomechanics and imaging studies have begun to shift the paradigm of PCL injuries and reconstruction. PCL injuries is accounting for an estimated 3 per cent of all knee injuries and 37 per cent of soft-tissue knee injuries. [1] PCL avulsion from the posterior aspect of the proximal tibia presents a different group of injuries which has its own challenges."

The Posterior Cruciate Ligament serves as a primary restraint against posterior tibial translation and adjusts rotational movement in near extension. Once injured, a malfunctioning posterior cruciate ligament carries the potential for long-term instability, decreased activity level and degenerative changes.[2- 4]

Avulsion fractures of posterior cruciate ligament (PCL) represent a specific form of Posterior Cruciate Ligament injuries.[5]Improper treatment of this injury results in an incompetent Posterior Cruciate Ligament that leads to knee instability and secondary osteoarthritis.[6]

Many operative methods of these fractures are reported. Conventional techniques using direct posterior or posteromedial approach are widely used despite the potential risk of complication, such as damage to the neurovascular structure, tearing of the gastrocnemius muscle and scarring of the wound.[7,8]

Cancellous screws or cannulated screws are generally used for open reduction and internal fixation. However, screw fixation is indicated only for the large and non- comminuted fragment. Small or comminuted fragments are difficult to fix; in addition, there is a potential risk of fragmentation of the fracture fragment.[9]

Due to its deep location and the complexity of the adjacent anatomy, minimally invasive and arthroscopic techniques are gaining interest.[10, 11]

This growing popularity has prompted a rapid increase in arthroscopic techniques, albeit a paucity of studies exists regarding their clinical outcome.[12] Arthroscopic surgery has an advantage of less soft tissue damage, however, it requires specialized equipment and experience.[9]

The Tight Rope like device has recently gained popularity and has been well accepted for achieving solid fixation with good clinical results. This technique provides accurate reconstruction of the anatomic footprint and rigid fixation for early rehabilitation and it can address concomitant intra-articular lesions. It does not require an open approach or a second surgical procedure for hardware removal.[12]

In this technique, the tibial avulsion of the Posterior Cruciate Ligament is reduced under a direct arthroscopic view, offering the possibility to achieve re-fixation of the avulsion to the anatomic insertion site. The reduction also can be controlled with an intraoperative picture intensifier, enabling anatomic re-fixation. Even in the case of a comminuted fracture pattern, the Tight Rope device can be used because of the broad tibial insertion site of the Posterior Cruciate Ligament and its resulting ligamentotaxis, which helps to mold the bony fragments and facilitate reduction.[13]

Hence, the study was intended to bring out various advantages and disadvantages in study of arthroscopic fixation of PCL Tibial avulsion fractures using Tightrope like device.

AIMS AND OBJECTIVES

I. To evaluate the functional and radiological outcomes of arthroscopic fixation of Posterior Cruciate Ligament avulsion fractures with Tightrope like device.

II. To study the advantages and disadvantages of this technique.

III. To compare my study results with established literature

REVIEW OF LITERATURE

NORMAL ANATOMY OF KNEE JOINT

The knee is the largest joint in the body. It is a complex 'hinge' joint made up of the lower end of the femur, the upper end of the tibia and the patella, which slides in a groove on the end of the femur. The knee joint has three components, the lateral tibiofemoral, medial tibiofemoral and patellofemoral joints. Four bands of tissue, the anterior and posterior cruciate ligaments, and the medial and lateral collateral ligaments connect the femur and the tibia and provide joint stability.[14] (Fig. 1)

Strong thigh muscles give the knee, strength and mobility. The surfaces where the femur, tibia and patella touch are covered with articular cartilage, a smooth substance that cushions the bones and enables them to glide freely.

Semicircular rings of tough fibrous-cartilage tissue called the lateral and medial menisci act as shock absorbers and the bones of the knee are surrounded by a thin , smooth tissue capsule lined by a thin synovial membrane which releases a special fluid that lubricates the knee.[14]

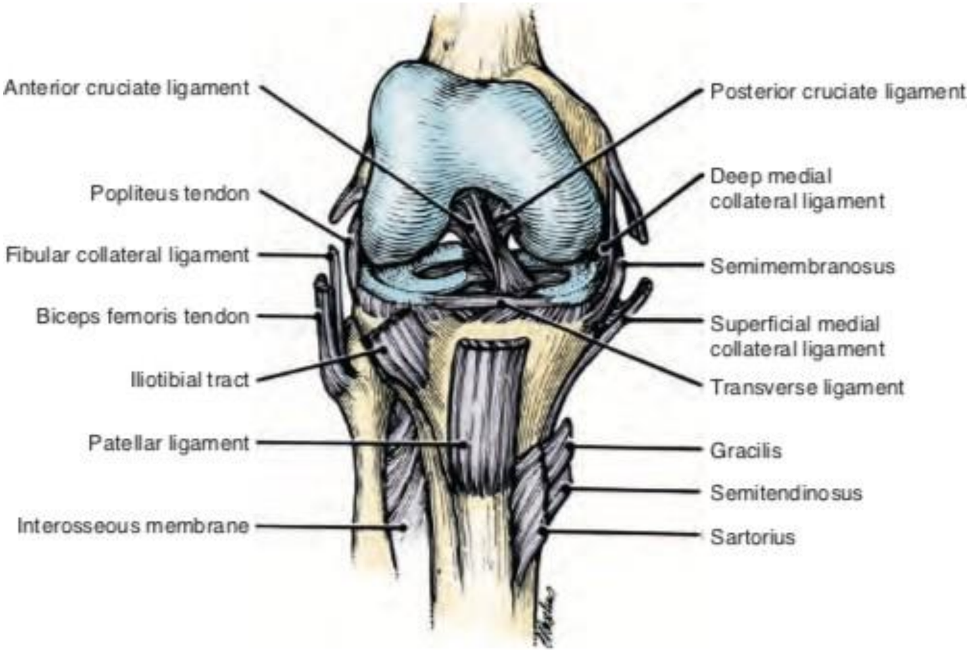

FIG-1 NORMAL HEALTHY KNEE
(From Scott WN: *Ligament and extensor mechanism injuries of the knee: diagnosis and treatment,* St Louis, MO, 1991, Mosby Year Book.)

TYPE OF JOINT:

Knee joint a synovial modified hinge joint, which also permits a small degree of rotation. In the knee joint, the femoral and tibial condyles articulate, as does the patella and patellar surface of the femur. Fibula does not contribute to theknee joint.[14] Fibrous capsule: It is attached superiorly to the femur about 1cm above the articular margin with three special features. It is attached to the margins of the articular surfaces except anteriorly, where it dips downwards. In the anterior part of the capsule there is a large opening through which the synovial membrane is continuous with the suprapatellar bursa. This bursa extends superiorly three finger breadths above the patella between the femur and quadriceps.[14] Posteriorly, the capsule communicates with another bursa under the medial head of gastrocnemius and often, through it, with the bursa of semimembranosus. Postero-laterally, another opening in the capsule permits the passage of the tendon of popliteus. The lateral expansions extend backwards on each side and downwards to the tibia forming medial and lateral patellar retinacula. On its deep surface, it is attached to periphery of each meniscus and connects it to adjacent margin of head of tibia; this connection is termed as coronary ligament. [14]

Ligamentum patellae: It is a strong, flat, ligamentous band, about 8 cm in length.[15] It is the central portion of common tendon of the quadriceps femoris, which is continued from the patella to the tuberosity of the tibia. The ligamentum patellae is related to the superficial and deep infra-patellar bursa and also to the infrapatellar pad of fat.

Extra capsular ligaments: The capsule of knee joint is reinforced by extra capsular ligaments (Fig-2) 15,16

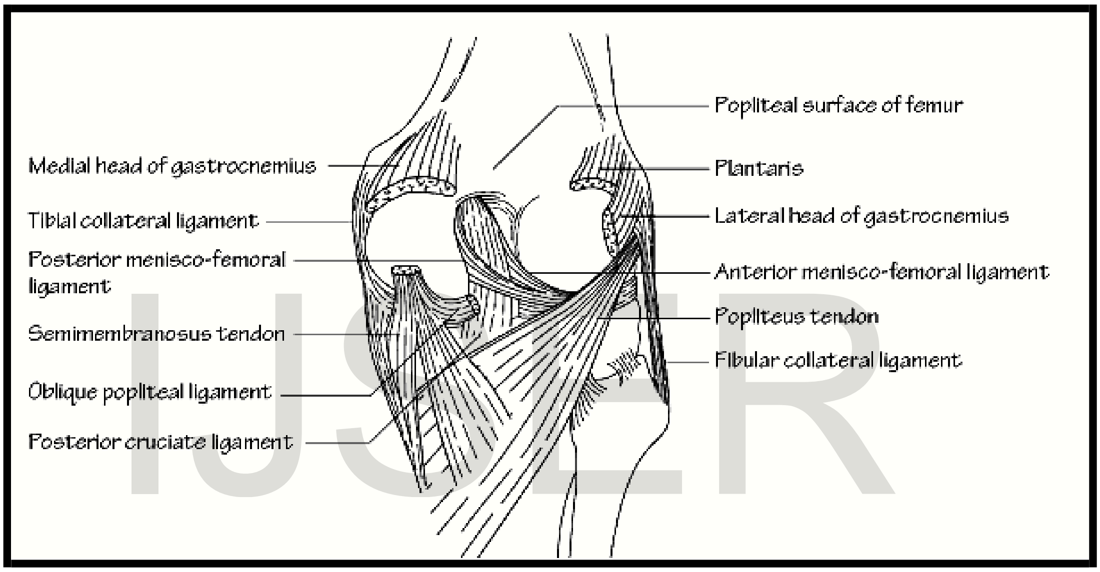

FIG 2: EXTRACAPSULAR LIGAMENTS OF KNEE[15]

The oblique popliteal ligament: This is an expansion from the tendon of semimembranosus. It runs upwards and laterally blending with the posterior surface of the fibrous capsule. It gets attached to the intercondylar line and the lateral condyle of femur. [14]

The arcuate popliteal ligament: It has Y shaped fibers, the stem of which is attached to the head of fibula. The posterior limb arches medially over tendon of popliteus to be attached to the posterior border of intercondylar area of tibia. The anterior limb, which is sometimes absent, extends to lateral epicondyle of femur where it is connected with lateral head of gastrocnemius. It is often termed short lateral ligament. **The fibular collateral ligament:** It is a strong, rounded cord, attached above, to the lateral epicondyle of the femur, immediately above the groove for the tendon of the popliteus and below, to the head of the fibula, in front of the apex. The greater part of it is hidden by the tendon of biceps femoris, which embraces and is attached to the ligament. The ligament has no attachment to the lateral meniscus.[17]

The tibial collateral ligament: It is a broad, flat band, situated nearer to the back than to the front of the joint. It is attached above, to the medial epicondyle of the femur immediately below the adductor tubercle; below, to the medial condyle and medial surface of the shaft of the tibia. It consists of anterior and posterior parts. The anterior part is flattened band and about 10cm long and is easily distinguished from the fibrous capsule which lies deep to it; one or more bursae may separate it from the fibrous capsule and medial meniscus. It is attached below to the medial border and posterior surface of the medial surface of tibia. It covers the medial geniculate vessels and nerve and the anterior part of the tendon of semimembranosus. It is crossed below by the tendons of sartorius, gracilis and semitendinosus. The posterior part of the ligament is short and blends with the capsule and the medial meniscus. It is attached to the medial surface of the tibia above the groove for the semimembranosus. 15,17

Intra capsular ligaments/cartilages: The cruciate ligaments and menisci are enclosed within the knee joint.

The anterior cruciate ligament: It passes from the front of the intercondylar area of the tibia to the medial side of the lateral femoral condyle. This ligament prevents hyperextension and resists forward movement of the tibia on the femur. [17]

The posterior cruciate ligament: It passes from the back of the intercondylar area of the tibia to the lateral side of the medial condyle. It becomes taut in hyper flexion and resists posterior displacement of the tibia on the femur. [17]

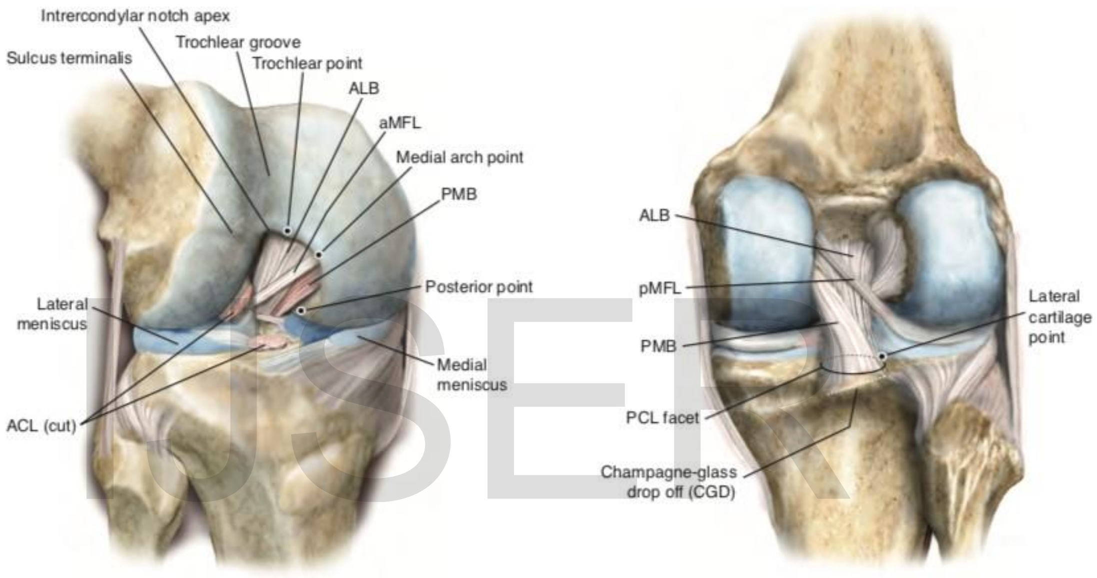

Figure 3: ANTERIOR AND POSTERIOR VIEW OF THE KNEE JOINT
(from Anderson CJ, Ziegler CG, Wijdicks CA, et al: Arthroscopically pertinent anatomy of the anterolateral and posteromedial bundles of the posterior cruciate ligament. *J Bone Joint Surg Am* 94:1936–1945, 2012.)

The menisci (semi-lunar cartilages):

These are crescentic fibro-cartilaginous ‘shock absorbers’ within the joint. They lie within deepened grooves on the articular surfaces of the tibial condyle. The medial meniscus is C shaped and larger than the lateral meniscus. It is broader and thicker posteriorly. The lateral meniscus is smaller, thicker and forms a complete ring. Either meniscus may occasionally appear discoid with thickened periphery extending into normally thinning centre. The menisci are attached to the tibial intercondylar area by their horns and around their periphery by small coronary ligaments. The lateral meniscus is loosely attached to the tibia and connected to the femur by two menisco-femoral ligaments .If dominant part is anterior, it is called anterior menisco-femoral ligament of Humphrey (anterior to the PCL) and if posterior part is dominant it is known as menisco- femoral ligament of Wrisberg (posterior to the PCL). [18] The outer margin of medial meniscus is blended with fibrous capsule and deep surface of the medial collateral ligament. The lateral surface of the lateral meniscus is grooved by, and blends with, the tendon of popliteus, which is separate from fibular collateral ligament. The transverse ligament joins the anterior ends of menisci. Functions of menisci include the distribution of stresses over the articular cartilage, the absorption of shocks during axial loading, the stabilization of the joint in both flexion and extension, and joint lubrication; they also make a minor contribution toward secondary stabilization of the knee after cruciate ligament injuries. Because of their nerve supply, they give rise to proprioceptive impulses. [18]

The transverse ligament: It connects the anterior convex margin of the lateral meniscus to the anterior end of medial meniscus; its thickness varies in different subjects, and is sometimes absent. [16]

Synovial Membrane: The synovium is a thin membrane that lines the knee capsule and attaches to the margins of the articular surfaces and the periphery of the fibro cartilaginous menisci. Small gap exists between the insertion of the synovial membrane/capsule and the nearby articular cartilage, effectively resulting in a ‘‘bare area.’’ Anteriorly, the synovial lining extends superiorly, above the patella and deep to the quadriceps femoris, to form the suprapatellar bursa, held in position by a small muscle, the articularis genus , arising from the vastus intermedius. The synovial membrane envelops the anterior and posterior cruciate ligaments so as to exclude them from the synovial cavity (intra-articular but extra synovial). Posteriorly, the synovial membrane extends caudally on the deep surface of the popliteus tendon, forming the popliteal bursa. An additional bursa, the semimembranosus bursa, lies between the medial head of the gastrocnemius and medial femoral condyle, and also communicates frequently with the synovial cavity of the joint.[19]

Bursae around the Knee Joint: As many as thirteen bursae have been described around the knee joint- four anterior, four lateral and five medial. These are as under;[14]

Anterior

1. Subcutaneous prepatellar bursa
2. Subcutaneous infrapatellar bursa
3. Deep infrapatellar bursa
4. Suprapatellar bursa

Lateral

1. A bursa deep to the lateral head of gastrocnemius.
2. A bursa between the fibular collateral ligament and the biceps femoris.
3. A bursa between the fibular collateral ligament and the tendon of popliteus.
4. A bursa between the tendon of popliteus and the lateral condyle of tibia.

Medial

1. A bursa deep to the medial head of gastrocnemius
2. The anserine bursa is a complicated bursa which separates the tendons of sartorius, gracilis and semitendinosus from one another, the tibia and from the

tibial collateral ligament.

3. A bursa deep to the tibial collateral ligament
4. A bursa deep to the semimembranosus
5. Occasionally a bursa is present between the semimembranosus and the semitendinosus.

RELATIONS OF KNEE JOINT: [14,15]

Anteriorly: Quadriceps femoris, patellar retinacula and supra patellar retinacula and supra-patellar bursa

Posteriorly: Oblique popliteal ligament, popliteus, popliteal artery with vein posterior and tibial nerve posterior to both; lymph nodes; heads of gastrocnemius, lower end of semimembranosus and semitendinosus

Postero-medially: Sartorius and gracilis tendons

Postero-laterally: Biceps femoris with the common peroneal nerve on its medial side

MOVEMENTS OF KNEE JOINT:

Flexion and extension are the principle movements at the knee. Some rotation is possible when the knee is flexed but is lost in extension. During the terminal stages ofextension the large medial tibia condyle screws forwards onto the femoral condyle to lock the joint. Conversely, the first stage of flexion is unlocking the joint, byinternal rotation of the medial tibial condyle, an action performed by popliteus.[14,15]

The principal muscles acting on the knee are: [15]

- Extension: Quadriceps femoris.

- Flexion: Predominantly the hamstrings but also gracilis, gastrocnemius and sartorius.
- Medial Rotation: Popliteus, semitendinosus and semimembranosus bring about medial rotation of the flexed leg assisted by the sartorius and gracilis.
- Lateral Rotation: Lateral rotation of the flexed leg is brought about by the biceps femoris.

During the last 30 degrees of extension, medial rotation of the femur occurs so that the articular surfaces of femur and tibia are completely used up. This is called locking of the knee. Similarly during initial stages of flexion, lateral rotation takes place, which unlocks the knee joint. This is brought about by the action of popliteus. Locking of knee helps the knee to remain in the position of full extension without much muscular effort.

15

NERVOUS INNERVATION:

The nerves of the knee are branches from the femoral, tibial, and common fibular nerves. The muscles that perform flexion and extension of the knee are innervated by the femoral and sciatic nerve. Lacerations to these two major nerves will impair mobility of the knee and sensation to the lower limb.

15

The remaining nerves go around the knee or inferiorly along the popliteal fossa. The popliteal nerve on the backside of the knee has large tracts innervating the lower leg and foot. The popliteal nerve branches just above the knee to form the tibial and peroneal nerve, the tibial nerve continues on the posterior part of the lower leg while the peroneal nerve travels around and down the front of the leg ascending to the foot.

Fractures of bones forming the knee joint pose a risk of injury to these nerves impairing motion and sensation of the lower leg. [15]

KINESIOLOGY OF THE KNEE JOINT:

The curvatures of the articular surfaces of the knee are such that hinge movements are combined with gliding, rolling, and rotation about a vertical axis. Flexion of the thigh at the knee is first accompanied by lateral rotation of the thigh, and the femur then rolls posterior-forward on the tibia. Conversely, the last part of extension is accompanied by medial rotation of the thigh, and the collateral ligaments are then taut and the joint is most stable. [20]

The quadriceps femoris extends the leg, and the hamstrings flex it. The biceps rotates the leg laterally, and the semitendinosus rotates it medially. The popliteus muscle, acting from a fixed tibia, is believed to be significant in rotating the femur laterally.[20]

The range of flexion depends on position of the hip and whether movement is active or passive. Usually, some passive movement of the tibia beyond alignment of the long axes of the thigh and leg (hyperextension). Flexion of the knee is normally limited by contact with the calf muscles; however if the movement ends sooner it indicates a retraction of quadriceps or shortening of capsular ligaments. Males usually have a lower range of flexion than females due to a larger calf circumference. Normal range of motion, is between 120 and 150. [20]

In extension, the knee passively locks because of the medial rotation of the femur on the tibia. This position turns the lower limb into a rigid column suitable for weight-bearing. The beginning of flexion, the femur rotates laterally on the tibia and unlocks the knee enabling the lower limb to enter the swing phase of gait. [20]

BIOMECHANICS OF THE TIBIO-FEMORAL JOINT:

The primary impacted anatomical structure in this case study is that of the lateral tibial plateau. Fracture of this site will closely affect many secondary, synergistic structures most notably the tibiofemoral articulation. Dysfunction in this articulation will give rise to limitations in the both extension and flexion.[21]

During Arthrokinematics of closed chain knee flexion / extension the convex femoral condyles move on concave tibial condyles; therefore distal and proximal segments are moving in opposite directions. During extension the tibia glides anteriorly on the femur if this glide is prolonged the last 20 of motion will initiate the "home screw mechanism", locking the knee. During, flexion involves a combination of rolling and gliding of the femoral condyles on the tibial condyles. The femur rolls posterior and glides anterior to the tibia. For the femur to continue to roll on the tibia without "falling out" of the tibial plateau it must simultaneously glide forward. Please refer to the figure

for a schematic representation of rolling and gliding of the femur.[21]

POSTERIOR CRUCIATE LIGAMENT:

PCL is a complex structure comprising of two bundles:

- Antero-lateral (AL)
- Postero-medial (PM)

PCL comprising of two bundles: the anterolateral (AL) and the posteromedial (PM), named in relation to their origin on the femur and insertion on the tibia. Each of these structures possesses an individual anatomic course which determines its function. The AL is therefore tense in knee flexion while the PM is tense in extension; the AL bundle has a greater tensile strength and the PM bundle is more isometric.[22] (Fig. 3)

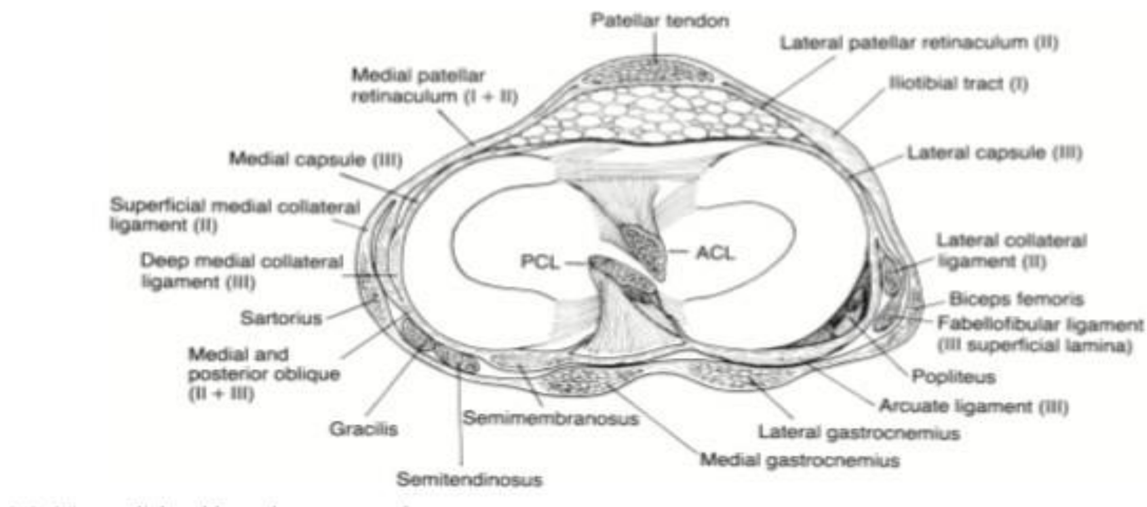

Figure 4: CROSS-SECTION OF KNEE JOINT

(from Blevins FT, Boublik M, Steadman JR. Anatomy: ligaments, tendons, and extensor mechanism. In: Siliski JM, ed. Traumatic Disorders of the Knee. New York: Springer-Verlag; 1994:10.)

The general set of PCL structures originates in a wide area in the anteromedial aspect of the femoral condyle within the intercondylar groove in a crescent-shaped prominence called the medial intercondylar ridge. This position has been shown to be variable. [23] Its insertion is usually constant and is located in a posterior depression in the intercondylar imminence known as PCL fossa. It was found that this insertion point was approximately 7 mm anterior to the posterior tibial cortex; however, a thinner thin bundle of fibers is inserted directly into the posterior cortex and mixed with the posterior capsule and periosteum. [24]

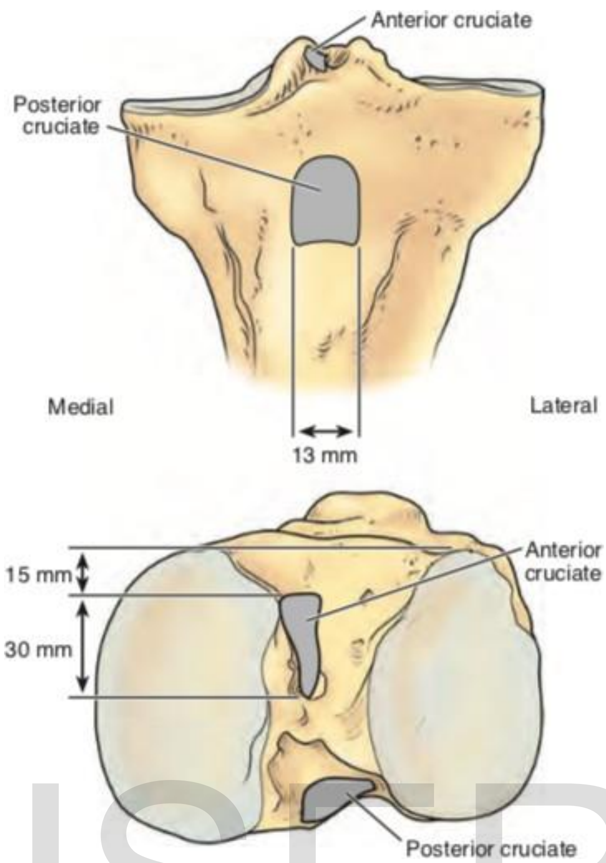

Figure 5: ATTACHMENTS OF PCL
(From Girgis FG, Marshall JL, Al Monajem ARS: The cruciate ligaments of the knee joint. *Clin Orthop* 106:216, 1975.)

The average length of the PCL is approximately 38 mm, it is thinner in the middle substance and the total beam decreases from approximately 32 mm in cross section in its femoral origin to approximately 13 mm in its tibial insertion. [25-27](Fig. 5) The blood supply to PCL is derived mainly from the middle geniculate artery, a branch of the popliteal artery. It also receives additional supply of capsular vessels and vasculature of the synovial sheath. The nerve endings are present within the PCL substance and consist of Ruffini corpuscles for pressure and Pacini corpuscles for the velocity and the Golgi tendon apparatus. PCL lesions can affect proprioception and afferent sensory pathway from the knee joint.

BIOMECHANICS OF POSTERIOR CRUCIATE LIGAMENT:

PCL serves as a primary rear stabilizer and as a secondary stabilizer in external rotation. The point of maximum tensile strength is at 90 degrees of flexion; however, the action of the posterior stabilizer starts at 30 degrees of knee flexion. Therefore, tensile strength increases exponentially from extension to flexion. Studies with corpses in which the PCL was sectioned showed an increase in posterior translation in flexion of 10 to 15 mm and an increase in external rotation of 21 degrees. [28] The PCL has a synergistic function with structures of the postero-lateral corner; therefore, a combined injury will inadvertently result in marked posterior and external rotational instability. [28](Fig. 6)

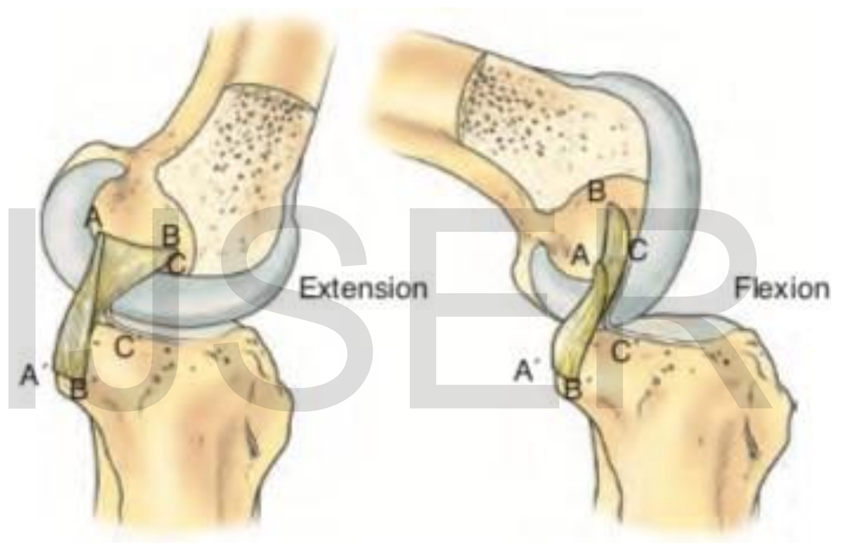

Figure 6: BIOMECHANICS OF PCL

(From Girgis FG, Marshall JL, Al Monajem ARS: The cruciate ligaments of the knee joint. *Clin Orthop* 106:216, 1975.)

It has been shown that the role played in the stability of external rotation contributes to the mechanism called "screwing" when the knee moves from flexion to extension. [29] Biomechanical studies of knees deficient in PCL have shown a markedly altered biomechanics of the joint. This was particularly evident in the increase in joint reaction forces in the medial femoral condyle. [30] Therefore, PCL plays a more important role in the kinematics of the normal knee than originally anticipated, and it has been shown that this function depends to a large extent on the anatomical junctions rather than the isometric properties of the knee ligament.

EPIDEMIOLOGY AND INJURY MECHANISM:

The incidence reported in the literature variable: between 1 and 40 percent of all acute knee injuries. [31] These figures depend on the type of report of the center, and the main trauma centers and the sports injury units report different levels of incidence.[32,33] It is estimated that up to two thirds of PCL injuries are associated with multiple injuries and only 6.5% occurred in isolation. [31]

In isolated lesions, the PM bundle often remains intact, [34] while in 60% of cases concomitant injuries occur in the postero-lateral corners. [35] Therefore, combined injuries require greater attention to bone structures and even the risk of neurovascular injuries as a result of occult dislocation of the knee. However, when isolated, PCL lesions can become chronic with an associated posterior capsular stretch. The severity of the interruption of the PCL is classified according to the posterior tibiofemoral translation or "posterior sinking sign" from the original 10 mm anterior position of the medial tibial plateau to the medial femoral condyle. The degree of injury is described with reference to this original position: grade I is from 0 to 5 mm, grade II is from 5 to 10 mm and grade III is greater than 10 mm from posterior sinking. It is estimated that

15 to 20 percent of the lesions isolated from PCL represent an avulsion of their distal tibial junction.[36]

The fracture of the bone fragment with the union of PCL can be divided into three types:

- Rupture of PCL with involvement of an osteochondral sleeve;
- True PCL avulsion resulting from posterior dislocation or subluxation of the knee;
- Shear fracture of the posterior tibial plateau that involves the fixation of PCL.

31,36

CLINICAL EVALUATION:

. A complete history of the mechanism of injury and subsequent symptoms is critical for the clinical evaluation of PCL lesions. Knee pain, swelling and stiffness may be the only presentation symptoms. Initial signs of trauma that could be identified include abrasions and contusions on the knee. A popliteal hematoma may be indicative of an avulsion lesion of PCL rather than a more contained intrasubstance tear. It is necessary to identify the signs of associated injuries, therefore, it is important to have a clear documentation of the initial and current symptoms. The traditional sensation of a "pop" associated with lesions of the anterior cruciate ligament (ACL) is unlikely to manifest at the time of injury. Likewise, the signs of mechanical instability may notbe easily identifiable.[37]

A complete clinical examination is required and must also include the examination of the ACL and collateral ligaments.

Posterior Drawer Test[38]: The most basic test for PCL injury is the posterior drawer test. The starting position is essentially the same as that for the anterior drawer test the patient's knee is flexed 90° and the foot stabilized. In a patient with a torn PCL, a **dropback phenomenon** usually occurs in this position: gravity causes the tibia to sub- lux posteriorly with respect to the femur, resulting in an abnormal appearance that is best appreciated when both knees are viewed in profile. When such a dropback phenomenon occurs, the tibial tubercle appears less prominent than usual, and the patella appears more prominent than usual. Subtle changes may often detected by comparing the injured with the normal knee. In the acute injury situation, the dropback is less likely to occur or may be masked by acute swelling. The posterior

drawer test is completed by pushing posteriorly on the proximal tibia with both hands. In the abnormal case, the tibia is felt or seen to sublux further posteriorly with respect to the femur. If considerable dropback has already occurred, the application of a posterior force may not sublux the tibia much further. Unlike the anterior drawer test, a fairly firm end- point is usually felt once the abnormal posterior laxity has been taken up, even in the case of complete PCL rupture. (Fig. 7)

Figure 7: POSTERIOR DRAWER TEST

Godfrey's Test[38]: The Godfrey test is another way of looking for the dropback phenomenon. In Godfrey's test, the examiner or an assistant holds the patient's legs in the 90/90 position with both the knees and the hips flexed to 90°. Again, in this position gravity causes the tibia to sublux posteriorly in a knee with an injured PCL.

Grading Posterior Laxity[38]: The results of the posterior drawer and dropback tests are usually graded by the relationship of the proximal tibia to the distal end of the femoral condyles. Normally, the anterior cortex of the proximal tibia sits about 10 mm anterior to the distal end of the femoral condyles when the knee is flexed about 90°. Every 5 mm of posterior dropback or posterior drawer is considered a grade of abnormal laxity. Thus, in a **grade** 1 posterior drawer, the normal 10 mm of prominence of the anterior tibia with respect to the femoral condyles is reduced to 5 mm. In a **grade 2** posterior drawer or drop- back, the proximal tibial cortex is flush with the femoral condyles. In the **grade 3** or **grade 4** posterior drawer or dropback, the anterior tibial cortex is respectively displaced 5 mm or 10 mm posterior to the femoral condyles.

Lachman Test[38]: Lachman test has surpassed the anterior drawer test as a basic screening examination for abnormal anterior knee laxity. This test was first described by Torg and attributed to his mentor, Lachman.

The test is done in 20-30 degree of flexion. The patient lying supine, examiner stands at the side of the table near the knee and grasps the lower leg with one hand. Usually, the examiner's thumb is placed just over the tibial tubercle and the other fingers are wrapped around the rest of the calf. The other hand is used to grasp the thigh just above the patella. The thumb of this upper hand presses against the femur through the quadriceps tendon while the other fingers wrap around the posterior thigh. If the patient is properly relaxed, the limb should feel like a dead weight. The fingers of the examiner's upper hand, which are supporting the thigh, are also able to sense any tightening in the hamstrings. If any of the hamstrings are felt to be tight, identifying the tight muscle to the patient and massaging it a bit often allows the patient to relax. Once relaxed, the examiner pulls forward on the tibia with one hand while simultaneously pushing backward on the femur with the other hand in a reciprocating manner. The amount of anterior excursion and the quality of the endpoint are assessed. Lachman test can be performed with effusion and when patient has pain and knee cannot be flexed to 90 degrees. (Fig. 8)

Figure 8 : LACHMAN'S TEST

Further clinical evaluation can be obtained with a reverse pivot shift test

Reverse Pivot Shift Test[38]: The reverse pivot shift test, described by Jakob, begins with the patient in the same supine, relaxed position. To test the right knee, the examiner faces the patient and rests the patient's right foot on the right side of the examiner's pelvis with the foot in external rotation. The palm of the examiner's left hand supports the lateral side of the calf at the level of the proximal fibula. The examiner then bends the knee to 70° or 80° (Fig. 6-62A). In patients with posterolateral rotatory instability, external rotation in this position causes the lateral tibial plateau to sublux posteriorly in relation to the lateral femoral condyle. This is perceived as a posterior sag of the proximal tibia. The examiner now allows the knee to extend, leaning slightly against the foot to transmit an axial and valgus load to the knee. As the knee approaches 20° of flexion, the lateral tibial plateau reduces from its posterior subluxed position and a jerk-like shift is appreciated.

A positive active quadriceps test can also help detect the presence of posterior laxity. The examiner should be aware of the false positive anterior drawer test and the pseudo-positive Lachman test that may result from subsequent laxity in chronic knee cases with PCL deficiency; it is necessary to evaluate the gait to determine the posterior translation, external rotation and varus thrust during the posture phase, and misalignment in varus could also be present and exacerbate the symptoms of instability. Misalignment of varus and varus recurvatum may indicate an associated PLC lesion.[37] The initial images will include anteroposterior and lateral lateral radiographs. The objective of these primary images is to look for concomitant fractures and to guarantee the congruence of the joint. The more elaborate simple radiographs, including views of stress, have been replaced by the arrival of the availability of magnetic resonance imaging (MRI). Therefore, MRI has become the modality of choice with the highest sensitivity and specificity.[37]

MRI is also useful for evaluating chondral surfaces, meniscus and other ligaments. A computed tomography (CT) scan can be a useful adjunct in the evaluation of PCL avulsion lesions, which provides a better summary of the bony element of the lesion. The reformatted and three-dimensional computed tomographies can also help with the preoperative planning of the surgical approach and the fixation method. Magnetic resonance imaging has been shown to be less optimal in the evaluation of chronic PCL[39] lesions, since a PCL with chronic rupture can still assume a normal anatomical position.

MANAGEMENT:

Non-surgical treatment is often recommended for isolated grade I and grade II injuries, with activity modification, quadriceps rehabilitation, and functional reinforcement. In contrast, evidence from medium and long-term single-arm studies reported favorable outcomes after surgical treatment of isolated PCL lesions. [40]

Surgical approaches

The fixation of the avulsed tibial union of the PCL can be carried out by open exposure or by means of arthroscopy. Despite adequate experience, Kim and his colleagues[41] believed that the technique of arthroscopic-assisted reduction and fixation was difficult and had a very steep learning curve. In our experience, similar fixation can be achieved through open exposure through the postero-medial approach.

A posterior approach of the knee is required for the fixation of the avulsion or reconstruction of PCL by means of a tibial incrustation technique. This technique gained popularity in the previous decade due to the concerns resulting from the sharp curve associated with the insertion of the transtibial graft. The clinical series have reported satisfactory results using a direct posterior approach for the repair of tibial osseous avulsion of PCL or graft reconstruction of the PCL using the tibial inlay technique. [41-47]

DIAGNOSIS:

HISTORY OF ILLNESS AND MECHANISM OF INJURY:

The most common mechanisms of PCL injuries include pretibial trauma, hyperflexion, and hyperextension of the knee. Fowler and Messieh[48] reported that, isolated PCL injuries were common in athletes and hyperflexion was the most frequent mechanism of injury. In most of the PCL injuries caused by hyperflexion, the posteromedial bundle remains intact and only the anterolateral bundle is ruptured. However PCL tears mostly occur in combination with other injuries.[49] According to Fanelli and Edson,[50] about 95% of the PCL injuries in an emergency department setting were combined with other ligament injuries. The PCL can also be torn in a car accident because a posterior force is applied to the tibia when the knee in a flexed position hits the dashboard. This can be combined with posterolateral ligament injuries if the anteromedial aspect of the knee strikes the dashboard with a varus force applied.[51] **PHYSICAL EXAMINATION:**

A careful vascular examination of the lower extremities is essential because a PCL injury can be accompanied by a popliteal artery injury. If the pulses are weak or the ankle-brachial index is ≤0.8, an intimal tear should be suspected and arteriography should be performed. If blood flow disruption below the knee is obvious, arteriography should be omitted to prevent delay in treatment.[51]

Acute PCL injuries present with joint swelling and about 10ºto 20º of restriction in further flexion due to pain. Chronic PCL injuries may present with limited activity such as having difficulty in climbing slopes due to lethargy and pain in the anterior and medial areas of the knee rather than instability. The posterior drawer test is the most accurate test for PCL injuries. At $90^{0}$of knee flexion, posterior sagging of the tibia is observed on the affected side. If the tibia is pulled forward or the quadriceps is contracted with the knee flexed to 90º (quadriceps active test), anteroposterior instability of the knee is noted).[51] However, these tests can be unreliable for detecting acute PCL injuries with severe swelling.[52] In contrast, the sensitivity of the posterior drawer test increases for the detection of chronic PCL injuries because of the absence of swelling and pain in further flexion. [53]

A presence of ≥10 mm posterior translation requires tests for posterolateral ligament complex (PLC) injuries. The presence of tenderness and an arcuate fracture in fibula head suggest acute a PLC injury, but a diagnosis of chronic PLC injury should be based on various test results. In the dial test, the thigh-foot angle is measured with an external rotation force applied to the knees flexed to 30º and 90º. If the angle on the affected side is ≥10^{o}-15^{o}greater than the contralateral side at 30º of flexion only, at 90^{o}of flexion only, and at both 30º and 90º of flexion, the diagnosis is an isolated PLC injury, an isolated PCL injury, and a combination of PCL and PLC injury, respectively. Posterior translation is greater in combined injuries of the PCL and PLC than in an isolated injury. [53]

Considering that the dial test can be misleading in cases of minor injuries) [54], it is recommended to reduce the tibia with an anterior force during the test. To better assess posterior subluxation of the tibia, the examiner should palpate with 4 fingers posterolateral translation of the posterolateral condyle of the tibia with respect to the posterolateral condyle of the femur with an assistant holding the knees flexed to 90^{o}. [55] The posterolateral drawer test, external rotation recurvatum test, and reverse pivot shift test can also be used to assess injuries to the posterolateral structures. However, a positive external rotation recurvatum test is more indicative of an ACL injury than a PCL injury) [56] and the reverse pivot shift test should be used with care because the test may yield positive results in about 30% of normal knees.

Combined PLC injuries have much influence on the prognosis of PCL injury treatments. This is why the exact assessment of PLC injuries is important. However, it may be impossible to detect PLC injuries with a single test. Therefore, it is recommended to palpate the articular surface during various tests with suspicion of PLC injuries and determine the diagnosis based on the test results. Besides, the overall lower limb alignment should be assessed for varus malalignment and gait for instability such as varus thrust. [57]

IMAGING

Radiography is a valuable tool in diagnosing PCL injuries. The presence of a fracture can be determined on the anteroposterior, lateral, and Merchant views of the knee. The lower limb alignment, especially the presence of varus malalignment, can be evaluated on the standing radiographs. The presence and degree of instability can be assessed on stress radiographs. Especially, PCL injuries can be best visualized on posterior stress radiographs. [58,59] A presence of $\geq$10 mm posterior translation on posterior stress radiographs may suggest posterolateral ligament injuries combined with PCL injuries. [60]

External rotation valgus stress radiogram is useful in assessing PLC injuries[61] and ultrasound can be used to evaluate the degree of instability. [62]

Magnetic resonance imaging (MRI) has 96 to 100% accuracy for the detection of acute PCL injuries and can determine the location and severity of an injury and other damages to the cartilage and ligaments. Bone bruise patterns on MRI can be helpful in identifying the mechanism of injury. In acute PCL injuries, bone bruises are often located anterior to the tibia. In chronic PCL injuries, MRI scans may appear to be normal if the ligament healed spontaneously. The popliteo fibular ligament, an important structure in posterolateral instability of the knee, may not be clearly visualized on MRI. [63]

INSTRUMENTED EXAMINATION:

The KT-1000 can be used to assess anteroposterior instability, but may be less accurate than Telos stress radiography.[53]

ARTHROSCOPY:

History of Arthroscopy[64]: Prof. M. Takagi of Tokyo, Japan, in 1918 was the first to examine the interior of the joint of human cadaver with the aid of a cystoscope. In 1920 he succeeded in designing such an instrument, which he called 'arthroscope'.

The diameter of his scope was 7.3mm, but this was found to be unsuitable for practical application. He nevertheless succeeded in using this instrument to examine the interiors of the knee joint which showed signs of tuberculosis. After numerous experiments and many disappointments Takagi succeeded in 1931 in producing an arthroscope with a diameter of 3.5m, which could also be used to examine articular cavities other than that of the knee.

Bircher, independent of Takagi, in 1922 published the results of 20 arthroscopic examinations of knee joint, made with the aid of a laprothoracoscope, according to Jacobeus. This method of what he called 'arthro-endoscope', enabled Bircher to view the interior of the knee joint in order to identify pathologic changes and verify diagnosis on the basis of these observations. He described his method as superior to all other methods, and maintained that it was suitable only for inspection of knee joint. He reported no complications, but held that the jacobeus laprothoracoscope was more effective and less dangerous for the knee joint than for the abdominal cavity. 1925 Kreuzer was first of the English speaking investigators to describe an arthroscope of his own design, its mechanism of action, and the results obtained with it. He made a plea for the early diagnosis of meniscal lesions by means of this procedure.

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and Mayer described their experience in examining 10 cadaver knees and 3 patients. They used fluid irrigation of joint and reported that they had a clear view of the supra patellar recess, the femoral and tibial condyles, the anterior cruciate ligament and the menisci. A good view of the menisci was ensured when knee flexed at 30 degrees. They examined three cases of tuberculosis of knee, making a correct diagnosis in two of these cases. The method of arthroscopy did not remain unnoticed in the Netherlands. In 1925 Bircher read a paper on endoscopy of knee joint with special reference to diagnosis of meniscal lesions. In this lecture he once again confirmed the value of this method in front of Dutch audience.

In Germany, however, studies on arthroscopy of the knee were continued, as demonstrated in publications by Sommer and Vaubel. Sommer used the Grave arthroscope and filled the knee joint with oxygen. In his view, arthroscopy has the advantage that it can be repeated several times without lasting inconvenience to the patient. Vaubel's reason for resorting to arthroscopy was likewise the fact that conventional methods of investigations often let him down. He established the diagnosis by examining the joint for the presence of swelling or deformation, shrinkage of the capsule, inflammatory symptoms or limitation of movement. Vaubel defined the purposes of arthroscopy as follows:

i) To examine the knee joint and identify the pathological changes present in the interior.

ii) To attempt a differential diagnosis between specific arthropathies of the knee and poly-articular systemic diseases.

iii) To assess the course of these diseases on the basis of repeated examinations.

iv) To be used as an aid in intra-articular operations.

v) To facilitate research into the biology of joints.

He used an optical system with a diameter of 2.3 mm, with a shaft diameter of 3.1 mm. This instrument had been developed especially for arthroscopy of knee, and the scope was found suitable for diagnostic purposes. For photography, he used a scope with a diameter of 4 mm and a shaft diameter of 4.7 mm. Two instruments were used: one with a view direction of 90 degrees and one with a view direction of 45 degrees. All parts of the instrument except the scope were heat resistant and sterilizable. Vaubel carried out 11 arthroscopies in patients suffering from inflammatory arthropathies or osteoarthritis. The examination was carried out under local Anaesthesia. In order to dilate the joint capsule, physiological saline or air was used. The examination focused mainly on synovial membrane and articular cartilage. Vaubel examined no patients with abnormalities of cruciate ligaments and menisci. He reported that he could see entire lateral meniscus if the knee was 30 degrees flexed and the lateral intra-articular space was sufficiently wide. In that case or examination of the medial compartment, the instrument had to be introduced on the lateral side of the joint. This ensured an adequate view of the medial meniscus. Professor Takagi designed several new instruments, including 11 new different optical systems and several types of trocar as well as various accessory devices for special purposes. The type 11 arthroscope had smallest diameter of 2.7 mm and could be used for the examination of rabbit knee joint. Using the type 12 arthroscope, it was even possible to pass a small biopsy forceps through the shaft, along with the endoscopes. This made possible to take biopsy specimens under direct visual control, and to coagulate minor haemorrhages if necessary.

In 1932, Takagi succeeded in making photographs through the arthroscope, and in 1936 Takagi presented colour photographs and even a film made through arthroscope.

Watanbe published his first arthroscopic atlas in 1957 with drawings and in 1959 with photographs. At that time he recommended the type 13 arthroscope as the instrument of choice for routine use. This was later perfected to the type 19 arthroscope. In 1959, finally, the type 21 arthroscope was developed, with which photographs could be made. Hurter, in 1955, discussed various sites of insertion of instrument for inspection of menisci, anterior cruciate ligament and the cartilage of the femoral condyles using his self-designed arthroscope of 5 mm diameter.

In 1967, Mexican rheumatologist Robles Gil and his co-workers reported experience with 60 arthroscopies in various rheumatic conditions of different degrees of severity. They used type 21 Watanabe arthroscope. He observed various stages of synovitis in 30 patients with degenerative joint disease. He described characteristic changes of the synovial membrane e.g.: vascular dilatation and venous thrombosis. He described the method as very valuable in diagnostic, therapeutic and prognostic terms, and in cases of traumatic synovitis and cartilage lesions. The orthopaedic surgeon Casscells reported 150 arthroscopies in 1971. He described arthroscopy as eminently suitable for the following purposes:

i) To diagnose lesions of the meniscus and cartilage, and to take a synovial biopsy specimen.

ii) For follow up patients after an earlier operation for osteochondritis dissecans or a synovectomy. Casscells, however, stressed that arthroscopy is not a method which obviates all other methods of investigation, but merely an aid which should be used in conjunction with other aids such as history, physical findings, radiological findings and particularly arthrograms.

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In 1972, Jackson from Toronto, Canada, examined and operated 104 knee joints, arthroscopy found to be 'very useful' in 20% cases, 'useful' in 50% cases and 'not useful' in 25% cases. In 1973 O'Conor reported on arthroscopy as diagnostic aid and therapeutic method in crystal induced synovitis of the knee joint. In 1974, he described use of the arthroscope in acute lesions of ligaments of knee.

Lanny L. Johnson, after attending the first AAOS instructional course on arthroscopy given by Jackson in 1968 quickly became one of the leading practitioners and innovators of arthroscopy in North America. Initially, he used Needlescope, a small diameter arthroscope developed by Dyonics and promoted the concept of multiple punctures of the knee to explore all regions of the joint.

Figure 9: Japanese professor Kenji Takagi, "father of arthroscopy,"

Who was the first to view the inside of cadaver knee in 1918 using the cystoscope
(From-Passler HH, Yang Y. The Past and the future of Arthroscopy. Berlin Heidelberg. Springer-Verlag. 2012.)

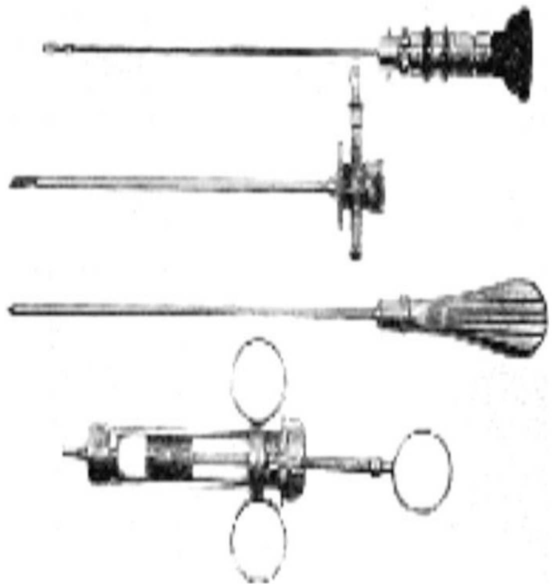

Figure 10: Takagi's No. 1 arthroscope
(From-Passler HH, Yang Y. The Past and the future of Arthroscopy. Berlin Heidelberg. Springer-Verlag. 2012.)

Fig. 11: Dr. Eugene Bircher

Performing a knee surgery with his arthroscope in 1917.

Gas was used to fill up the joint
(From-Passler HH, Yang Y. The Past and the future of Arthroscopy. Berlin Heidelberg. Springer-Verlag. 2012.)

PCL lesions can be visualized with arthroscopy in acute cases. They may appear to be healed in chronic cases, but arthroscopy will reveal ACL pseudo laxity where the

ACL appears lax due to posterior translation of the proximal tibia but the laxity resolves when an anterior force is applied to the tibia. Care should be taken not to misinterpret this pseudo laxity as an indication of ACL injuries. An abnormal contact can also be observed between the medial femoral condyle and the medial meniscus anterior horn due to the posterior translation of the proximal tibia.

PLC ruptures can be visualized with arthroscopy or evidenced by hemorrhage in some cases. However, it is more common to identify a "lateral gutter drive through sign" that can be observed by inserting the arthroscope into the posterolateral aspect of the knee or tension of the popliteus tendon. 65,66

TREATMENT PRINCIPLES:

Conservative treatment is indicated for PCL injuries with 5 to 10 mm posterior instability (grade I and II) and surgical treatment is recommended for PCL injuries with

≥10 mm posterior instability (grade III) or with combined collateral ligament injuries or avulsion fractures10). However, the natural history, healing potential, and the influence of remnant, alignment, and posterolateral ligaments should be taken into consideration in determining treatment plans.

Natural history:

Surgical treatment of less than moderate isolated PCL injuries (grade I and II) still remains controversial. Short-term results of nonoperative treatment have been reported successful in many studies. However, there are studies showing unfavorable long-term results including degeneration of the tibiofemoral cartilage in the medial compartment and increased tibiofemoral pressure and meniscal strain[67-69], which eventually led to arthritis. In the study of Dejour et al. [70], osteoarthritis occurred eventually in the patients in whom the isolated rupture of the PCL was functionally well tolerated for 3 to 18 months.

According to Clancy et al. [71], degenerative arthritis was observed in 80% of the patients after nonoperative treatment. Likewise, nonoperative treatment of grade I and II isolated PCL injuries have been associated with functional limitation and early degenerative arthritis in many studies. Therefore, surgical treatment of grade II PCL injuries can be considered as an option if a hot spot is shown on bone scan of highly active patients or the surgeon is competent.

Healing potential:

Acute PCL tears, especially those within substance, can be treated with conservative measures because of the ligament's high healing potential2-6). However, when PCL injuries are combined with PLC injuries, the PCL should be treated with reconstruction and the PLC with repair or reconstruction because the PLC tears do not heal with conservative treatment, which eventually leads to instability and cartilage degeneration. [72]

Remnant:

Remnants are observed in most PCL injuries because the ligament has a high chance of spontaneous healing. It has been known that preservation of the remnant fibers during operative treatment of PCL injuries plays a pivotal role in obtaining successful outcomes. If remnant fibers are observed, re-tensioning of the remnant PCL fiber, stent procedure, single-bundle or double-bundle PCL reconstruction with PCL remnant preservation, albeit technically challenging, can be performed depending on the quality of the PCL remnants. If no remnant is present, albeit controversial, double-bundle PCL reconstruction may be an appropriate procedure. [73,74]

Alignment:

Left untreated, varus malalignment may increase the risk of treatment failure after PLC and PCL reconstruction. Therefore, if varus malalignment is present, an osteotomy should be carried out even in acute cases of PCL combined with PLC injuries. [52] Improvements can be made with varus malalignment correction alone and then subsequent reconstruction procedures may become unnecessary. An increase in tibial slope results in an anterior shift of the resting position of the tibia relative to the femur and anterior tibial translation under an axial load. [52,75] A varus osteotomy may improve posterolateral instability and make PLC reconstruction unnecessary.

Rehabilitation

In contrast to ACL rehabilitation, PCL rehabilitation should be carried out at a slow pace. Depending on the patient's condition and the surgeon's intraoperative judgment, appropriate joint exercises that allow early joint motion within a safe range should be determined. Although some differences exist among studies in terms of the appropriate timing and method, the rule of thumb is as follows. Postoperatively, there is a tendency to posterior translation in flexion of the knee, especially in active flexion. In addition, the tendon graft becomes weak by the 6th postoperative week and requires protection. [76] Therefore, during the 2nd and 3rd postoperative week, the knee should be immobilized in an extended position with a padded posterior splint or a long leg brace. Quadriceps femoris muscle strengthening exercise and straight leg raising exercise are started immediately after surgery for synergy effect. To prevent joint adhesion, joint exercises should be performed in anteroposterior and mediolateral directions. Passive flexion exercise is performed with the tibia pulled forward until $90^{o}$of flexion is achieved by the 4th to 6th postoperative week. For isolated PCL injuries, weight bearing can be helpful in maintaining muscle strength even before the 6th postoperative week without the risk of posterior translation because the tibial slope increases the tendency to anterior tibial translation. However, for combined PCL injuries, partial-weight bearing is allowed soon after surgery and progressed to full weight-bearing at the 6th to 12th postoperative week. In addition, passive range of motion should be gradually increased to 140of flexion avoiding active contraction of the hamstrings. From the 12th postoperative week when collagen fibers become organized, flexion exercise is permitted, light jogging is allowed 3 to 6 months after surgery, and sports activities are allowed 6 months after surgery.[76]

REVIEW STUDIES:

Sachin Joshi et al[77]evaluated the clinical and functional outcome of open reduction and internal fixation of tibial avulsion injuries of the PCL using cannulated cancellous screws. They performed open reduction and internal fixation using cannulated cancellous screws in 14 patients (mean age, 33.9 years) with isolated PCL avulsion injuries. Patients with a duration of injury more than 12 weeks were excluded. The minimum follow-up period was 12 months. Results were assessed radiologically and clinically. Final functional outcome was assessed using the Lysholm knee scoring system. The average follow-up period was 13.5 months. At the final follow-up, all 14 patients achieved fracture union. The average flexion was 121.7°±9.2° with full extension achieved in all patients. Mild instability (1+) was noted in 4 patients. The Lysholm functional score was excellent in 11 patients, good in 2 patients and fair in 1 patient with an average score of 97±7.6. Stable early fixation for PCL avulsion injuries with early controlled mobilization provided excellent to good results.

N A Bhalerao et al[78] evaluated the functional and radiological outcomes of arthroscopic fixation of PCL avulsion fractures using Tightrope like device, its technical difficulties and clinical outcome. The average age of the 10 patients was 31.7 years. Out of 10 patients 7were male and 3 were female. 6 out of 1Ofractures were right sided and rest 4 was left sided. Stable reduction was achieved in all the fractures. The Lysholm knee score was excellent in 4 cases and good in rest 6 cases.

Clemens Gwinner et al[13] studied arthroscopic reconstruction technique for bony tibial avulsion fractures of the PCL and initial clinical outcomes. Patients underwent a thorough clinical and radiological examination of both knees at 3, 6, 12, 18, and if possible also at 24 months. A total of four patients (1 female, 3 male; ø 38 (± 18) years), who underwent arthroscopic refixation of a PCL avulsion fracture using 3 Tight Rope device were enrolled in this study. Mean follow up was 22 [18–24] months. The mean subjective IKDC was 72.6% (± 9.9%). Regarding the objective IKDC three patients accounted for grade A, one patient for grade C. The 4 Center for Musculoskeletal Lysholm score yielded 82 (± 6.9) points. The KOOS score reached (± 13%; symptoms 76%, pain 81%, function 76%, sports 66%, QoL 64%). All patients showed complete osseous integration and anatomic reduction of the bony avulsion. The mean posterior tibial translation at final follow up was 2.8 [0–7] mm. All-arthroscopic treatment of tibial avulsion fractures of the posterior cruciate ligament provides satisfactory clinical results in a preliminary patient cohort. It is a reproducible technique, which minimizes soft tissue damage and obviates a second surgery for hardware removal. Further clinical studies with larger patient cohorts and a control group are needed to further confirm these preliminary results.

MATERIALS AND METHODS

TYPE OF STUDY:

The present prospective observational study carried out at Tertiary Institute to evaluate the functional and radiological outcomes of arthroscopic fixation of Posterior Cruciate Ligament avulsion fractures with Tight rope like device.

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DURATION OF STUDY:

This study was conducted during the period from May 2017 to October 2018.

PLACE OF WORK:

The study was conducted at Department of Orthopedics Dr. Vithalrao Vikhe Patil Foundation's Medical College, Vilad Ghat, Ahmednagar

STUDY POPULATION:

All patients who present to the hospital and admitted with PCL tibial avulsion fractures were included in the study.

SAMPLE SIZE:

A total of sample size of 30 patients with PCL tibial avulsion fractures was included.

SAMPLE SIZE ESTIMATION:

Following parameters were considered for sample size:

$$n = \frac{4pq}{L^2}$$

- Population under study is 1800.
- Prevalence of Posterior Cruciate Ligament avulsion fractures is (p)=1.5
- Absolute precision (L)= 5%
- Confidence level set at 95%
- Minimum Sample Size = 23
- Attrition (drop-out rate)= 10%
- Total Sample Size= 26

Hence finally the total number of patients studied was 30.

ETHICAL APPROVAL:

The study was conducted after obtaining clearance from the Ethical Committee of the institute and permission from the appropriate authority.

INCLUSION CRITERIA:

- Age: 21 to 45 years of age of both the sexes who are willing to participate in the study
- Radiological (X-ray and MRI) diagnosis of PCL avulsion fractures

EXCLUSION CRITERIA:

- Associated bleeding/ coagulation disorders
- Infected joint.
- Multi-ligamentous injury

STUDY TOOLS:

Instruments Used:

- TV, Camera system & Light source
- Shaver System
- Pneumatic Tourniquet
- Basic Arthroscopic Instruments
- Trocar, Cannula, Arthroscope (30^0), Probe, Hand Instruments
- PCL Reconstruction Instruments
- Tibial Guide, Guide Wires, Reamers, Graft Sizer, Femoral Aimer, Beath Pin,
- Suture wheel
- Ethibond No. 5
- Might rope / Tight rope.
- Underwater cautery.
- Exchange rod
- Portal cannula

Figure 12: EQUIPMENT NEEDED FOR SURGERY

OPERATIVE TECHNIQUE

Anaesthesia

- Spinal/ Epidural / General

Patient Positioning

- Patient supine on operating table with thigh supported with lateral post and knee kept in 90 degrees of flexion.

Tourniquet

- Pneumatic tourniquet will be applied to the thigh after exsanguination of the affected limb.
- Affected lower limb from below tourniquet to toe tip will be scrubbed, painted and draped.

Figure 13: INSTRUMENTATION NEEDED FOR SURGERY

SURGICAL TECHNIQUE[5]

- The patient undergoes spinal/epidural or general anaesthesia, receive perioperative antibiotics, and was placed in the supine position on the operating table.
- After a thorough physical examination, a tourniquet was applied to the patient's thigh, the lateral post adjusted(Fig. 15), and the leg was prepared and draped in a sterile fashion.(Fig. 16)

Figure 14: SCRUBBING DONE BEFORE STARTING THE SURGERY

POSITIONING AND TOURNIQUET

APPLICATION

Figure 15: POSITIONING AND TOURNIQUET APPLICATION

PAINTING AND DRAPING

Figure 16: PAINTING AND DRAPING

PORTALS

Figure 17: ANTEROMEDIAL, ANTEROLATERAL AND POSTEROMEDIAL PORTALS

- The arthroscopic portals used were as follows: anteromedial portal, anterolateral portal, and posteromedial portal.(Fig. 17)

- Routinely, diagnostic arthroscopy was performed to be aware of concomitant lesions. Fracture debris and blood clots removed to create visual access to the tibial fracture site of the PCL.
- The arthroscope was advanced posteriorly between the medial femoral condyle and the PCL into the popliteal recess.
- The posteromedial portal was created by a percutaneous guide needle, adjacent to the posteromedial femoral condyle and about 1 cm above and posterior to the joint line.

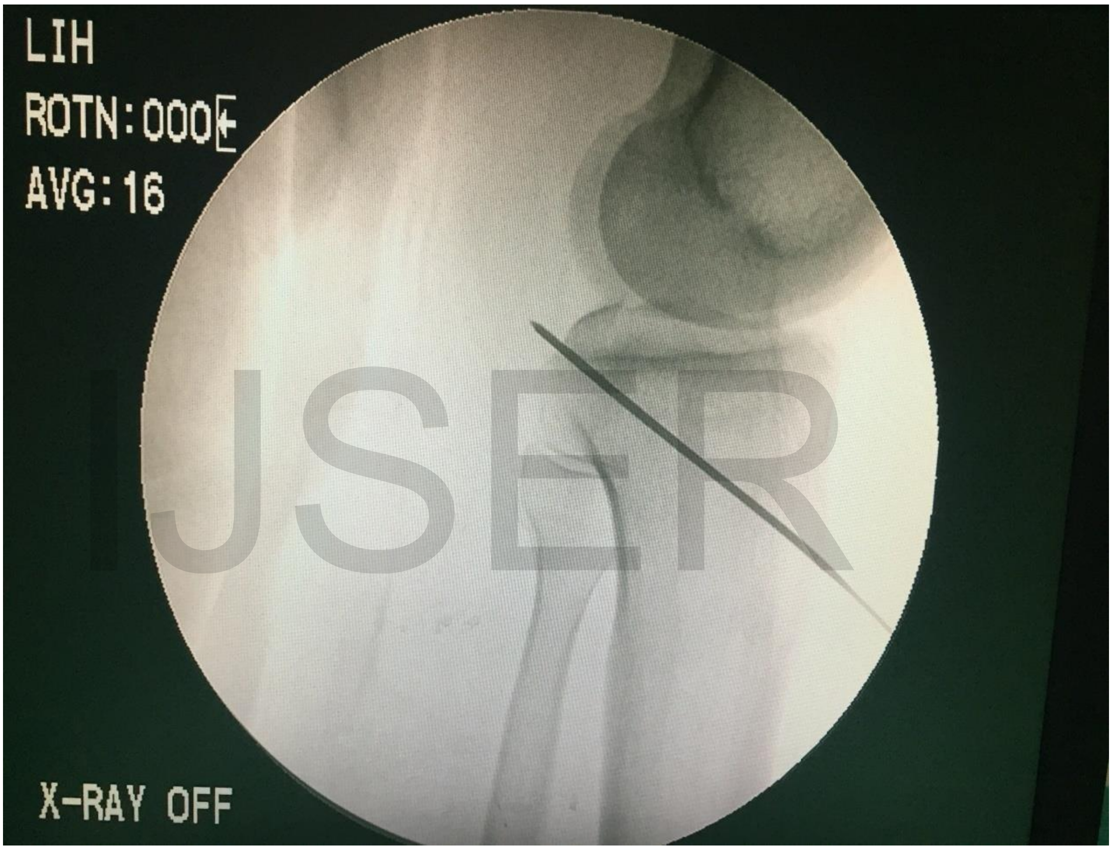

Figure 18 : INTRA-OP IMAGE OF TRANS-TIBIAL GUIDE WIRE INSERTION

- Partial synovectomy and opening of the posterior capsule was performed to expose the extent of the bony avulsion.

- The size of the fragment was measured by use of the 5-mm tip of the probe, the fracture gap was debrided, and the avulsion fragment was reduced for testing purposes.
- After completion of the initial diagnostic arthroscopy, a 1.5-cm-long incision was performed about 10 to 30 mm distal to the tibial tuberosity on the anteromedial lowerleg.
- A tibial PCL drill guide was inserted into the joint by use of its tip to reduce the fracture under direct visualization. (Fig. 19)

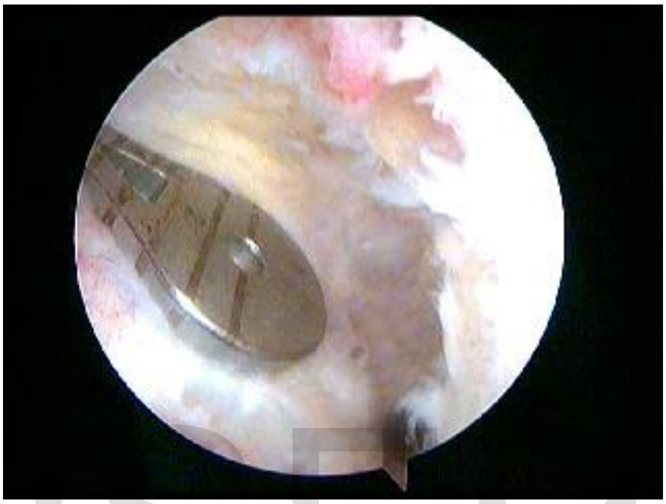

FIGURE 19: REDUCTION OF THE AVULSED FRAGMENT HELD WITH THE TIP OF DRILL GUIDE

- The drill sleeve was then placed on the anteromedial tibial cortex, just above the footprint of the pes anserinus. With the drill guide held in this position and under a clear arthroscopic view through the first posteromedial portal, a 2.4-mm guidewire was inserted, aiming for the mid part of the avulsion, to secure the reduction of the bony avulsion temporarily.(Fig. 20, 21)

FIGURE 20: TRANS- TIBIAL GUIDE WIRE INSERTION

FIGURE 21: CONFIRMATION OF GUIDE WIRE INSERTION THROUGH THE AVULSED FRAGMENT BY ARTHROSOPY

- The central guide wire was over-drilled with a 4-mm cannulated drill bit. Both the guide wire placement and the drilling direction were controlled by a picture intensifier on straight anteroposterior and lateral views.(Fig. 22)

FIGURE 22 : OVER-DRILLING THE GUIDE WIRE WITH 4 MM CANNULATED DRILL BIT.

- A TightRope was attached to the beeth pin and pulled in a transtibial manner through the bony avulsion.

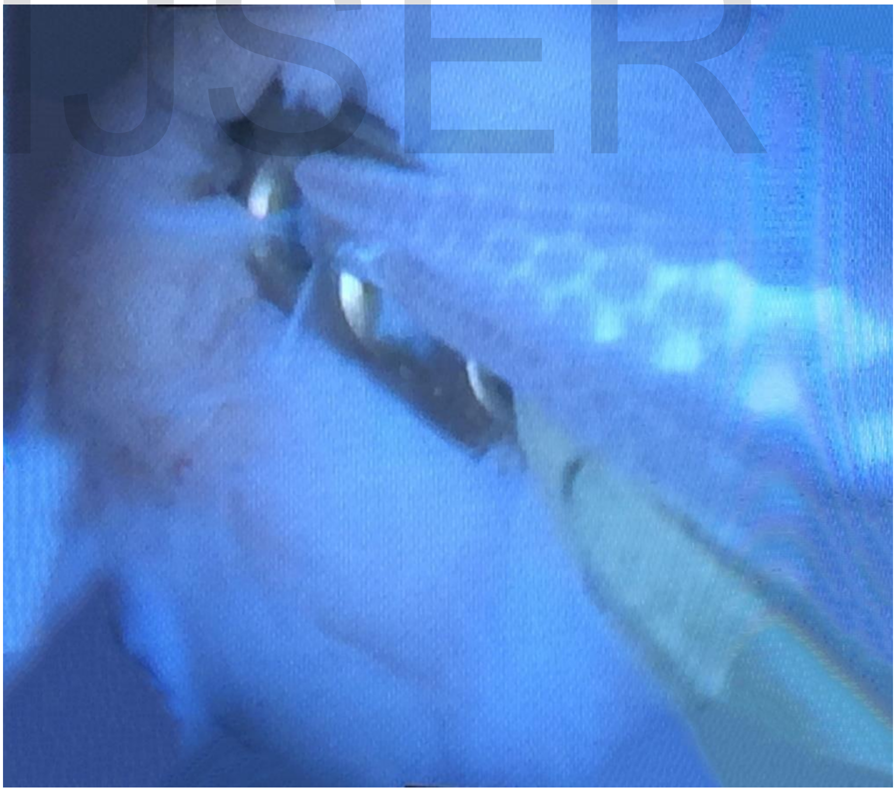

FIGURE 23 : BUTTON FLIPPED OVER THE AVULSED FRAGMENT

- Once the oval button of the Tight Rope device was flipped under arthroscopic visualization, traction was applied to the pretibial sutures.(Fig. 23)
- The securing guide wire was then removed, and the Tight Rope tightened with the tibia drawn anteriorly until complete reduction was achieved.
- The Tight Rope was then knotted securely with suture wheel anteriorly.(Fig. 24)

FIGURE 24 : TIGHT ROPE SECURED WITH SUTURE WHEEL OVER TIBIAL CORTEX ANTERIORLY

- Finally, the pretibial incision and the arthroscopic portals was closed in standard fashion.

ANALYSIS:

Clinical Parameter (Pre-Op)

- Pain (Visual Analogue Scale)
- Knee Function (Knee Society Score)
- Posterior Drawer test
- Sag sign

Radiological Parameter (Pre-Op)

- X-ray evidence of Posterior Cruciate Ligament avulsion fracture
- MRI evidence of Posterior Cruciate Ligament avulsion fracture

Clinical Parameter (Post-Op)

Follow up was done on OPD basis every monthly for six months postoperatively with clinical and radiological evaluation, based on:

- Pain (Visual Analogue Scale)
- Knee Function (Knee Society Score)
- Posterior Drawer test
- Sag sign

Radiological Parameter (Post-op)

- X-ray to confirm accurate reduction and fracture union.

POST-OP PHYSIOTHERAPY:

- Isometric exercises were started immediately post-op.
- Sequential knee bending was achieved up to full ROM over 6 weeks.

- Weight bearing was permitted immediately post-op up to 1 month with posterior knee brace; thereafter with hinged knee brace up to 6 months.

Post-op Rehabilitation

- Isometric exercises are started immediately post-op comprising of Ankle pumps and Static quadriceps exercises.(Fig. 27, 28, 29, 30)

Figure 25: POST-OP PHYSIOTHERAPY 1- ANKLE PUMPS

Figure 26: POST-OP PHYSIOTHERAPY 2- STATIC QUADRICEPS EXERCISE

- Sequential knee bending is achieved up to full ROM over 6 weeks.
- Weight bearing is permitted immediately post-op up to 1 month with posterior knee brace; thereafter with hinged knee brace up to 6 months.

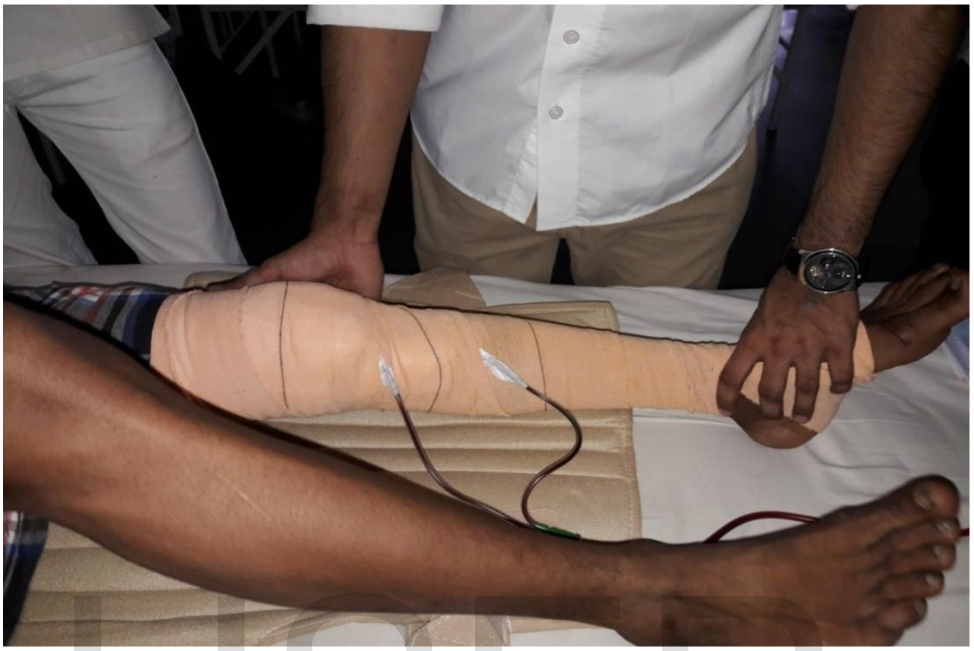

Figure 27: POST-OP PHYSIOTHERAPY 3- HEEL SLIDE

Figure 28: POST-OP PHYSIOTHERAPY 4- ADDUCTOR STRENGTHENING

Figure 29: POST-OP CLINICAL PHOTO- DAY 0

Figure 30: CLINICAL PHOTO: 1 MONTH FOLLOW-UP

Figure 31: CLINICAL PHOTO: 3 MONTH FOLLOW-UP

Figure 32 : 6 MONTH FOLLOW-UP

STATISTICAL ANALYSIS

The statistical analyses performed using the Statistical Package for Social Science (SPSS) version21 for Windows. Data were expressed as mean values ± standard deviations (SD) for continuous variables. Frequency and proportions were reported for categorical variables. The p-value of < 0.05 was considered statistically significant.

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CASE EXAMPLES

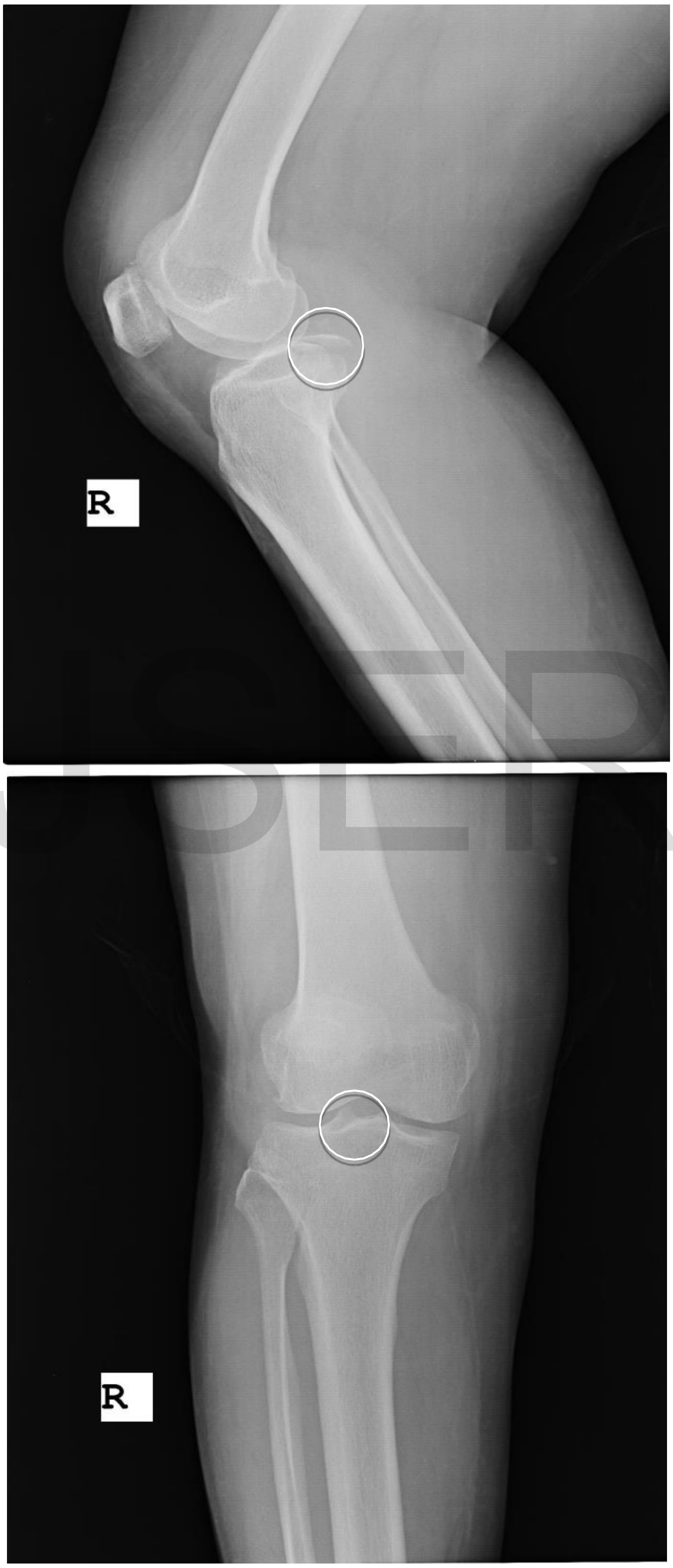


Figure 33 : PRE-OP X-RAYS OF KNEE JOINT IN AP AND LATERAL VIEW SHOWING PCL TIBIAL AVULSION

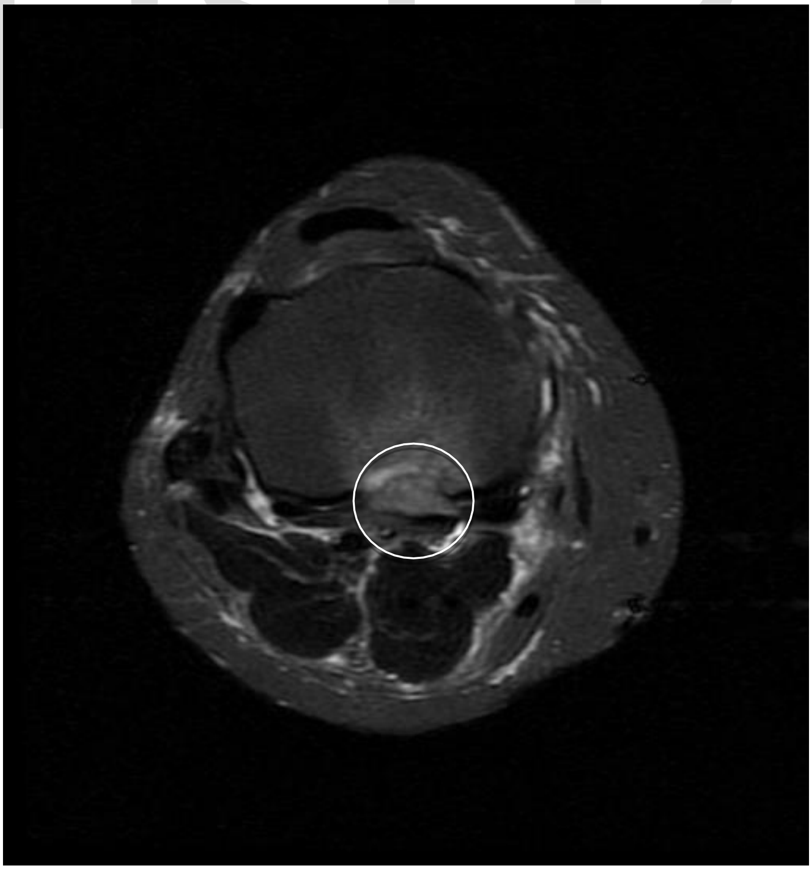


Figure 34 : PRE-OP MRI SHOWING PCL TIBIAL AVULSION

Figure 35 : POST-OP X-RAY SHOWING PCL TIBIAL AVULSION REDUCTION USING TIGHTROPE AND SUTURE WHEEL

OBSERVATION AND RESULTS

Table 1: Distribution according to age:

Age group (years)	No of Patients	Percentage
21-25	03	10.00
26-30	12	40.00
31-35	07	23.33
36-40	05	16.67
41-45	03	10.00
Total	30	100

The above table shows distribution of patients according to age. It was observed that majority of patients were in age group 26-30 years (40%) followed by 31-35 years (23.33%) The mean age of the patients was 31.26 ±09.85 years.

Chart 1: Distribution according to age:

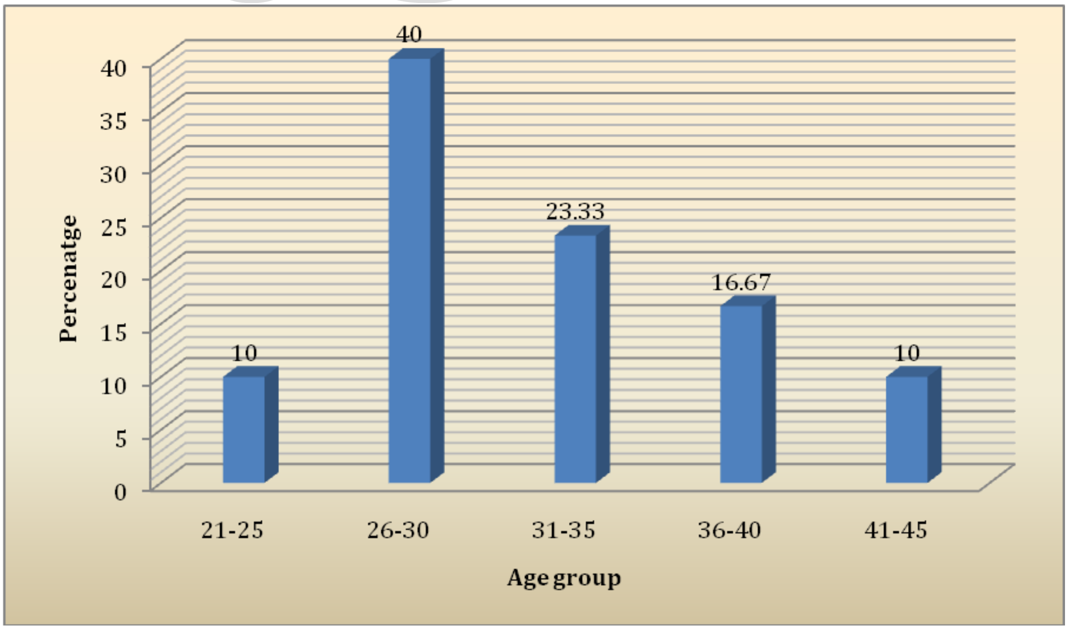


Table 2: Distribution according to sex:

Sex	No of Patients	Percentage
Male	23	76.67
Female	07	23.33
Total	30	100

The above table shows distribution of patients according to sex. It was observed that majority of patients were in male (76.67%) and females were 23.33%.

Chart 2: Distribution according to sex:

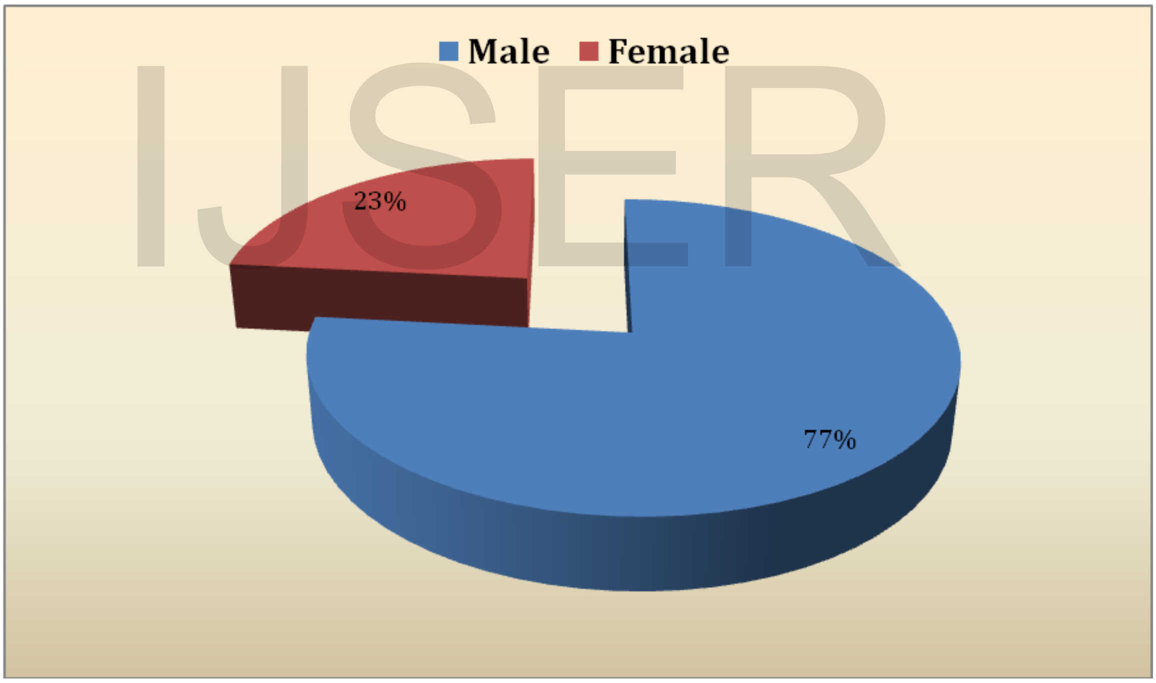


Table 3: Distribution according to mechanism of injury:

Mechanism of injury	No of Patients	Percentage
Road traffic accident	19	63.33
Trauma	09	30.00
Sports injury	02	06.67
Total	30	100

The above table shows distribution of patients according to mechanism of injury. It was observed that majority of patients had road traffic accident (63.33%) followed by trauma (30%) and sport injury (6.67%)

Chart 3: Distribution according to mechanism of injury:

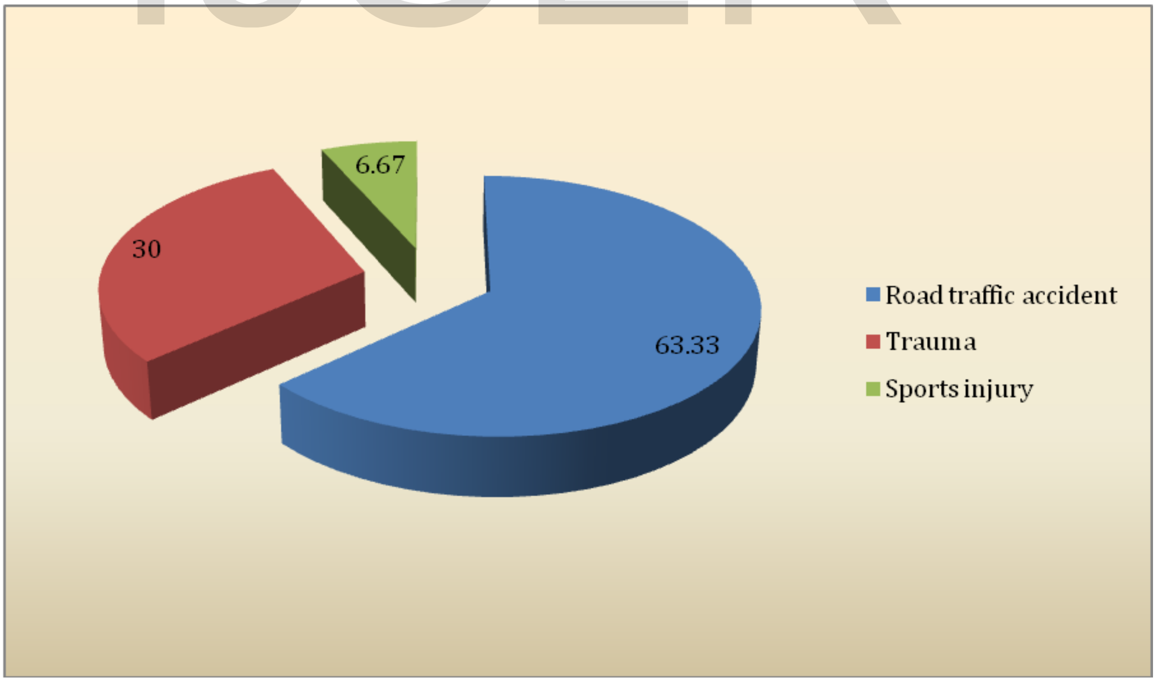


Table 4: Distribution according to side of injury:

Side	No of Patients	Percentage
Right	21	70.00
Left	09	30.00
Total	30	100

The above table shows distribution of patients according to side involved. It was observed that majority of patients right side affected (70%) followed by left side (30%)

Chart 4: Distribution according to side of injury:

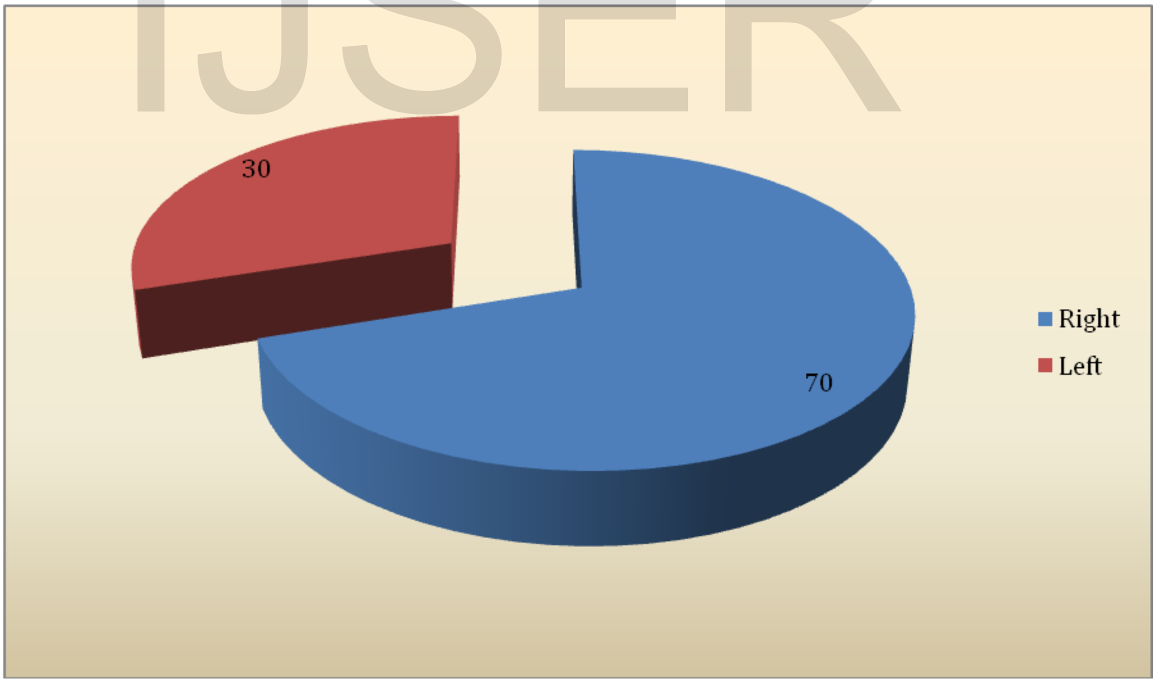


Table 5: Distribution according to duration of injury to surgery:

Duration of injury (weeks)	No of Patients	Percentage
<1	03	10.00
1-2	10	33.33
3-4	08	26.67
>4	09	30.00
Total	30	100

The above table shows distribution of patients according to time of surgery from injury. It was observed that majority of patients get operated within 1-2 weeks of injury (33.33%) while 9 (30%) was operated after 4 weeks of injury.

Chart 5: Distribution according to duration of injury to surgery:

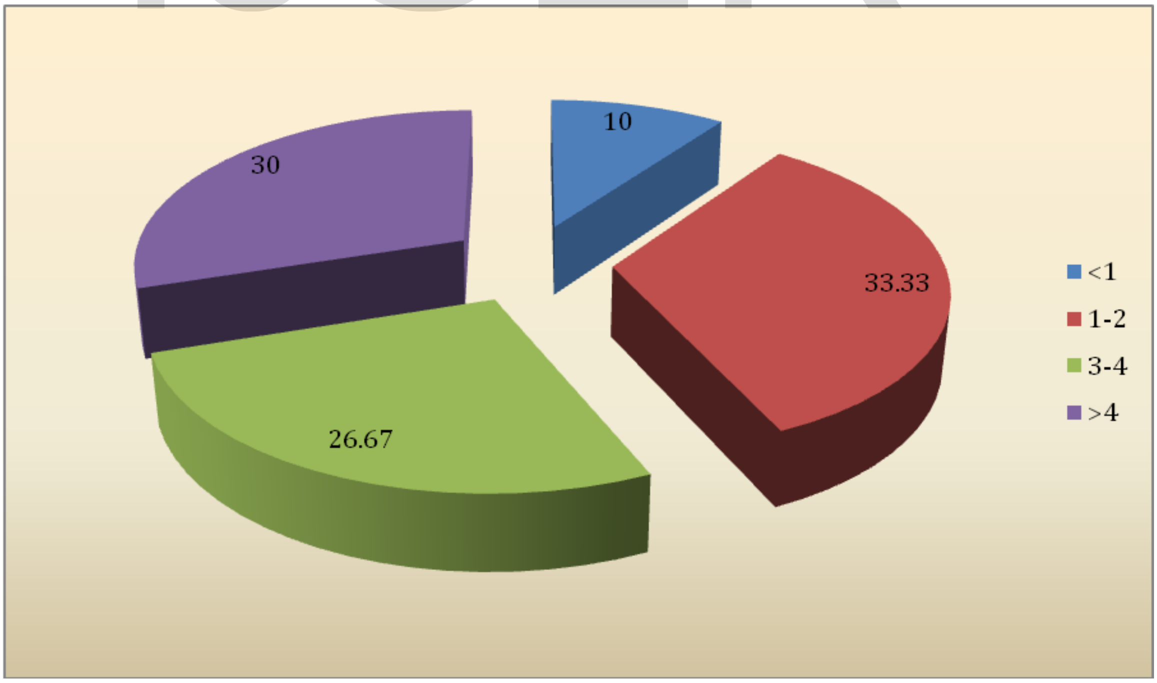


Table 6: Distribution according to pre-operative clinical parameters:

Clinical Parameters	Mean	SD
Pain (VAS)	**7.13**	**1.17**
Knee Function (KSS)	**36.10**	**8.10**
Posterior drawer test positive (n=30)	**23**	**76.67**
Sag sign present (n=30)	**21**	**70.00**

The above table shows distribution of patients according to pre-operative clinical parameters. The mean VAS score was 7.13±1.17. The mean Knee function score (KSS) was 36.10 ±8.10. The Posterior drawer test positive among 23 (76.67%) patients. The sag sign was present among 21 (70%) patients**.**

Table 7: Comparison of pre and post-operative pain:

Pain	Pre-op	Post-op	P value
VAS	**7.13 ±1.27**	**3.13 ±0.82**	**<0.05***

(P<0.05 statistically significant)

The above table shows distribution of patients according to pre and post- operative VAS score. The mean pre-operative VAS score was 7.13±1.27 and mean post-operative VAS score was 3.13 ±0.82. The VAS score showed statistically significant difference pre and post-operative. (P<0.05)

Chart 6: Comparison of pre and post-operative pain:

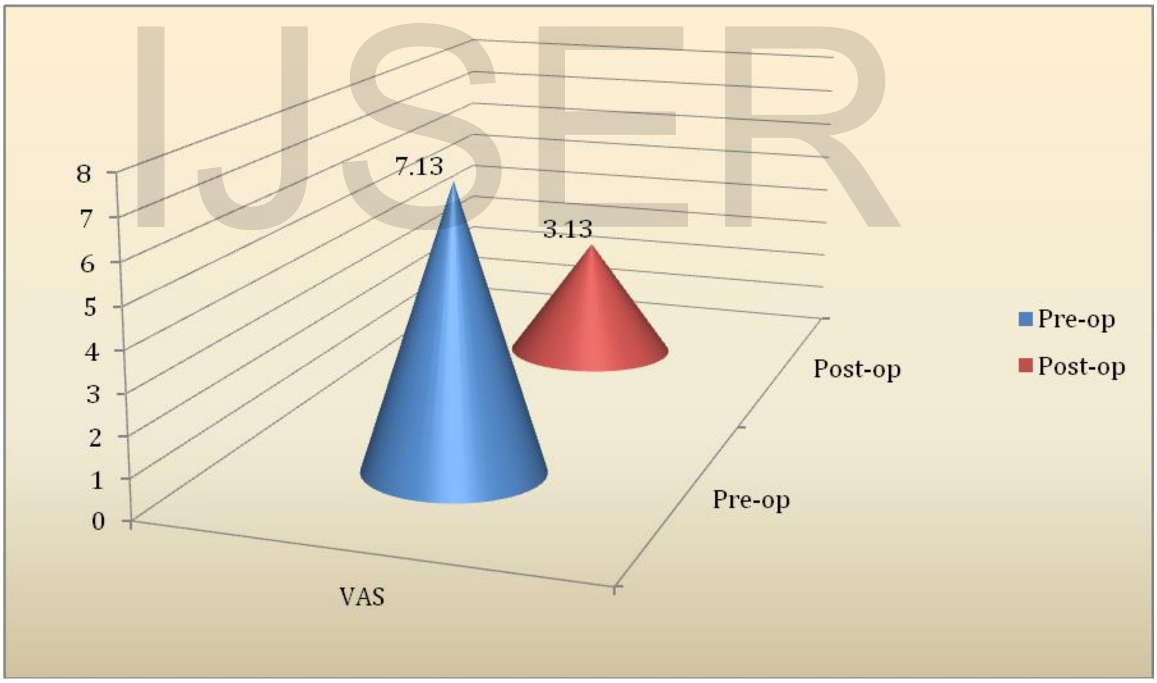


Table 8: Comparison of pre and post-operative knee function:

Knee function	Pre-op	Post-op	P value
KSS	**36.10 ±8.10**	**92.73 ±5.84**	**<0.05***

(P<0.05 statistically significant)

The above table shows distribution of patients according to pre and post- operative knee function score. The mean pre-operative KSS score was 36.10 ±8.10 and mean post-operative KSS score was 92.73 ±5.84. The KSS score showed statistically significant difference pre and post-operative. (P<0.05)

Chart 7: Comparison of pre and post-operative knee function :

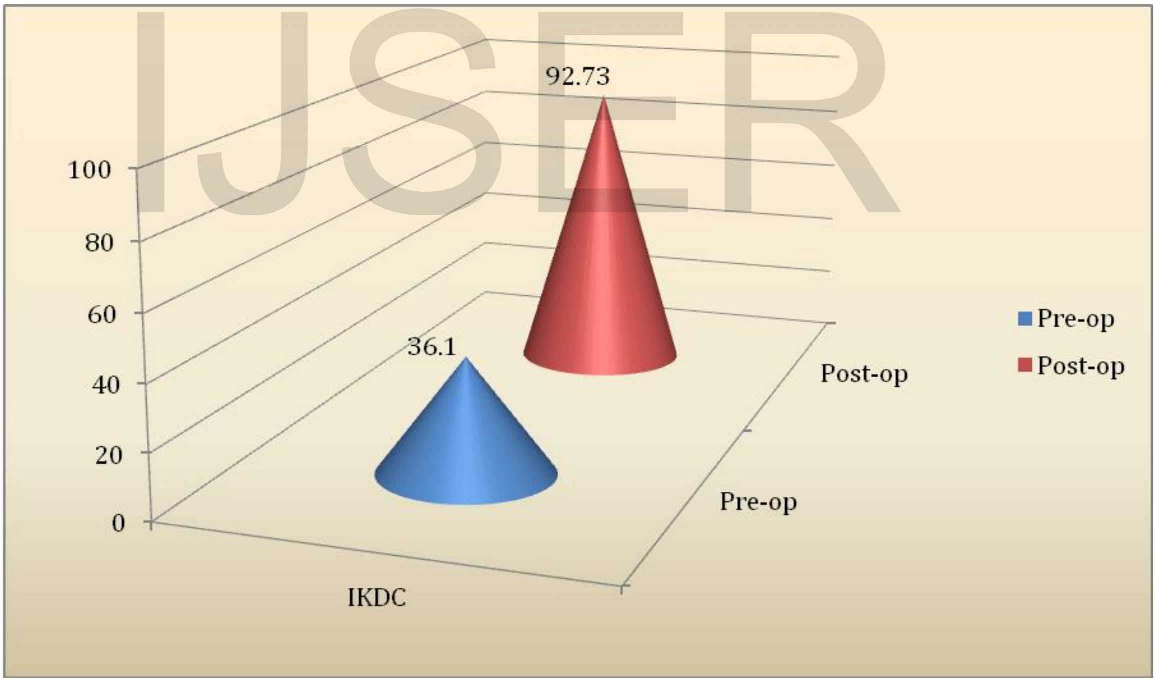


Table 9: Distribution according to post-operative radiological parameters:

Radiological Parameters	No of Patients	Percentage
Accurate Reduction	30	100
Fracture Union	30	100

The above table shows distribution of patients according topost-operative radiological parameters. The accurate reduction was observed in all patients (100%) and with fracture union. (100%)

Chart 8: Distribution according to post-operative radiological parameters:

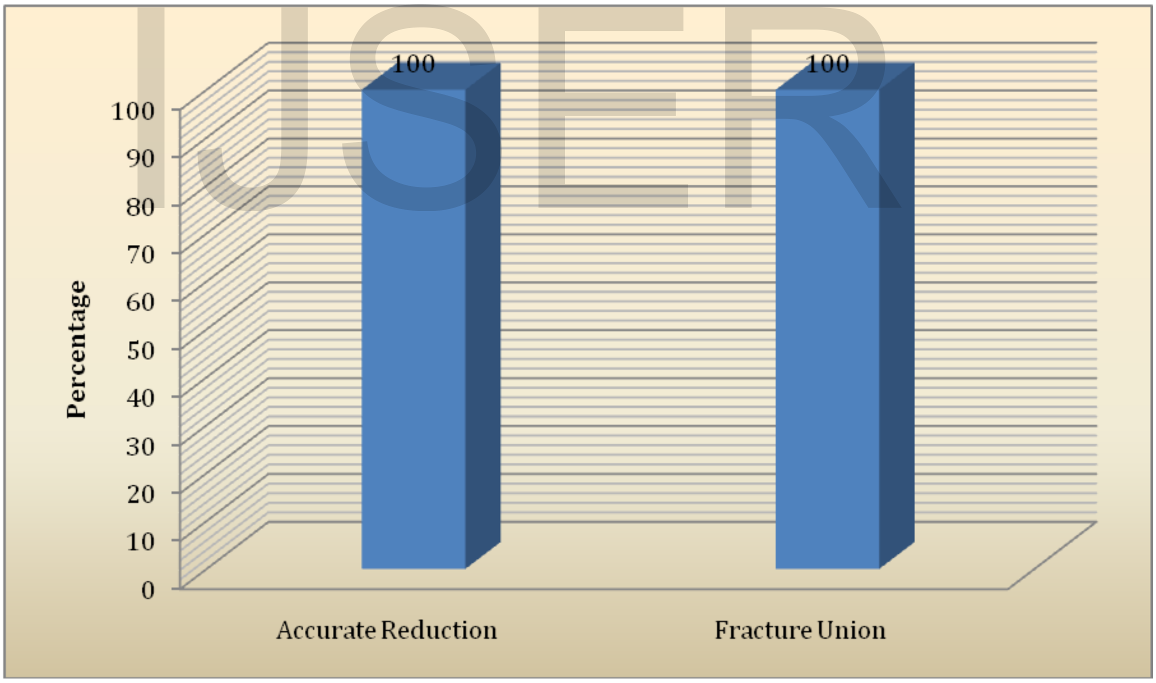


Table 10: Distribution according to final evaluation by KSS:

KSS	No of Patients	Percentage
Excellent	21	70.00
Good	07	23.33
Fair	02	06.67
Poor	00	00.00
Total	30	100

The above table shows distribution of patients according to final outcome by KSS score. It was observed that majority of patients had Excellent outcome (70%) followed by Good (23.33%) and Fair (6.67%)

Chart 9: Distribution according to final evaluation by KSS:

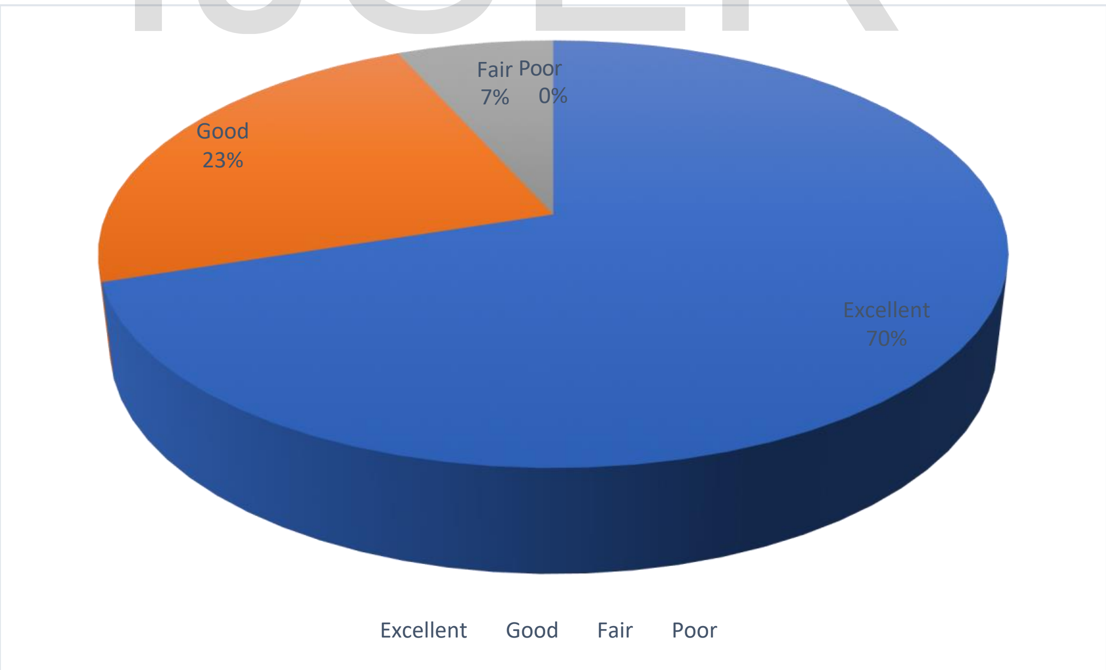
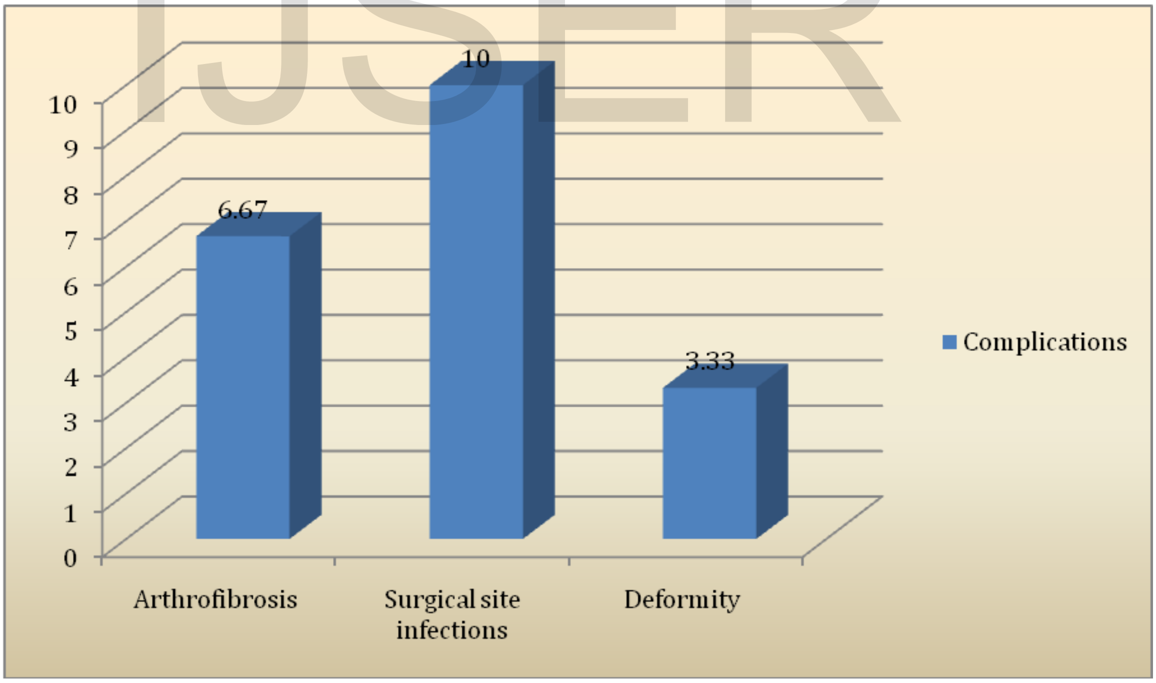


Table 11: Distribution according to complications:

Complications	No of Patients (n=30)	Percentage
Arthrofibrosis	02	06.67
Surgical site infections	03	10.00
Deformity	01	03.33

The above table shows distribution of patients according to complications. It was observed that majority of patients had surgical site infections (10%) followed by arthrofibrosis (6.67%) and deformity (3.33%)

Chart 10: Distribution according to complications:



DISCUSSION

The present study was a prospective observational study undertaken to evaluate the functional and radiological outcomes of arthroscopic fixation of Posterior Cruciate Ligament avulsion fractures with Tightrope like device in a tertiary care center.

The study was conducted in Department of Orthopaedics at tertiary care hospital from May 2017 to October 2018. A total sample size of 30 patients referred to the department OPD with Posterior Cruciate ligament avulsion fractures in 21 to 45 years of age of both the sexes was included. Patients associated bleeding/ coagulation disorders, infected joint, multi-ligamentous injury were excluded from study.

The study was conducted after taking ethical clearance from the institute and informed consent from the patients. The data was collected from patients regarding demographic profile, clinical spectrum and functional outcome.

In the present study, the distribution of patients according to age showed that majority of patients were in age group 26-30 years (40%) followed by 31-35 years (23.33%) The mean age of the patients was 31.26 ±09.85 years. The range from 22 years to 45 years.

Sachin Joshi et al[77] evaluated the clinical and functional outcome of tibial avulsion injuries of the PCL observed mean age of 33.9 years among patients. Nitin Bhalerao et al[78] studied arthroscopic fixation of PCL tibial avulsion fractures using tight rope like device observed the average age of the 10 patients was 31.7 years.

Clemens Gwinner et al[13] studied reconstruction technique for bony tibial avulsion fractures of the PCL and initial clinical outcomes observed mean age of 41.5

±13.8 years.

It was observed that majority of patients were in male (76.67%) and females were 23.33% with male dominance.

Nitin Bhalerao et al[78] studied arthroscopic fixation of PCL tibial avulsion fractures using tight rope like device observed out of 10 patients 7were male and 3 were female.

Clemens Gwinner et al[13] studied reconstruction technique for bony tibial avulsion fractures of the PCL and initial clinical outcomes observed males were 75% and females were 25%.

The distribution of patients according to mechanism of injury showed that majority of patients had road traffic accident (63.33%) followed by trauma (30%) and sport injury (6.67%)

Sachin Joshi et al[77] evaluated the clinical and functional outcome of tibial avulsion injuries of the PCL observed the most common mode of injury was road traffic accident (64.28%) with a majority involving motorcycle accident followed by either sports-related injury or fall.

It was observed that majority of patients right side affected (70%) followed by left side (30%)

Nitin Bhalerao et al[78] studied arthroscopic fixation of PCL tibial avulsion fractures using tight rope like device observed 6 out of 10 fractures were right sided and rest 4 were left sided.

In the present study, it was observed that majority of patients get operated within 1-2 weeks of injury (33.33%) while 9 (30%) was operated after 4 weeks of injury.

Sachin Joshi et al[77] evaluated the clinical and functional outcome of tibial avulsion injuries of the PCL observed out of 14 patients 11 patients presented to the clinic within 3 weeks of injury while three patients presented between 3 to 12 weeks after injury. The average period of follow-up was 13.5 months.

The mean VAS score was 7.13 ±1.27. The mean Knee function score (KSS) was 36.10 ±8.10. The Posterior drawer test positive among 23 (76.67%) patients. The sag sign was present among 21 (70%) patients.

The mean pre-operative VAS score was 7.13 ±1.27 and mean post-operative VAS score was 3.13 ±0.82. The VAS score showed statistically significant difference pre and post-operative. ($P<0.05$)

The mean pre-operative KSS score was 36.10 ±8.10 and mean post-operative KSS score was 92.73 ±5.84. The KSS score showed statistically significant difference pre and post-operative. ($P<0.05$)

W. Zhu et al[79] evaluated the outcome of the treatment of tibial avulsion fracture of posterior cruciate ligament observed the mean score (and standard deviation) increased from 38.9 ± 4.9 points to 95.2 ± 3.8 points with significance.

Sachin Joshi et al[77] evaluated the clinical and functional outcome of tibial avulsion injuries of the PCL observed the average flexion was 121.7°±9.2° with full extension achieved in all patients. Mild instability (1+) was noted in 4 patients. The accurate reduction was observed in all patients (100%) and with fracture union. (100%)

Sachin Joshi et al[77] evaluated the clinical and functional outcome of tibial avulsion injuries of the PCL observed at the final follow-up, all 14 patients achieved fracture union.

W. Zhu et al[79] evaluated the outcome of the treatment of tibial avulsion fracture of posterior cruciate ligament observed. 16 cases were followed up for 7–30 months (average 13.6), and 2 cases were out of follow-up. In the 16 followed patients, flexion and extension were back to normal within 6 weeks, and return to normal walk in 12 weeks.

It was observed that majority of patients had Excellent outcome (70%) followed by Good (23.33%) and Fair (6.67%)

Sachin Joshi et al[77] evaluated the clinical and functional outcome of tibial avulsion injuries of the PCL observed the functional score was excellent in 11 patients, good in 2 patients and fair in 1 patient.

Clemens Gwinner et al[13] studied reconstruction technique for bony tibial avulsion fractures of the PCL and initial clinical outcomes observed regarding the objective IKDC outcome 75% patients accounted for grade A and 25% patient for grade C.

It was observed that majority of patients had surgical site infections (10%) followed by arthrofibrosis (6.67%) and deformity (3.33%)

W. Zhu et al[79] evaluated the outcome of the treatment of tibial avulsion fracture of posterior cruciate ligament observed the bone healing was good (100%) without any vascular or nerve complications. All the patients regained the preinjury activity level.

The results of the study indicate that using a Tight Rope device appears to be a feasible and reproducible alternative for PCL avulsion fractures. Even though bony avulsions only account for a small subgroup of all PCL injuries, accurate reduction seems mandatory to enable physiological joint biomechanics and to prevent further osteoarthritic progression and to minimize failure of concomitant meniscal or ligament repair. According to current literature, two approaches are mainly used for the surgical treatment of displaced tibial avulsion fractures of the PCL; an open and an arthroscopic one. Both appear to have advantages and disadvantages.

Recently, arthroscopic approaches are gaining interest, as they are able to address concomitant lesions, such as chondral or meniscal tears. In addition, they are less invasive due to decreased exposure of the posterior capsule or muscle and therefore reducing both soft tissue damage and postoperative scar formation.

On the basis of the growing popularity of the Tight Rope device in AC joint repair the presented technique has been implemented.

The present study major limitation of the study was small number of patients. A large sample size study should be performed to draw firm conclusion

CONCLUSION

The results of the study indicate that using a Tight Rope device appears to be feasible and reproducible alternative for PCL avulsion fractures.

The arthroscopic approaches are able to address concomitant lesions, such as chondral or meniscal tears. In addition, they are less invasive due to decreased exposure of the posterior capsule or muscle and therefore reducing both soft tissue damage and postoperative scar formation.

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ANNEXURE I: CONSENTS

INFORMED CONSENT FORM

For submission of Research proposal to
Ethics Committee of aforementioned Medical College

1. I, Mr. / Mrs.____, age ________ years residing at ____he reby give my informed consent to participate in the ____ ________________Project

2. There is no compulsion on me to participate in this project and I am giving my free consent for it.

3. I am ready and willing to undergo all tests and treatments in the present project.

4. I have read and I have been explained the general information and purpose of the present project.

5. I have been informed / I have read the probable complications while participating in the present project.

6. I know that I can withdraw from the present project at any time.

7. Any data or analysis of this project will be purely used for scientific purpose and my name will be kept confidential except when required for any legal purpose.

8. I can read English / I can understand data read out to me in English.

Signature of parent/Guardian Signature of Volunteer In case of minor person.

Witnesses: 1.

2.

संमती पत्र

संशोधन प्रकल्प मेडिकल कॉलेजच्या
नीति समितीस सादर करण्यासाठी

1. मी --/-------वय---------- वर्षे,राहणार ---------------------------------- माझ्या स्वेच्छेने -- प्रकल्पामध्ये सहभागी होण्यास संमती देत आहे.

2. माझ्यावर प्रस्तुतच्या प्रकल्पामध्ये सहभागी होण्यासाठी कोणाचाही दबाव नाही.

3. प्रस्तुतच्या प्रकल्पात येणाऱ्या तपासण्या व औषधोपचार घेण्यास मी तयार आहे.

4. प्रस्तुतच्या प्रकल्पाची सर्वसाधारण माहिती मला समजेल अशा भाषेत मी वाचली आहे / मला समजावून सांगण्यात आले आहे.

5. मला प्रस्तुतच्या प्रकल्पात संभाव्य धोक्यांची माहिती सांगण्यात आलेली आहे / मी वाचलेली आहे.

6. या प्रकल्पामधून मी कधीही बाहेर पडू शकतो / शकते याची मला माहिती आहे.

7. या प्रकल्पात निघणारे निष्कर्ष केवळ शास्त्रीय कारणांसाठी वापरले जातील / प्रकाशित केले जातील याची मला कल्पना आहे. तसेच माझी ओळख कायदेशीर बाबींव्यतिरिक्त इतर वेळेस गुप्त ठेवली जाईल.

8. मला मराठी वाचता येते / मराठी वाचून दाखविलेले समजते.

सहभागी व्यक्तीची सही

सहभागी व्यक्ती अज्ञान असल्यास त्याचे
पालक किंवा घोषित पालकाची सही.

साक्षीदार :

1.
2.

प्रमुख संशोधकाची सही

CONSENT - 7 | Arthroscopy.

NAME : ______________________ Registration No. :______________

Date : _____/_____/________.

आम्हाला हॉस्पिटलच्या डॉक्टरांनी सांगितले आहे की, आमचा रूग्ण
______________________ यांचे खालील ऑपरेशन करायचे आहे :

भूल देताना किंवा दिल्यानंतर खालील धोके होऊ शकतात :

१) अतिसंवेदनशीलतेमुळे धोका पोहचू शकतो. (Hypersensitivity may be a risk factor)

२) हृदयाची कार्यक्रिया बंद पडू शकते. (Cardiac arrest may occur)

ऑपरेशन करताना किंवा केल्यानंतर खालील धोके होऊ शकतात :

१) ऑपरेशनच्या जागेवर जंतूसंसर्ग होऊ शकतो. (Infection may occur at operative site)

२) पुन्हा ऑपरेशनची गरज पडू शकते. (Revision surgery may be needed)

३) वर्तमान परिस्थितीत कितपत सुधारणा होईल याचे आश्वासन देता येणार नाही.
(Improvement in current condition can not be assured)

४) ऑपरेशनच्या जागेवर महत्त्वाच्या नसांना व रक्तवाहिन्यांना धोका पोहचू शकतो.
(Neurovascular damage may occur at operative site)

५) अतिदक्षता विभागात ठेवण्याची गरज पडू शकते. (I.C.U. care may be needed)

६) उजव्या / डाव्या हाताची / पायाची हालचाल व संवेदना कमी होऊ शकतात.
(Movements and sensations of right/left upper/lower limb may decrease)

७) सांध्याची अस्थिरता व जखडण असे घडू शकते. (Joint instability and stiffness may occur)

वरील सर्व गोष्टी लक्षात घेता आम्ही हॉस्पिटलच्या डॉक्टरांना ऑपरेशनची परवानगी देत आहोत. तसेच काही धोका झाल्यास आम्ही हॉस्पिटलच्या डॉक्टरांना, कर्मचाऱ्यांना तसेच हॉस्पिटलला जबाबदार धरणार नाही.

नाव :	नाव :
नाते :	नाते :
सही :	सही :
दिनांक :	दिनांक :

ANNEXURE II: PROFORMA

PROFORMA OF CASE STUDY

Case no.: **OPD/IPD NO:**

Name:

Age/Sex :

Address

Occupation:

DOA : **DOP :** **DOD:**

Chief complaints:

History of Present Illness:

Mechanism of Trauma: Direct / Indirect

Past History: D.M/ T.B. / H.T. / B.A.

: Major Medical/ Surgical history

: Any other joint Arthropathy:

Family History:

Personal History:

Sleep: **Appetite:**

Bowel& Bladder Habits:

Addictions: **Drug allergy:**

General Examination:

Built: **Nourishment:** **Weight:**

Temp: Pulse:

: R.R.:

E/o Pallor/ icterus/ cyanosis/ oedema/ lymphadenoapathy

Systemic Examination:

CVS- CNS-

RS- GIT-

Local Examination:

1. Thigh wasting
2. Muscle power
3. Range of movement
4. Posterior drawer test
5. Lachman test
6. Reverse pivot shift test
7. Godfrey's test

Provisional Clinical Diagnosis:

X-ray:

Investigation: CBC, B.T., C.T., Plasma Glucose Surgery

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Annexure III: Masterchart

Sr.No	Patient No.	Age	Gender	Side of injury	Mechanism of injury	Diagnosis	Preoperative parameters						Duration since injury (weeks)	Post-operative parameters					Result
							Clinical assessment				Radiological fingings			Clinical assessment				Radiological findings	
							Pain (VAS)	Knee function (KSS)	Posterior Drawer test	Sag sign	X-ray	MRI		Pain (VAS)	Knee function (KSS)	Posterior Drawer test	Sag sign	X-ray	
1	PT 1	22	M	R	RTA	PCL Tibial avulsion	7	38	Positive	Present	Present	Present	<1	3	94	Negative	Absent	fracture united & accurately reduced	Excellent
2	PT 2	35	M	R	RTA	PCL Tibial avulsion	5	36	Positive	Present	Present	Present	1 to 2	4	98	Negative	Absent	fracture united & accurately reduced	Excellent
3	PT 3	42	M	L	RTA	PCL Tibial avulsion	10	33	Positive	Present	Present	Present	1 to 2	3	96	Negative	Absent	fracture united & accurately reduced	Excellent
4	PT 4	45	F	R	RTA	PCL Tibial avulsion	4	24	Positive	Present	Present	Present	1 to 2	4	98	Negative	Absent	fracture united & accurately reduced	Excellent
5	PT 5	35	M	L	RTA	PCL Tibial avulsion	9	26	Positive	Present	Present	Present	>4	5	85	Negative	Absent	fracture united & accurately reduced	Good
6	PT 6	24	M	R	Trauma	PCL Tibial avulsion	7	28	Abesnt	Present	Present	Present	>4	2	98	Negative	Absent	fracture united & accurately reduced	Excellent
7	PT 7	33	F	R	RTA	PCL Tibial avulsion	6	32	Abesnt	Abesnt	Present	Present	>4	3	85	Negative	Absent	fracture united & accurately reduced	Good
8	PT 8	25	M	L	Trauma	PCL Tibial avulsion	7	42	Positive	Present	Present	Present	1 to 2	4	90	Negative	Absent	fracture united & accurately reduced	Excellent
9	PT 9	32	M	R	Trauma	PCL Tibial avulsion	8	45	Positive	Abesnt	Present	Present	3 to 4	2	85	Negative	Absent	fracture united & accurately reduced	Good
10	PT 10	28	F	R	RTA	PCL Tibial avulsion	7	32	Abesnt	Present	Present	Present	>4	3	95	Negative	Absent	fracture united & accurately reduced	Excellent
11	PT 11	34	M	L	Sports Injury	PCL Tibial avulsion	6	45	Positive	Abesnt	Present	Present	<1	2	98	Negative	Absent	fracture united & accurately reduced	Excellent
12	PT 12	28	M	R	RTA	PCL Tibial avulsion	7	32	Positive	Present	Present	Present	3 to 4	2	92	Negative	Absent	fracture united & accurately reduced	Good
13	PT 13	31	F	R	RTA	PCL Tibial avulsion	8	36	Abesnt	Present	Present	Present	1 to 2	3	98	Negative	Absent	fracture united & accurately reduced	Excellent
14	PT 14	26	M	R	Trauma	PCL Tibial avulsion	7	38	Positive	Abesnt	Present	Present	1 to 2	3	95	Negative	Absent	fracture united & accurately reduced	Excellent
15	PT 15	35	M	R	Trauma	PCL Tibial avulsion	8	25	Positive	Present	Present	Present	>4	3	90	Negative	Absent	fracture united & accurately reduced	Good
16	PT 16	26	M	L	RTA	PCL Tibial avulsion	7	28	Positive	Present	Present	Present	3 to 4	3	85	Negative	Absent	fracture united & accurately reduced	Good
17	PT 17	36	M	R	Trauma	PCL Tibial avulsion	5	26	Abesnt	Abesnt	Present	Present	>4	2	80	Negative	Absent	fracture united & accurately reduced	Good
18	PT 18	28	M	R	RTA	PCL Tibial avulsion	6	27	Positive	Present	Present	Present	1 to 2	4	80	Negative	Absent	fracture united & accurately reduced	Fair
19	PT 19	40	F	R	RTA	PCL Tibial avulsion	7	28	Positive	Present	Present	Present	3 to 4	4	85	Negative	Absent	fracture united & accurately reduced	Fair
20	PT 20	29	M	R	Trauma	PCL Tibial avulsion	7	35	Positive	Abesnt	Present	Present	<1	3	95	Negative	Absent	fracture united & accurately reduced	Excellent
21	PT 21	38	F	L	RTA	PCL Tibial avulsion	8	37	Abesnt	Present	Present	Present	>4	2	98	Negative	Absent	fracture united & accurately reduced	Excellent
22	PT 22	30	M	R	RTA	PCL Tibial avulsion	7	44	Positive	Present	Present	Present	3 to 4	4	98	Negative	Absent	fracture united & accurately reduced	Excellent
23	PT 23	40	M	R	Sports Injury	PCL Tibial avulsion	9	48	Positive	Abesnt	Present	Present	>4	3	95	Negative	Absent	fracture united & accurately reduced	Excellent
24	PT 24	30	M	L	RTA	PCL Tibial avulsion	7	54	Positive	Present	Present	Present	1 to 2	4	98	Negative	Absent	fracture united & accurately reduced	Excellent
25	PT 25	40	M	R	RTA	PCL Tibial avulsion	9	52	Positive	Present	Present	Present	3 to 4	3	98	Negative	Absent	fracture united & accurately reduced	Excellent
26	PT 26	30	F	R	Trauma	PCL Tibial avulsion	8	42	Positive	Present	Present	Present	1 to 2	4	90	Negative	Absent	fracture united & accurately reduced	Excellent
27	PT 27	45	M	L	RTA	PCL Tibial avulsion	7	38	Abesnt	Abesnt	Present	Present	3 to 4	3	92	Negative	Absent	fracture united & accurately reduced	Excellent
28	PT 28	30	M	R	RTA	PCL Tibial avulsion	8	34	Positive	Present	Present	Present	>4	4	98	Negative	Absent	fracture united & accurately reduced	Excellent
29	PT 29	28	M	L	RTA	PCL Tibial avulsion	6	44	Positive	Present	Present	Present	3 to 4	2	95	Negative	Absent	fracture united & accurately reduced	Excellent
30	PT30	27	M	R	Trauma	PCL Tibial avulsion	7	34	Positive	Abesnt	Present	Present	1 to 2	3	98	Negative	Absent	fracture united & accurately reduced	Excellent

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Annexure IV: Knee Society Score

PAIN
None
Mild / Occasional
Mild (Stairs only)
Mild (Walking and Stairs
Moderate – Occasional
Moderate - Continual
Severe

FLEXION CONTRACTURE (IF PRESENT)
5°-10°
10°-15°
16°-20°
>20°
Extension lag
<10°
10-20°
>20°

TOTAL RANGE OF FLEXION				
		11-15	16-20	21-25
26-30	31-35	36-40	41-45	46-50
51-55	56-60	61-65	66-70	71-75
76-80	81-85	86-90	91-95	96-100
101-105	106-110	111-115	116-120	121-125

ALIGNMENT (VARUS & VALGUS)
5 - 10
Over 15°

STABILITY (MAXIMUM MOVEMENT IN ANY POSITION)

ANTERO-POSTERIOR	MEDIOLATERAL
<5mm	<5°
5-10mm	6-9°
10+mm	10-14°
	15°

Part 2 - Function
Walking
Unlimited
>10 blocks
5-10 blocks
<5 blocks
Housebound
Unable

Stairs
Normal Up and down
Normal Up down with rail
Up and down with rail
Up with rail, down unable
Unable

Walking aids used
None used
Use of Cane/Walking stick deduct
Two Canes/sticks
Crutches or frame

Grading for the knee Society Score

Score 80-100	**Excellent**	**Score 70-79**	**Good**	**Score 60-69**	**Fair**	**Score below 60**	**Poor**