A Prospective Study of

FUNCTIONAL OUTCOME OF BICONDYLAR TIBIAL PLTEAU FRACTURE MANAGED WITH LOCKING COMPRESSION PLATE

Dissertation submitted to

THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY

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In partial fulfillment of the regulations for the award of the

M.S. DEGREE BRANCH - II

ORTHOPAEDIC SURGERY

GOVERNMENT MOHAN KUMARAMANGALAM MEDICAL COLLEGE, SALEM

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CERTIFICATE

This is to certify that **Dr. R.SUBRAMANI**, Postgraduate student (2012-2015) in the department of Orthopaedics, Government Mohan Kumaramangalam Medical College, Salem has done this dissertation "***A Prospective Study of*** **FUNCTIONAL OUTCOME OF BICONYLAR TIBIAL PLATEAU FRACTURE MANAGED WITH LOCKING COMPRESSION PLATE"** under my supervision in partial fulfillment of the regulation laid down by the Tamilnadu Dr. M.G.R Medical University, Chennai forM.S., (Orthopaedics) degree examination to be held during April 2015.

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DECLARATION

I, **Dr. R.SUBRAMANI**, solemnly declare that this dissertation titled **"A PROSPECTIVE STUDY OF FUNCTIONAL OUTCOME OF BICONDYLAR TIBIAL PLATEAU FRACTURE MANAGED WITH LOCKING COMPRESSION PLATE"** is a bonafide work done by me, at Government Mohan Kumaramangalam Medical College, Salem between the period 2012-2015, under the guidance of my unit Chief **Prof. Dr.R.T.PARTHASARATHY M.S.(Ortho)**, Associate professor of Orthopaedic Surgery. This dissertation is submitted to Tamilnadu Dr. M.G.R Medical University, towards partial fulfillment of regulation for the award of M.S.Degree (Branch – II) in Orthopaedic Surgery.

PLACE: Salem

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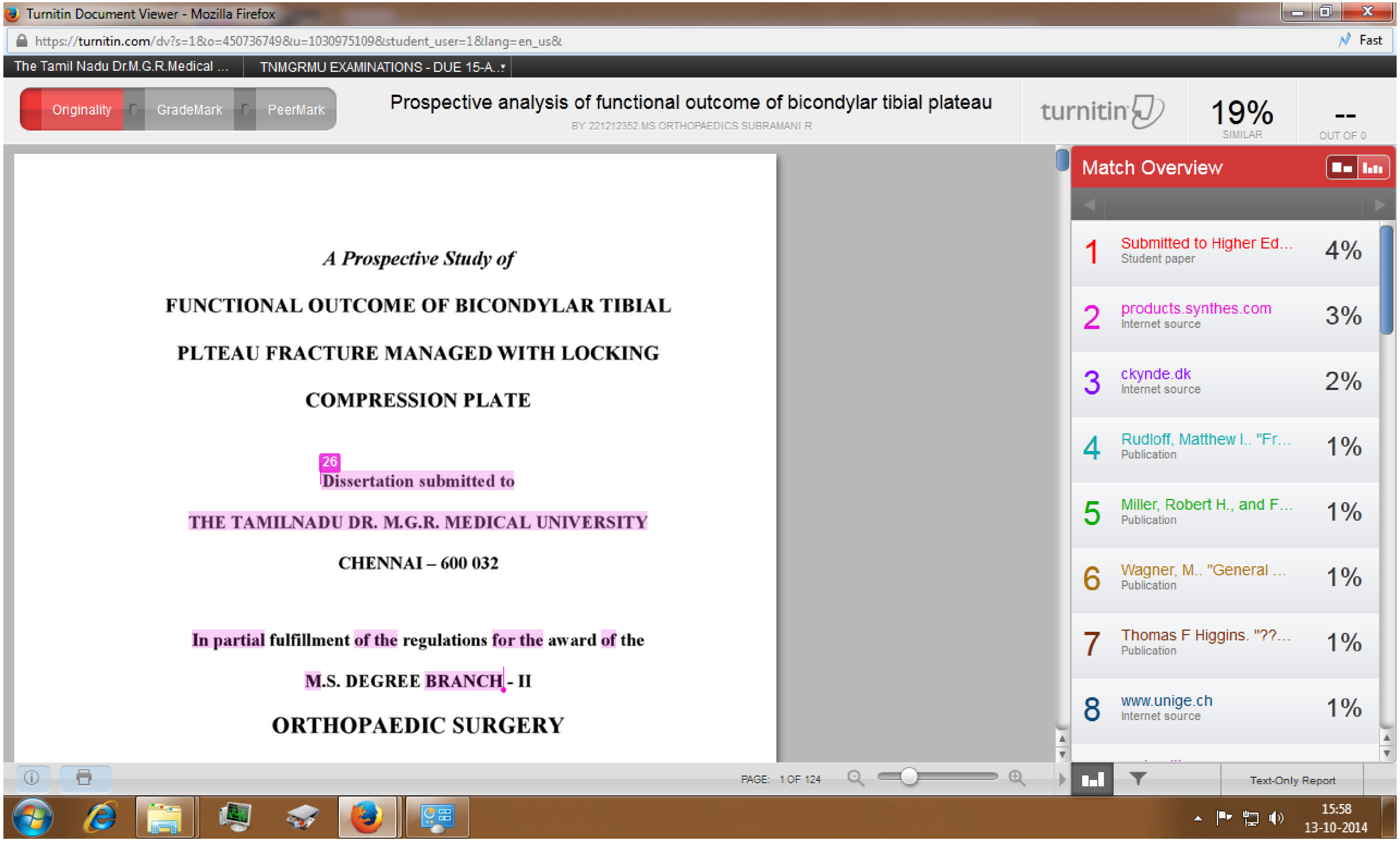
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INTRODUCTION

Tibial plateau fractures account for 1% of all fractures in adults and 8% in elderly. Fractures of tibial plateau more common in recent days due to increasing number of road traffic accidents .[1] These fractures resulting from direct axial compression(valgus) and indirect coronal forces.[2] The injuries span a wide spectrum, ranging from low energy unicondylar fractures to high energy bicondylar and comminuted fractures.

In addition, in elderly with osteoporotic bones, even low energy injuries such as domestic falls may lead to complex tibial plateau fractures. Hence the treatment of proximal tibial fractures has become a challenge for the orthopaedic surgeons.[3]

High energy tibial plateau fractures (Schatzker type V ,VI) associated with severe soft tissue injury and this complicates the treatment of this injuries.[4] The optimal treatment of Schatzker type V ,VI tibial plateau fractures remains controversial and challenging due to highly demanding surgical procedure and perioperative complications.[5,6]

The goals of treatment of high energy tibial plateau fractures are to restore anatomical articular congruity, mechanical alignment restoration, joint stability with minimal soft tissue dissection to allow for early mobilization and establishment of good functional outcome . [7]

Any fracture around the weight bearing joint like knee joint is of paramount importance as would result in significant morbidity and quality of life .

The optimal treatment for these fractures has always been a controversy. Studies have supported for both operative and non operative methods. In low energy fractures both operative and non operative treatment results in good functional outcome.

Available management for high energy tibial plateau fractures are skeletal traction ,Plaster of paris immobilization ,Minimal internal fixation with external fixation,circular external fixator ,Hybrid external fixator , open reuction and internal fixation with conventional plate and locking compression plate .

High energy Tibial plateau fractures initially treated with dual plating ,but associated with long term complications like wound problems ,implant irritation and implant exposure.

Newer methods for the treatment of high energy tibial plateau fractures are locking compression plates and Hybrid external fixation.

External fixators are associated with complications like pin tract infection ,knee joint stiffness, pain, discomfort and septic arthritis.

LCP has the advantages of better distribution of forces along the axis of bone. They can be inserted with minimal soft tissue stripping using minimally invasive percutaneous plate osteosynthesis(MIPPO). Substantially reducing failure of fixation in osteoporotic bones. Reducing the risk of a secondary loss of intraoperative reduction by locking with screws to the plate. Unicortical fixation option .Better preservation of blood supply to the bone as a locked plating does not rely on plate bone compression. Provide stable fixation by creating a fixed angle construct and angular stability . [8-10]

LCP is technically mature and as it offers numerous fixation possibilities and has proven to worth in complex fracture situations and in osteoporotic bones.[11]

AIM OF THE STUDY

This prospective study aims at evaluating the functional outcome of schatzker type V and VI tibial plateau fracture treated by locking compression plate at Department of orthopaedics and Traumatology ,Govt Mohan Kumaramangalam Medical college and Hospital ,Salem Between May 2012 and August 2014.

HISTORICAL REVIEW

Various strategies have been advised for the treatment of high energy tibial plateau fractures. Management options are ilizarov fixator, hybrid external fixation and internal fixation. If internal fixation be the treatment option advocate either locking compression plate or dual plating.

In earlier days closed reduction and Plaster of paris immobilization was the treatment of bicondylar tibial plateau fractures . In early 20th century the treatment has slowly moved to operative management .

Keetley in 1899 described the treatment of lateral condyle fracturs by open reduction and wire fixation.[12]

Accordind to Sirkin et al the treatment modality which offers its best for split unicondylar fracture, isolated undisplaced fractures and osteoporotic bone in old age is percutaneous fixation. Reduced operative time, small incision with minimal blood loss, short stay in hospital and early rehabilitation are the advantages of percutaneous fixation .[13]

Sir Robert Jones (1920) first stressed the importance of elevation in depressed condylar fractures[14]

Roberts in 1968 reported 100 cases of tibial condyle fractures treated by conservative and surgical. The results were good in 72% conservative, 80% traction mobilization and 81% surgical. He advocates early mobilization preservation for menisci and repair of torn ligaments for best results.[15]

Schatzker and Mcbroom in 1979, evaluated 70 cases of every types of tibial plateau fractures managed by conservative (56%) and surgical (44%) with average follow up of 28 months. Open methods showed 78% and conservative method showed 58% of acceptable results. Fractures managed by Open reductionand internal fixation with buttress plate and bone grafting showed 88% satisfactory results.[16]

Blokker et. al in1984 reviewed 60 tibial plateau fractures of which 75% patients had satisfactory results They concluded that the single major determinant in predicting the result in a patient treated with tibial plateau fracture was reduction accuracy.[17]

Tscherene and Lobenhoffer in 1993 studied 190 out of 255 cases and concluded that open reduction and internal fixation with the objective being precise reconstruction of the articular surface, stable fragment fixation and allowing early motion and repair of all concomitant lesion, achieved good results even in extremely difficult fractures after open reduction.[18]

Marsh J. L et al in 1995, treated twenty one high energy tibial plateau fractures with closed reduction lag screw fixation of the articular fragments and unilateral external fixator application. They considered this external fixation as a satisfactory management for complex plateau fractures.[19]

In 2002 Dennis P. Weigel and J. Lawrence Marsh evaluated the long-standing results of high energy tibial plateau fracture management. They stated that treatment by external fixation showed acceptable knee movement in 5 years follow up.[20]

In 2002, Gosling et al. presented their results in less invasive stabilization system in bicondylar fractures of tibial plateau and concluded that such injuries can be treated satisfactorily with lateral column locking plate .[21]

In 2003 Ali, Ahmad M., Burton, Maria studied the outcome of the operative management of high energy tibial plateau fractures in patients more than sixty years old. They concluded that ring external fixation is a secure, stable, and reliable method for management of high energy tibial plateau fractures in patients more than sixty years old.[22]

In 2004, Barei, Nork, Mills, Henley and Benirschke in their series of 83 patients concluded that high energy tibial plateau fractures can be effectively managed with dual incision and dual plating**.** Pre operative temporary external fixatior and appropriate handling of soft tissues may put in to a minimal wound complication rate .[23]

Gosling et al.2004 published the results of their study comparing the biomechanical stability afforded by lateral locking plate and bicolumn non locked plates. They concluded that both fixation techniques have a high resistance to vertical subsidence even with loads exceeding the average body weight. No statistically significant difference was seen between the two methods of fixation.[24]

Weil et al in 2008 described the posteromedial approach to tibial plateau to reduce and fix fractures of medial condyle and bicondylar fractures. They concluded that their approach and antiglide plating provided the solution for posteromedial shear fractures of tibial plateau.[25]

Musahl V et al (2009) reviewed the available literature concerning complex tibial plateau fractures and concluded that dual incision bicolumn plating was indicated for fractures with posteromedial fragment, medial fracture dislocations and posterior metaphyseal fragments.[26]

A study was conducted by Gosling et al in 2005 concluded that locking compression plates are valuable alternative for management of bicondylar tibial plateau fractures associated with severe comminution and soft tissue damage. [27]

A study was conducted by Gaudinez RF in 1996, Kumar A in 2000 stated that complications of hybrid external fixation are this joint stiffness , pain, discomfort pin tract infection, septic arthritis .[28,29]

A study was conducted by Kropp et al on 58 bicondylar tibial plateau fractures. A comparison was done between closed reduction internal fixation and external fixation. Results showed that, locking compression plate are associated with decreased time for union, decreased incidence of articular malunion, decreases knee stiffness and decreased overall complication. [30]

Cole in 2004 studied treatment of proximal tibia fractures using the less invasive stabilization system in 77 fractures. The LISS system consists of a pre-contoured, anatomically shaped plate that can be inserted with a minimally invasive technique and of screws that can be locked within the plate.[31]

Snow,martyn;Thompson in feb 2008 concluded LCP has mechanically superior to the low contact DCP when used as a bridging plate and tested in axial compression .[32]

Fitzpatrick DC, Doornik J, in feb 2009 stated that in osteoporetic bone locking plate improves the fixation and strength under axial loading.[33]

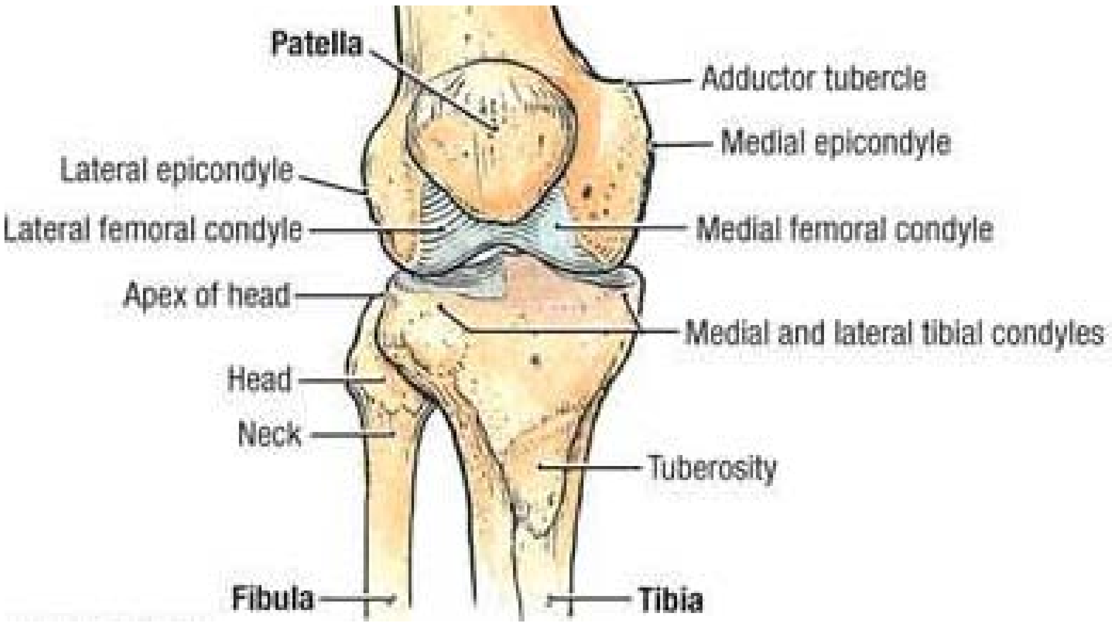
Sumit Arora et al in 2011 presented a case of proximal displaced tibial fracture that was treated with anatomical proximal tibial locking plate using minimally invasive percutaneous plate osteosynthesis. They concluded that "Patient made uneventful recovery even after he sustained re-injury and plate bending and was manipulated under anaesthesia for the same.[34]

Rosario Spagnolo • Fabrizio Pace in 2011 published the results of their study about locking compression plate in schatzker type V and VI tibial plateau management stated that anatomical locking plates and minimally invasive methods have the advantages of less soft tissue damage ,stable fixation and preserved biological healing .[35]

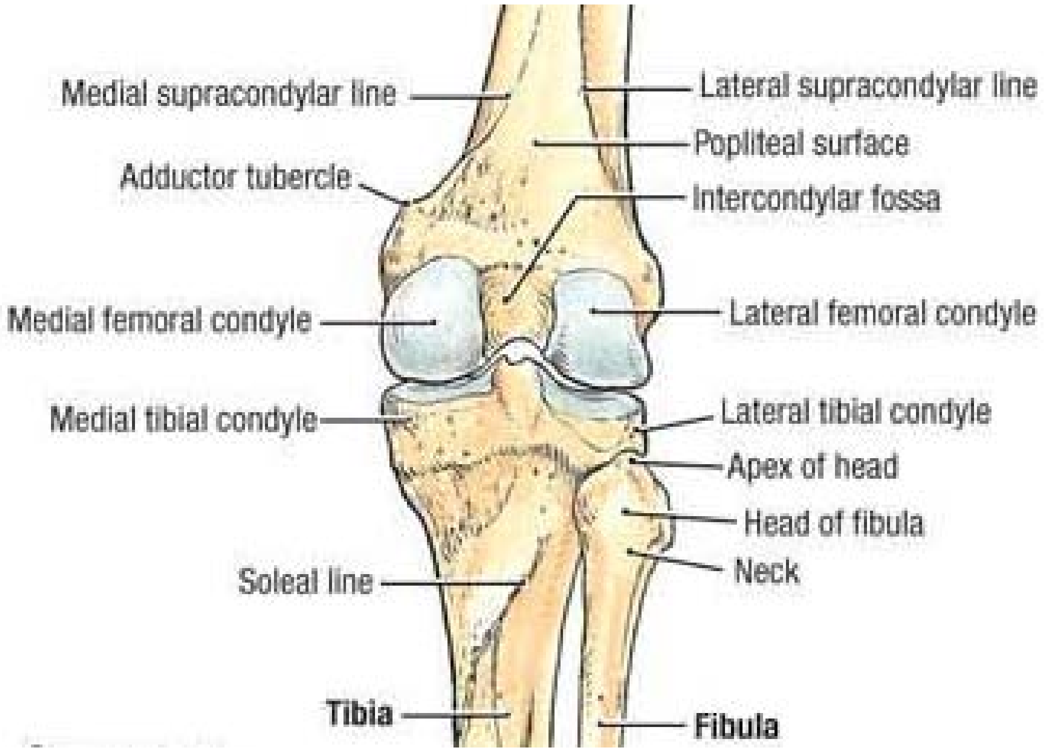
APPLIED ANATOMY OF KNEE JOINT

The embryological development of knee joint begins with the formation of leg bud at 28 days followed by the development of femur, tibia and fibula with in 37days . The knee joint arises from blastemal cells with the formation of patella, cruciate ligaments and menisci by 45 days.

The knee is the more complicated joint of the body. Knee joint is a modified Hinge type of synovial joint . It consists of three articulations .Two condyloid joints between each femoral condyle and corresponding tibial condyle and menisci .One saddle joint between the femur and patella .



ANTERIOR ASPECT OF KNEE



POSTERIOR ASPECT OF KNEE JOINT

Structures around the knee:

- Osseous structures
- Extra articular structures
- Intra articular structures

Osseous structures of the Knee :

- Proximal tibial plateau or Condyles
- Distal femoral condyles
- Patella

Femoral Condyles :[36]

The femoral condyles are two rounded prominences that are eccentrically curved and cuboid in form. Anteroposterior diameter is lesser than the transverse diameter . Flattened anterior surface of condyles creates a large surface area for contact and weight transmission. Condyles are slightly prominent anteriorly , and are separated by shallow articular depression called patellar surface .The condyles are considerably prominent posteriorly, and are separated by intercondylar fossa .The articular surface of the medial femoral condyle is longer than that of lateral condyle but the Lateral femoral condyle is more prominent and broader both in transverse and anteroposterior diameter . End on view of distal femur reveals the unique anatomical shape of distal femur .Medial surface has a 20-25 degree slope and lateral surface has a 10 degree inclination from the vertical line .Anterior surface of both femoral condyles has a inclination of 10 degree (Patello femoral inclination) .

Proximal tibial plateau or Condyle:[37,38]

The proximal tibia is expanded in the transverse axis, to create the adequate bearing surface for weight transmission through the lower end of femur.It forms the two flat surfaces the medial and lateral condyles.

Medial and lateral tibial condyle separated in midline by an irregularly roughened non-articulating intercondylar eminence with medial and lateral tubercles. Rounded off posterior lip of the lateral tibial plateau gives the space for sliding of lateral menisci during flexion .

Rough depressions present anterior and posterior to the intercondylar eminence that serves as attachment areas for cruciate ligaments and menisci. The condyles project backwards a little so as to overhang the upper part of the posterior surface of the shaft.

Medial condyle is larger and the upper articular surface is oval in outline. The lateral condyle overhangs the shaft in its posterolateral part. The articular surface is nearly circular in its outline and is slightly hollowed in its central part.

The articular surfaces on the plateau are not equal, the lateral being wider than the medial. In the sagittal plane, the lateral plateau appears convex and the medial plateau appears concave.

This is to be correlated when viewing lateral x rays of knee joint since the lateral plateau is usually visible as it lies at a higher level than medial plateau. Thus neither plateau provides much assistance in stabilising the knee.

According to Bohler, tibial plateau slopes posteroinferiorly 5-10 degrees from horizontal, with the plane of the articular surface forming an angle of 76 +/- 3.6 degrees with the tibial crest.

It is important to bear this in mind when screws are passed from anterior to posterior in proximal tibial region. The peculiar nature of the articular surfaces results in different injury patterns.

The medial tibial plateau is concave and axial load transmission leads to split fractures in medio lateral direction. The lateral tibial plateau is convex to the femoral side and axial load transmission leads to multifragmantary joint depression with joint broadening Additionally, the medial plateau has stronger trabecular bone owing to higher physiological stress in medial compartment of knee.

Hence, medial tibial plateau fractures are less common compared to lateral plateau fractures.Medial plateau fractures are high energy injuries and associated with neurovascular complications. The non-articular area in the plateau surface contains anterior and posterior tibial spines.

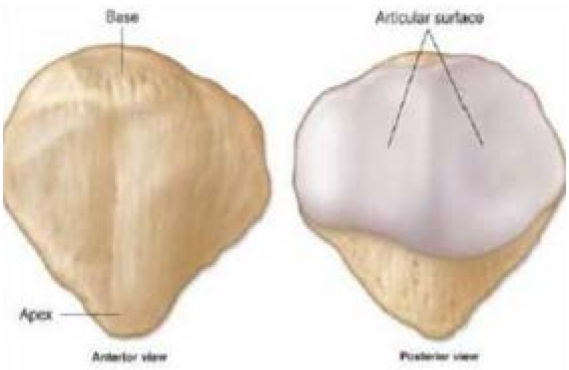
Anterior tibial spine lies medial and just posterior to the insertion of the Anterior cruciate ligament. The PCL is attached in the posterior intercondylar area, extending onto the posterior surface of the metaphysis. It is imperative that the width of intercondylar eminence is reconstructed and to appropriately restore the anatomic width of the proximal end of the tibia.

Tibial tuberosity lies at the upper end of the shaft of the tibia on the anterior border. It is divided into a smooth upper and a rough lower portion by a line or crest which marks the epiphyseal line. The upper smooth portion provides attachment to the ligamentum patellae.

The protuberance present in anterior tibial flare called Gerdy's tubercle which gives attachment to the Iliotibial band. Anterolateral approach to proximal tibia is based upon location of Gerdy's tubercle .

The fibular head is prominent along the posterolateral aspect of the tibial condyle and it provides attachment to the fibular collateral ligament and biceps tendon.

Patella : Patella is a triangular sesamoid bone developed in quadriceps tendon . It is a dense cancellous bone . It is narrower in distal pole compared to proximal pole . Articulating surface of patella divided into larger lateral and small medial facet by vertical ridge . It increases the leverage of the quadriceps muscle . It has the anterior and posterior surface ,three borders , and apex . It articulates with the femur .



EXTRA ARTICULAR STRUCTURES

The extra articular structures comprises of

- Musculotendinous units
- Ligamentous units

MUSCULOTENDINOUS UNITS:

These are made up of :

i) Quadriceps femoris - Anteriorly

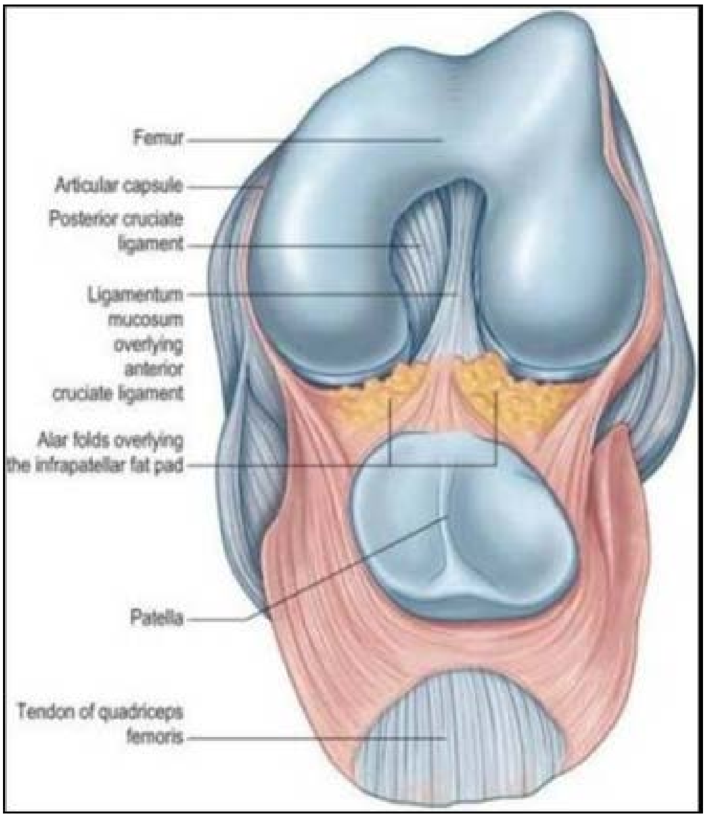
ii) Gastrocnemius , Popliteus - Posteriorly

iii) Semimembranosus ,Semitentendinosus

Gracilis ,Sartorius - Medially

iv) Bicep femoris , Iliotibial band - Laterally

CAPSULE :



The capsule is a sleeve of fibrous tissue extending from the patella and patellar tendon anteriorly above the medial, lateral and posterior extent of the joint.

Capsule is very thin and attached to articular surface at their margins. The capsule is deficient anteriorly through which the synovial membrane s herniate and forms the suprapa tellar pouches.

The deficient anterior portion of the capsule is supported by quadriceps femoris, patella and the ligamentum patellae.

On each side of patella, the capsule is strengthened by the expansions from quadriceps tendon (vastus medialis and lateralis) .

Behind the lateral tibial condyle there is an opening in the capsule which permits the tendon of popliteus.

EXTRACAPSULAR LIGAMENTS :

- Patellar tendon
- Medial collateral ligament
- Lateral collateral ligament
- Oblique popliteal ligament

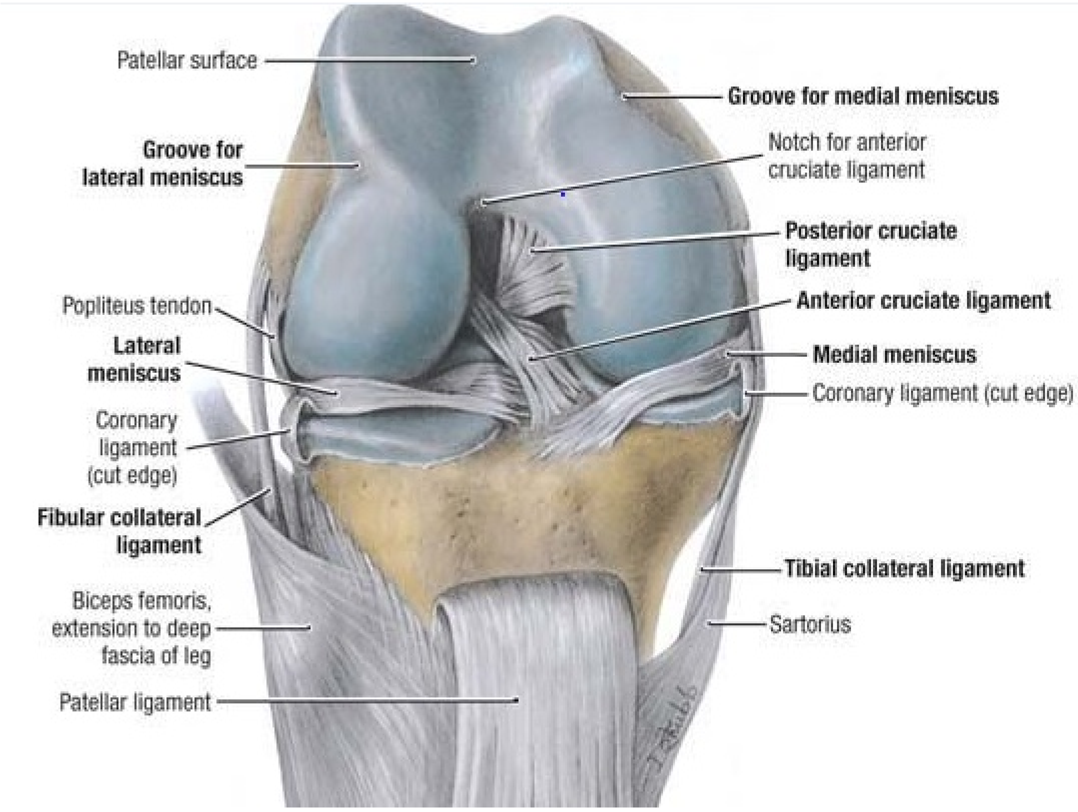
The patellar tendon is attached to the inferior pole of patella above and below to the tibial tuberosit y. It is the continuation of central portion of quadriceps tendon.

The Medial collateral ligament consists of superficial and deep parts. The superficial fibres are attached to the margins of the medial meniscus. The pes anserinus bursa overlies the superficial collateral ligament . The centre of the medial epicondyle is an indentation or sulcus where the deep fibres of the MCL insert.

The lateral collateral ligament attaches to the lateral femoral epicondyle proximally and to the fibular head distally. it lies superficial to the popliteus tendon and deep to the lateral patellar retinaculum. It is of prime importance in stabilizing the knee against varus stress with the knee in extension.

The oblique popliteal ligament is derived from the semimembranous muscle. It supports posterior aspect of joint capsule .

LIGAMENTS OF THE KNEE JOINT



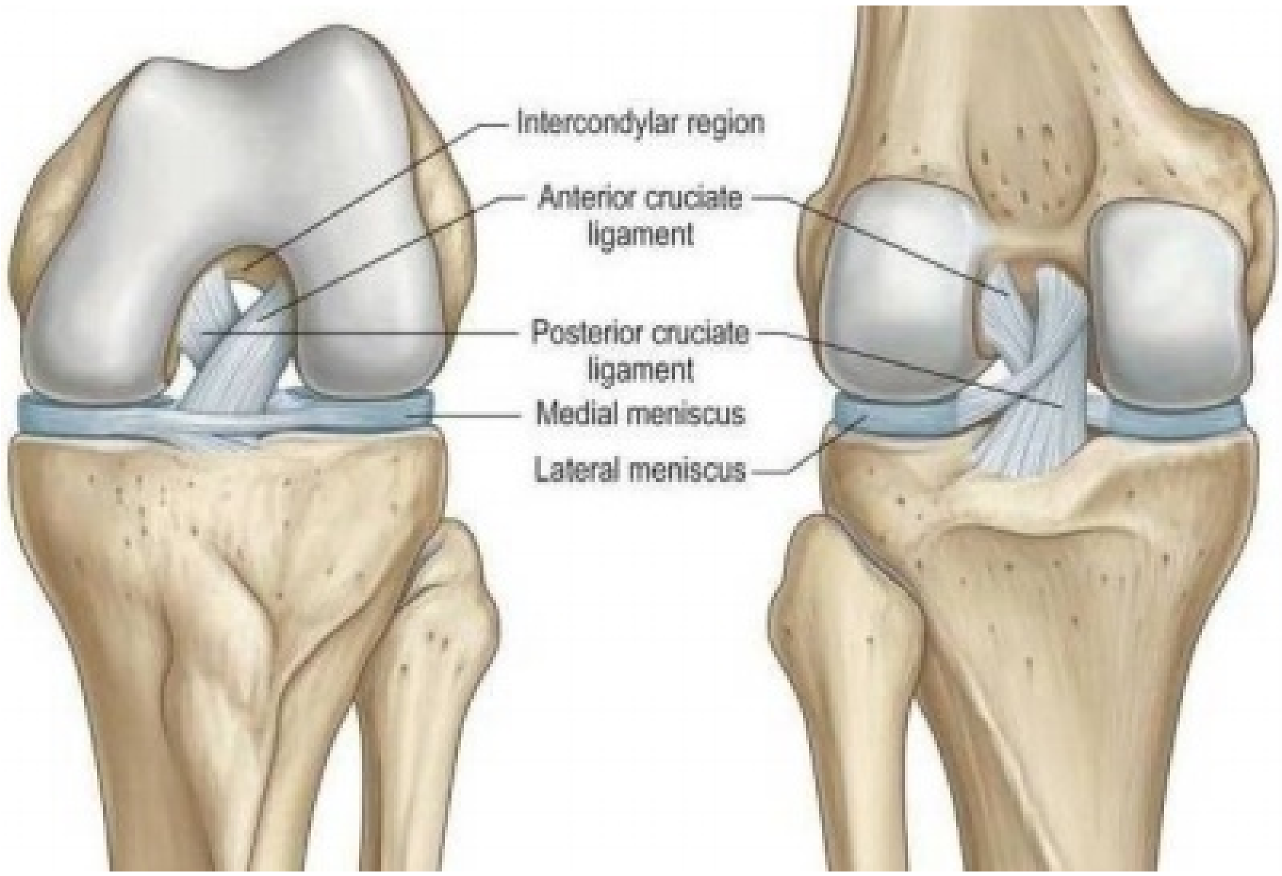
INTRAARTICULAR STRUCTURES:

- Cruciate ligaments
- Menisci

Anteroposterior stability provided by both cruciate ligaments. They are extra synovial in location but intracapsular.

Anterior Cruciate Ligament: (ACL)

The ACL is attached to the tibial intercondylar area and ascends posterolaterally, twisting on itself to get attached in to posteromedial aspect of lateral femoral condyle. It consists of three bundles and named according to their tibial attachment into anteromedial, intermediate and posterolateral fibres. The average length of ACL is 3.8 cm and the average width is 1.1cm. The tibial attachment is in front of anterior tibial spine. It prevents the tibia from anterior displacement and it is taut in flexion .



Posterior Cruciate Ligament: (PCL)

The PCL is thicker and stronger when compared to the ACL. It arises from the posterior intercondylar notch of tibia and it ascends to get attached to lateral surface of the med ial femoral condyle.

It consists of two types of fibers, anterolateral and posteromedial. They are named according to their femoral attachments. The anterolateral fibres taut in flexion while the posteromedial fibres taut in extension.

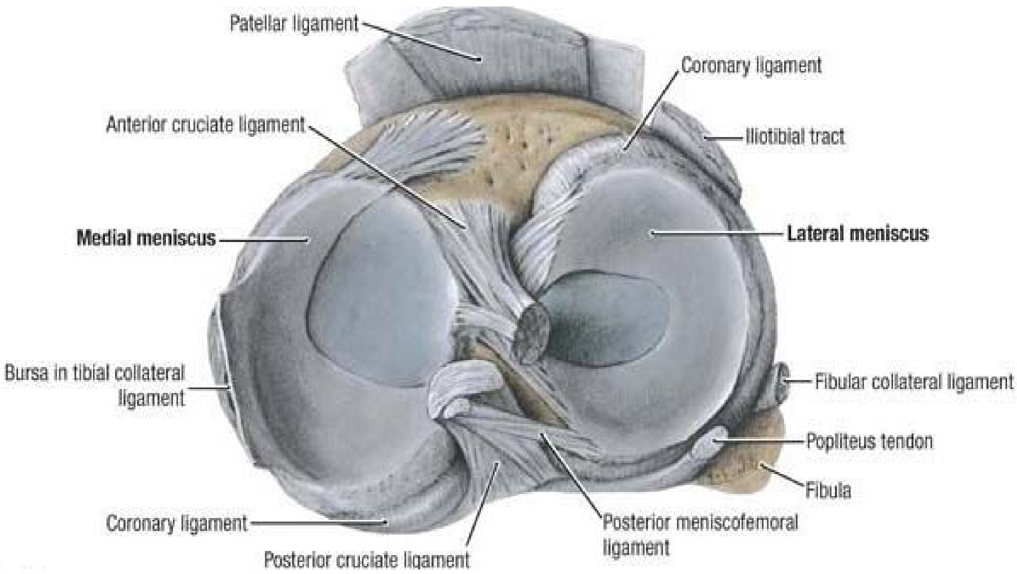
The posterior displacement of tibia over femur is prevented by the posterior cruciate ligament. It is almost vertical in its alignment in sagital plane. In the coronal plane it passes obliquely upwards and medially to its femoral attachment.

The length of PCL is 3.8 cms and the width is slightly bigger than ACL about 1.3 cms

MENISCI :

Menisci (semilunar cartilages) are crescentic, intracapsular, fibrocartilagenous laminae. It deepens the tibial condyle s to receive the femoral condyles.

The thick peripheral borders are convex and vascular, while the inner regions are avascular. The meniscal horns are richly innervated. There are no innervations in the central third .



Each menisci covers two third of tibial articular surface. The thinner collagen bundles parallel to the surface line the inner part of the articular surfaces and resists the compressive force, while the outer portion is being covered by synovium and capable of resisting the tensional forces.

Increasing the congruity of the articulation helps in spreading the load and it also provides proprioceptive feedback. It provides lubrication and Cushion effect to the underlying bone from the considerable forces generated during extremes of flexion and extension.

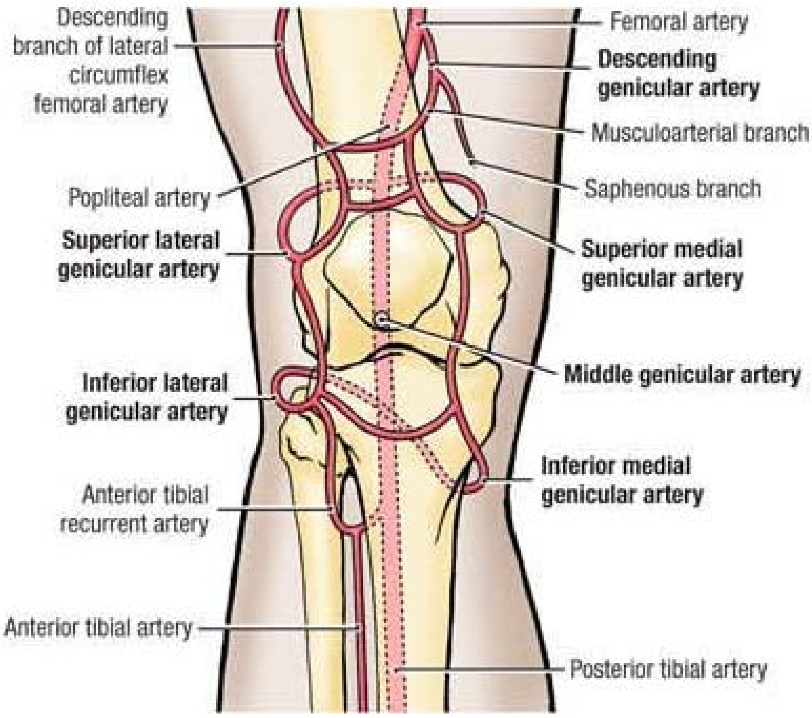
The semicircular medial meniscus is attached to the anterior tibial intercondylar area in front of the anterior cruciate ligament by its anterior horn . The tibial attachment of the meniscus is termed as ‘coronary ligament” . The relatively fixed medial meniscus moves much less when compared to the lateral meniscus because of the attachments.

The anterior horn of lateral meniscus being attached in front of the intercondylar eminence, the posterior horn is attached behind the eminence. As the popliteus tendon is attached to the lateral meniscus , the mobility of its posterior horn may be controlled by the meniscofemoral ligaments and by the tendon of popliteus.

BLOOD SUPPLY OF KNEE JOINT

Knee joint is supplied by genicular anastomosis around the joint. The anastomosis is between the medial and lateral superior and inferior genicular arteries, the descending genicular, the descending branch of the lateral circumflex femoral artery, the circumflex fibular and the anterior and posterior tibial recurrent arteries.

The popliteal artery is the continuation of femoral artery and divides in to anterior and posterior tibial arteries at the level of proximal end of the asymmetrical crural interosseous space between the wide tibial metaphysis and the slender fibular metaphysis.



BLOOD SUPPLY OF THE KNEE JOINT

ANASTOMOSES AROUND THE KNEE :[39]

- Descending genicular artery-branch of femoral artery.
- Descending branch of lateral circumflex artery.
- Lateral genicular artery
- Medial genicular artery.
- Medila inferior genicular artery.
- Lateral inferior genicular artery.
- Anterior tibial recurrent artery.
- Circumflex fibular branch of posterior tibial artery .

NERVE SUPPLY :[36,39] All three nerves supply the knee joint

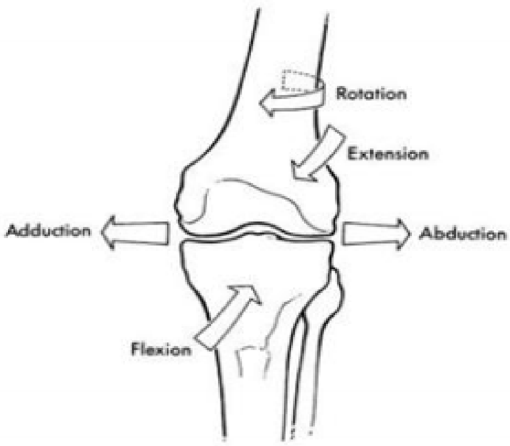
- Femoral nerve through its branches to vasti especially vastus medialis
- Sciatic nerve through genicular branches of common peroneal nerve
- Obturator nerve through its posterior division.

BIOMECHANICS OF THE KNEE JOINT

Functional stability of the knee is provided by both passive and active stabilizers. The passive stabilizers include the ligaments around the knee, osseous congruity and the menisci. The active stabilizers are the muscles that surround the knee.

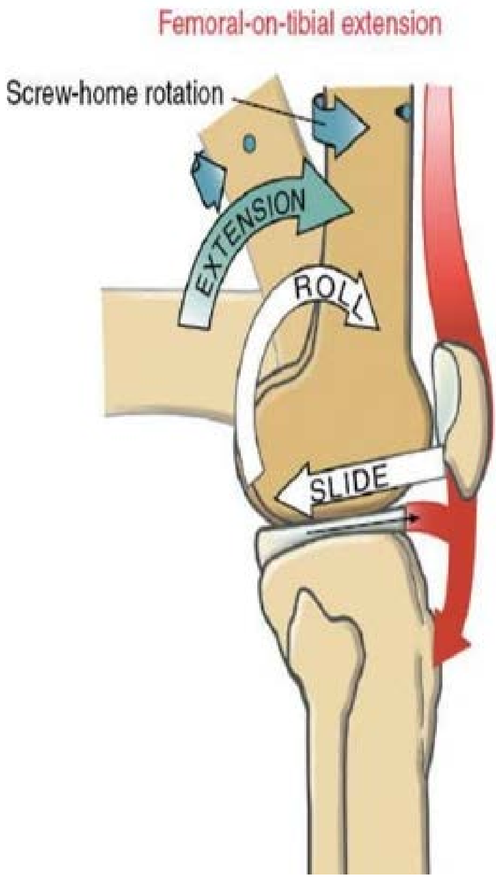
(A) KINEMATICS :[40,41]

Range of Movement (ROM): ROM of the knee ranges from +10 degree of (recurvatum) extension to 130 degree of flexion. Functional range of movement is from near full extension to about 90 degree of flexion. Rotation varies with position of flexion. At full extension there is minimal rotation. At 90 degree flexion, 45 degree of external rotation and 30 degree of internal rotation are possible. Abduction and adduction are essentially 0 degree .



Joint motion:

Flexion and extension of knee involves both rolling and gliding motions .The femur internally rotates during last 15 degree of extension ("Screw home" mechanism). Posterior roll back of the femur on the tibia during knee flexion increases maximum knee flexion. The axis of rotation of the intact knee passes through medial femoral condyle. In normal stance 75 to 90 % of load is borne on medial portion of knee.



(B) KINETICS : [40,41] Extension is by the quadriceps mechanism, through the patellar apparatus; the hamstring muscles are primarily responsible for flexion at the knee.

1.Knee stabilizers: - Although bony contours have a role in knee stability, it is the ligaments and muscles of the knee that play the major role.

2. Joint forces: a) **Tibiofemoral:** joint surfaces in the knee are subjected to a loading force equal to three times the body weight in level walking and up to four times body weight while climbing steps. The menisci share in load transmission. b) **Patellofemoral**: the patella aids in knee extension by increasing the lever arm and in stress distribution. The joint has the thickest cartilage in the body and it bears the most loads. Loads are proportional to the ratio of quadriceps force to knee flexion. The quadriceps provides an anterior subluxating force at 0-45 degree range of motion.

3. Axes :

- The mechanical axis:- femoral head to center of ankle
- Vertical axis:- from centre of gravity to ground
- Anatomic axis:- along the shaft of femur and tibia

TIBIAL PLATEAU FRACTURES

INCIDENCE :[42]

Fractures of tibial plateau 1% of all fractures and 8 % of the fractures in elderly .These fractures exhibit various combination of fracture patterns with variable degree of displacement and depression .

NATURE OF VIOLENCE :

It is divided into direct and indirect forces.

DIRECT :

- Automobile accidents
- Industrial accidents
- Valgus and varus stress forces
- Falling from height
- Athletics
- Direct impact

INDIRECT :

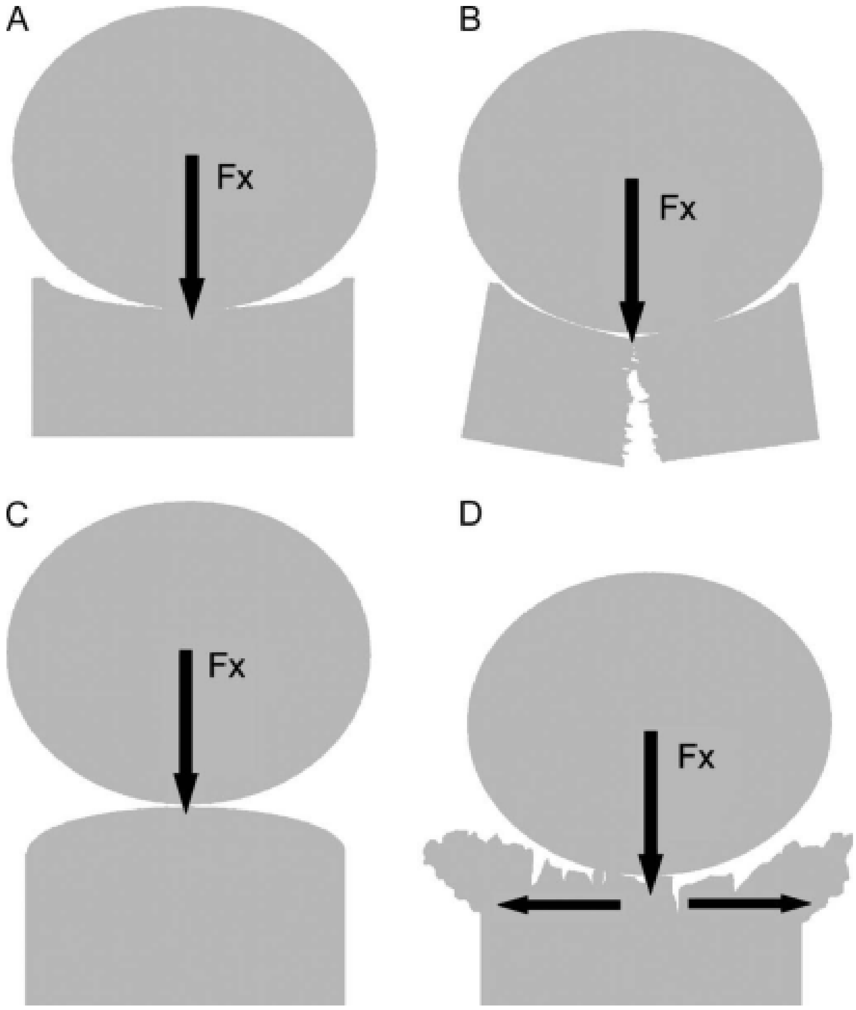
- Twisting injuries
- Missing steps
- Strumbling force

MECHANISM :[42]

Forces acting on the axis of bone with medial and lateral stress causes the tibial plateau fracture . Severity of the fracture pattern based on amount of forces acting at the joint level . Tibial plateau fractured by compression and shear forces exhibited by femoral condyles when the knee joint exposed to axial loading with varus and valgus forces. Isolated split fractures are virtually confined to adults with dense cancellous bone that is capable of withstanding the compressive forces on the joint surface.

With age, the strong cancellous bone of the proximal tibia gradually becomes more sparse and is no longer able to withstand the compressive forces. With impact loading, a depressed or split depressed fracture results .

FRACTURE MECHANICS



A: Medial compartment of knee is convex towards tibia, hence axial loads produce coronal plane split fragments **(B).** **C**: Lateral compartment is convex towards femur, and axial loads produce comminution and joint widening **(D)**

The medial collateral ligament acts like a hinge as valgus forces drive the lateral femoral condyle into the tibial plateau. The lateral collateral ligament acts in a similar way with varus forces and causing medial plateau fractures.

With the Magnetic Resonance Imaging (MRI) in patients with upper tibial fractures, ligament injuries have been observed in a higher percentage of patients. Thus in addition to the fracture, there may be an associated medial collateral ligament or anterior cruciate ligaments injury may be present in lateral plateau fracture, conversely, the tears of the lateral collateral ligament or cruciate ligaments may be associated with fractures of the medial tibial plateau.

The location of the fracture depends on the degree of flexion/extension of the knee. However when axial loads exceeds 8000 pounds, explosive severely comminuted fractures were produced. This mechanism is thought to occur clinically in a fall from a height on the extended knee.

Also direct injury to the upper part of the tibia, i.e., in the subcondylar (or) subchondral or metaphyseal region may lead to a fracture without involving the articular surface. These type of fractures may be due to road traffic accidents, assaults, etc.

TIBIAL PLATEAU FRACTURE CLASSIFICATION :

I. Schatzker classification

II. Hohl and Moore classification

III. AO/OTA classification

I.SCHATZKER CLASSIFICATION[41]

TYPE I – pure split : A wedge shaped uncomminuted fragment is split off and displaced laterally and downwards. This fracture is common in younger patients without osteoporotic bone.

TYPE II – split with depression: A lateral wedge is split off, but in addition the articular surface is depressed down into the metaphysis. This tends to occur in older people with osteoporotic bone.

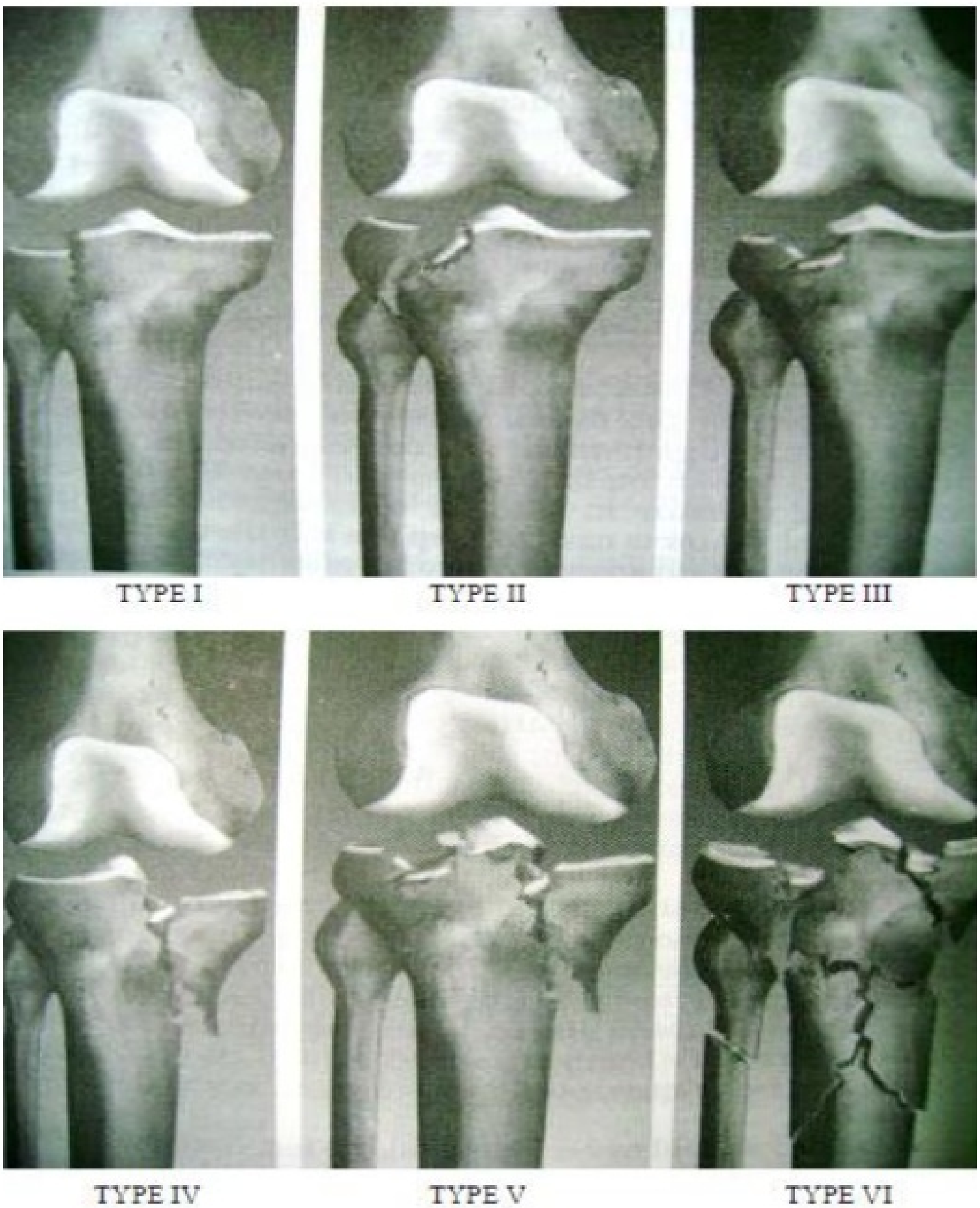
TYPE III - pure central depression: The articular surface is driven into the plateau. The lateral cortex is intact. These tend to occur in osteoporotic bone.

TYPE IV - fractures of medial condyle: These may be split off as a wedge or may be comminuted and depressed. The tibial spines are often involved. These fragments tend to angulate into varus.

TYPEV- bicondylar fractures: Both tibial plateau are split off. The distinguishing feature is that the metaphysis and diaphysis retain continuity.

TYPE VI -: bicondylar tibial plateau fracture with dissociation of metaphysic and diaphysis.

SCHATZKER`S FRACTURE CLASSIFICATION



II. HOHL AND MOORE CLASSIFICATION :[43,44]

Hohl and Moore described a classification system for fracture dislocations as they were found to be associated with higher incidences of ligamentous injuries, meniscal injuries and neurovascular injuries.

A. FRACTURE PATTERN

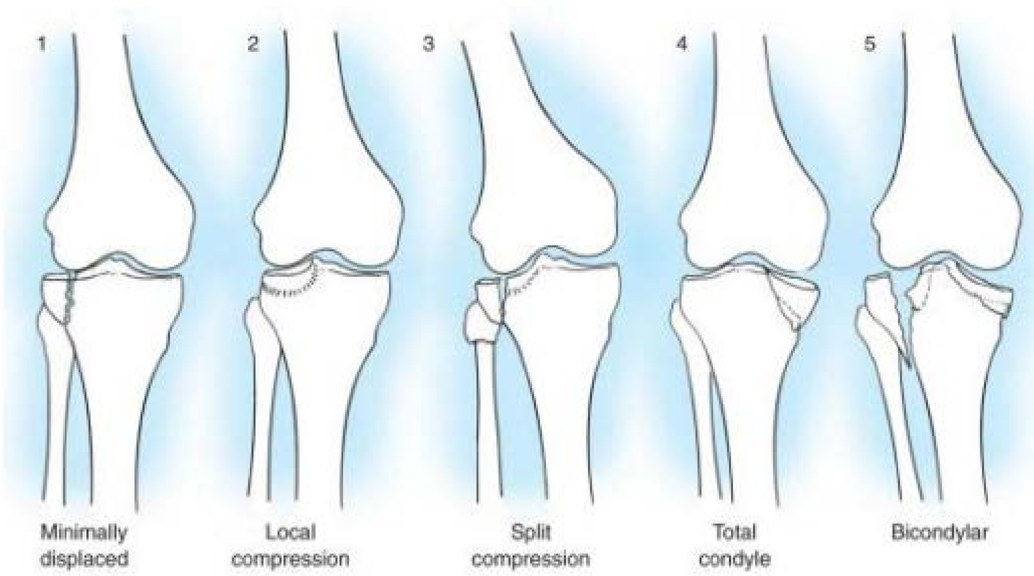
TYPE 1 : Split fractures of the lateral condyle

TYPE 2 : Lateral compression

TYPE 3 : Split with compression fracture

TYPE 4 : Total condylar fractures

TYPE 5 : Bicondylar fractures



B. FRACTURE – DISLOCATION PATTERNS :[43,44]

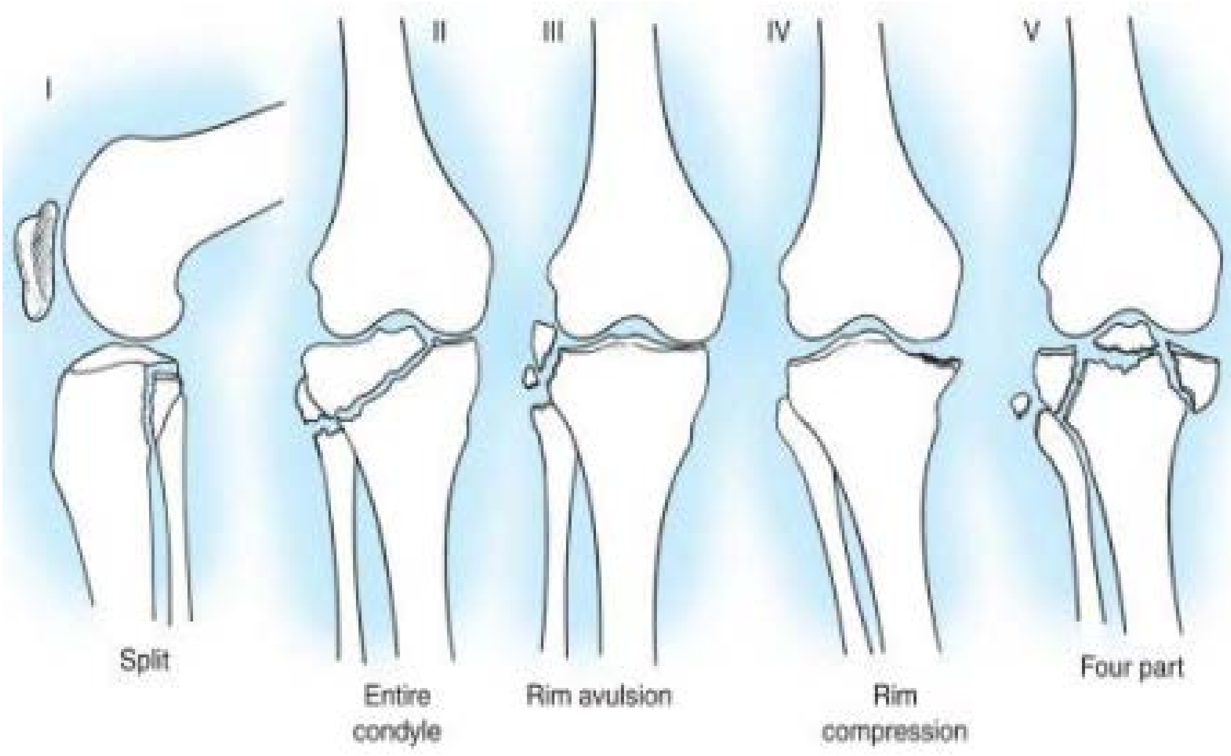
TYPE 1 : Coronal split fracture dislocation.

TYPE 2 : Entire condylar fracture dislocation.

TYPE 3 : Rim avulsion fracture dislocation.

TYPE 4 : Rim compression fracture dislocation.

TYPE 5 : Four part fracture dislocation.



AO/OTA CLASSIFICATION [45]

In AO/OTA system, proximal tibia is denoted as 41 and these fractures are

divided into extraarticular, partly articular and complete articular fractures.

Type A: extraarticular, hence tibial plateau is not involved

Type B: partial articular

B1—Simple articular split

B2—Split depression

B3—Comminuted split depression

Type C: complete articular

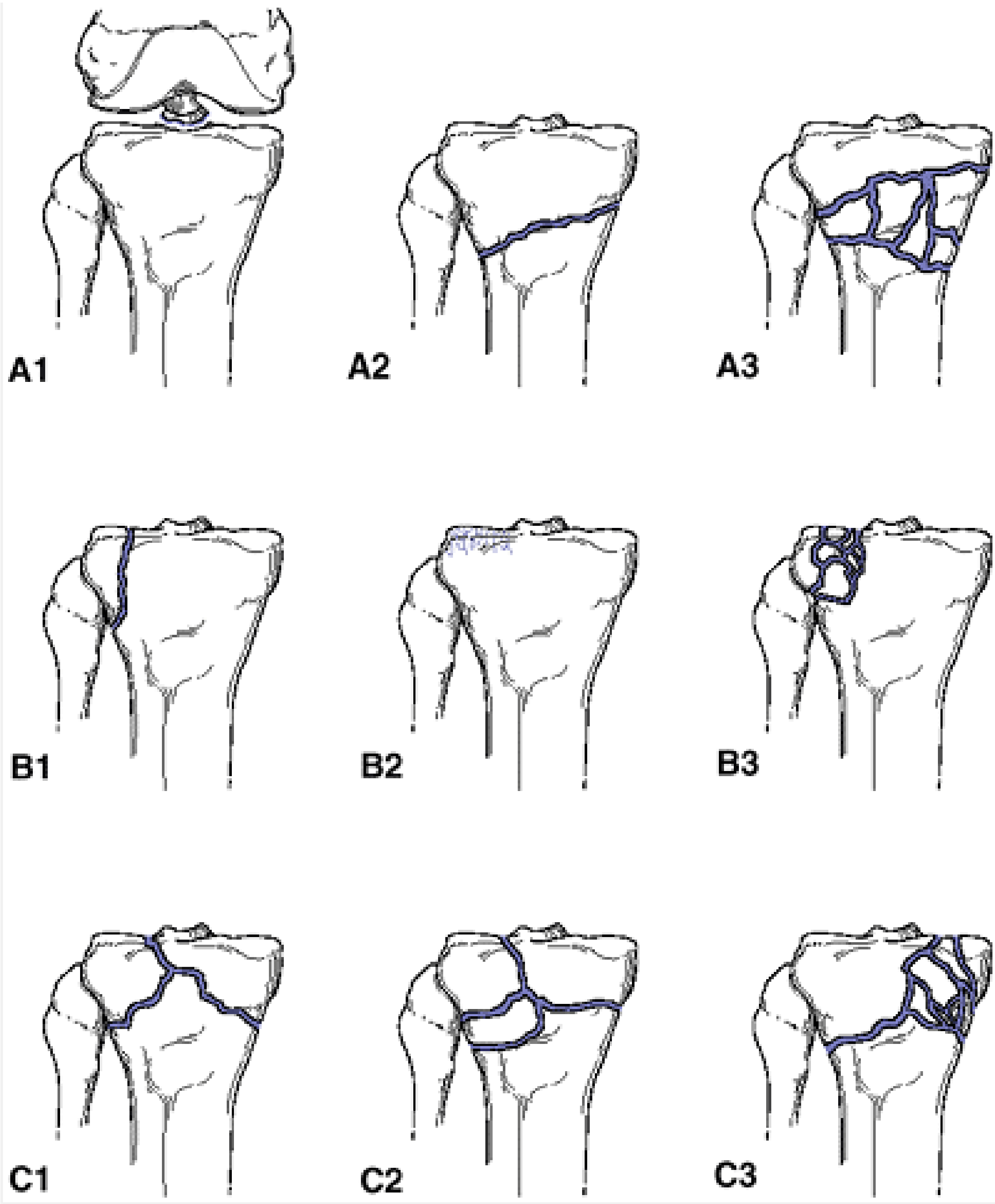
C1—Noncomminuted total articular fractures

C2—Metaphyseal comminution with simple articular

Fracture lines

C3—Total comminuted (both metaphyseal and

articular comminuition



AO/OTA CLASSIFICATION

DIAGNOSIS

History :

A thorough history was obtained, including the mechanism of injury. High energy injuries are the ones associated with neurovascular compromise, compartment syndrome, soft tissue injury and other essential injuries . Patient's overall medical status, functional and economical demands also have a bearing on the treatment. Owing to the severe nature of trauma, we routinely searched for associated injuries and enquired about symptoms of head injury, abdominal injury and chest injury.

Examination :

Clinical evaluation was performed carefully to assess the status of soft tissue and neurovascular integrity. Soft tissue examination was done by looking for abrasions, deep contusions, discolouration of skin, hemorrhagic or clear blisters and external wounds that expose the fracture to the outside environment. Surgery was delayed in cases with severe soft tissue injury till tissue edema resolves.

Compartment syndrome was assessed by serial examination of the leg. Weak or absent distal pulses, pallor, paresthesia, paralysis, pain on passive stretch of toes all point towards the onset of compartment syndrome. Urgent decompression was performed in cases with compartment syndrome. Arteriography was performed if the ankle brachial pressure index was less than 0.9. An assessment of ligamentous injury by performing Lachman test was also indicated as presence of ligamentous injury alerts the surgeon to a high energy injury.

Plain Radiograph :

- AP & Lateral views usually show a plateau fracture.
- In doubtful fracture 15° of AP Oblique view inclined caudally.
- Traction films and stress x-rays. To assess the efficacy of an applied ligamentotaxis force .[46,47]
- Oblique views with the leg in internal and external rotation help in visualizing the fracture lines more clearly.

CT Scan: [48,49,50]

Especially useful in determining personality of fracture ,the extent of injury, amount of articular depression, comminution and displacemen but gives limited information about the soft tissue status. CT with leg in traction to assess Ligamentotaxis and also to assess the coronal fracture line and plan insertion of screws. 3D reconstructions have been shown to guide treatment strategies effectively . CT scans prove valuable in clear assessment of fracture severity and guide preoperative planning, classification of the fracture and fixation strategies.

Magnetic Resonance Imaging :[51]

MRI is useful in assessing the extent of soft tissue injury, especially the status of cruciate ligaments and menisci. Its usefulness in studying fracture lines is inferior to CT except in stress fractures that show no fracture on plain radiographs. Whether MRI should be part of the standard set of investigations is a matter of controversy and may be undertaken if the surgeon wishes to address the soft tissue injury in the same sitting as the bony injury.

Arthroscopy:

Arthroscopy is useful for evaluation of ligament injuries and articular reduction .

Angiography:

Useful in High velocity injuries associated with vascular compromise.

MODALITIES OF TREATMENT :

The goals in treatment of a tibial plateau fracture are to obtain a stable, aligned, mobile and painless joint, early functional recovery and to minimize the risk of post-traumatic osteoarthritis .[16,52] If rational treatment is to be instituted, the surgeon must have a sound knowledge of the "personality" of the injury and a clear understanding of the knee examination, imaging studies and must be familiar with a variety of technique for treating tibial plateau fracture. selecting a method after a tibial plateau fracture depends on a number of factors including mechanism of injury, type of fracture, displacement, depression and surgeon factors. Often overlooked or underestimated are patient-related factors such as age of the patient, level of activity, concurrent medical condition and level of expectation.

Schatzker has formulated the following principles of treatment :[16]

- Tibial plateau fracture immobilized for more than 4 weeks usually lead to some degree of joint stiffness.
- Internal fixation of plateau fracture combined with immobilization of the knee leads to even greater degrees of joint stiffness.
- Regardless of the method or technique of treatment, the knee joint must be mobilized early.
- As long as joint mobility is preserved, secondary reconstructive procedures are possible.
- Impacted articular fragment cannot be dislodged by traction or manipulation alone, because there are no soft tissue attachments to lever them upward.
- Depressed articular surface defects do not fill in with hyaline cartilage and remain as permanent defects, therefore any joint that is unstable as a result of joint depression or displacement will remain unstable unless it is surgically corrected .

Conservative :

Non operative management may be used in wisely selected cases of tibial plateau fractures with acceptable results.

The common indications are:

- ✓ Fractures that can be expected to heal without a significant deformity
- ✓ Elderly patients who have high surgical risk
- ✓ Co existent medical morbidities

Methods are :–

- ✓ Closed reduction and plaster immobilization
- ✓ Skeletal traction and immobilization
- ✓ Functional cast brace

Isolated lateral condyle fractures with mild to moderate articular depression (upto 10 mm) can be expected to heal with good functional outcomes without any deformity.

But associated split and displaced fragments or larger articular depression usually heals with a valgus alignment and hence have a great risk of osteoarthritis due to uneven joint loading. Isolated medial condyle fractures, even with minimal displacement, have greater chances of healing in varus malalignment because of the peculiarity of the fracture pattern, tending to have more obliquity in the coronal plane. Hence anatomical reduction is recommended for all medial condyle fractures. Non operative management for schatzker type V & VI fractures in young and active adults usually gives substandard results.

Operative treatment :

Indications:

- Bicondylar fractures
- Split lateral condyle fractures
- Articular depression of more than half the articular surface
- Displaced fractures of medial condyle
- Valgus or varus instability > 10 degrees in 0 to 90 degrees knee arc of motion
- Open fractures
- Associated arterial injury or compartment syndrome

The advantages of surgical treatment :

- anatomical reduction,
- rigid fixation,
- mechanical axis of limb
- early joint mobilization and functional recovery .

Surgical options :

- Percutaneous cancellous screw fixation.
- ORIF with cancellous screws and Bone grafting.
- ORIF with Buttress plate and screws.
- ORIF with Buttress plate and screws and Bone grafting.
- External fixator/ Hybrid external fixator/ Ilizarov ring fixator.
- Arthroscopic assisted internal fixation.
- MIPPO (Minimal Invasive Percutaneous Plate Osteosynthesis)/ORIF with LCP plating.

Plates and screws:

Various plates available for proximal tibia are L buttress plate, T buttress plate and locking compression plate. Various precontoured plates are available which are very easy to apply.

The most common position of plate in tibial plateau is the anterolateral region of proximal tibia. This plate serves as a buttress and supports the weak lateral cortex of tibia in split and depression types of lateral plateau fractures.

Locking plates in lateral column have been extensively used in bicondylar fractures recently, as these are sturdier implants with stronger screws that provide resistance to the deforming forces at play in high energy bicondylar fractures.

Lateral plates are also provided with multiple parallel screw slots near the joint surface. This allows multiple screws to be placed parallel and close to the articular surface – the so called **—rafting screws .**

Posteromedial plates have a different role to play. These plates act in an antiglide fashion and resist the shearing forces on the posteromedial fragment and hence prevent varus collapse.

External fixators:[20]

Temporary external fixation is applied spanning the knee joint and restores limb alignment and maintains limb length, thus aiding soft tissue recovery before definitive internal fixation. The results of definitive external fixation may prove as good as internal fixation in high energy injuries if the frame is applied in a competent manner with adequate stability . Hybrid fixators and joint sparing fixators are useful in this regard .

COMPLICATIONS OF TIBIAL PLATEAU FRACTURE :

The complications occur by virtue of fracture and also after the treatment. Most of the complications are preventable. Preventive care begins with thorough examination of the injured limb. Important aspects to detect are the peripheral neuro vascular injures that may accompany with the upper tibial fractures,.

I) Early Complications:

- Bleeding
- Wound infection /Dehiscence - Superficial or Deep
- Sepsis
- Compartment syndrome

- Knee stiffness
- Nerve Injury (Lateral politeal. N)
- Vascular Injury (Anterior tibial A)
- Limb length discrepancy
- Deep vein thrombosis

II) Late Complications :

- Wound Infection
- Knee stiffness
- Malunion
- Knee instability - varus/valgus/anterior/posterior
- Extensor lag
- Angular deformities
- Redepression
- Refracture
- Delayed union
- Non-union

BIOLOGICAL FIXATION :

The rigid fixation of bone by using compression with conventional plate results in primary union, this concept gained wide acceptance a couple of decade ago. However cortical bone had always united by throwing callus before man had started interfering with it. A new phenomena was observed in cases where successful osteosynthesis with compression principle was made. This was the appearance of osteoporosis and termed as “stress protection osteoporosis”[53] it is due to avascularity and not stress protection

As the plate was tightened to obtain absolute rigidity the friction between the under surface of the plate and the cortex of the bone increased many time resulting in interference of the periosteal blood supply as long as the plate was there. On the contrary, if the rigidity of the plate fixation was inadequate it leads to resorption at the screw bone interface leading to non union.

Hence if we desire a good fixation with minimal interference to the biology of the bone, this require a new thinking in the concept of implant as well as in the concept of internal fixation. This change of concept is what is termed as“Biological fixation”.

The concepts of biological fixation includes : -[54]

- Fracture reduction by indirect method
- Adequate stability
- osteogenic property should be preserved
- No need for absolute plate –bone contact

Reducing the area of contact between plate and bone, as achieved by the limited contact DCP (LC-DCP) design, significantly reduced the vascular change caused by pressure on the cortex. However, the LC-DCP also has to be pressed against the bone in order to create the friction needed to fulfill its function.

The first implant designed to fulfill the new requirements was the small point contact fixator (PC-Fix). The PC-Fix was a narrow plate like implant with a specially designed under surface having only small points that come into contact with bone.The screws were self-tapping, unicortical and were available in one length only. The screw head locked firmly in the plate hole with a fine thread.

While the PC-Fix had limited applications in the metaphyseal and articular area. The LESS INVASIVE STABILIZATION SYSTEM (LISS)[55] was conceived for precisely for the distal femur and later for the proximal tibia. Its shape conforms to the anatomical contours of the specific area of the bone .

Additional contouring is not required as the plate fixator does not necessarily need to touch the bone. In addition to the locked unicortical screws. This implant is designed and instrumented for application via minimally invasive submuscular approach.

The fracture should be adequately reduced and aligned prior to the application of the LISS. This is especially true for the articular components of the distal femur or proximal tibia which must be anatomically reconstructed and held by plate independent lag screws.

The LISS can accommodate long fully threaded self-tapping screws that are locked in plate holes when drive home thereby providing the attributes of a fixed angle device .[56]

LOCKING COMPRESSION PLATE (LCP):

A further refinement of internal fixator systems,with screw heads locking firmly into the plate hole, has now been devised. This is a new plate hole configuration which brings to this most valuable innovation the advantages of conventional plating for example. Placement of a lag screw across the plate for certain fracture configurations. This is achieved through a new design, the “combination” plate hole which can accommodate either a conventional screw or the new “locking head screw (LHS)” which has a conical threaded head.

FEATURES OF LOCKING COMPRESSION PLATES

The locking compression plates have these LC-DCP features

- 50 degrees of longitudinal screw angulation
- 14 degrees of transverse screw angulation
- Uniform hole spacing
- Load (compression) and neutral screw positions

The locking compression plates have combination locking and compression holes that allow placement of conventional cortex and cancellous bone screws on one side or threaded conical locking screws on the opposite side of each hole. Tapered end for submuscular plate insertion, improving tissue viability.

Limited-contact plate design reduces plate to bone contact limiting vascular trauma.Holes in straight plates are oriented so that the compression component of the hole is always directed towards the middle of the plate.

Locking screw design :

Conical screw head:

Facilitate alignment to provide a secure screw plate fixation.

Large core diameter:

Improve bending and shear strength and distribute the load over a larger area in the bone 4.0mm and 5.0mm locking screws, self tapping. The locking screws mate with the threaded plate hole to form a fixed-angle construct. The shallow thread profile of the locking screw results from large core diameter.

GENERAL PRINCIPLES LOCKING COMPRESSION PLATE: [57]

- If a combination of conventional cortical and locking screws are used, a conventional cortical screw should be inserted first to pull the plate to the bone.

- If locking screws have been used to fix a plate to a fragment, subsequent insertion of a conventional screw in the same fragment without loosening and retightening the locking screw is not recommended.

- If a locking screw is used first, care should be taken to ensure that the plate is held securely to the bone to avoid spinning of the plate about the bone.

- Once the metaphyseal fragment has been fixed with locking screws, the fracture can be dynamically compressed using conventional screws in the DCU (Dynamic Compression Unit) portion of the LCP hole.

- First, use lag screws to anatomically reconstruct the joint surfaces.

- The behaviour of a locking screw is not the same as that of a lag screw. With the locked plating technique, the implant locks the bone segments in their relative positions regardless of how they are reduced.

- A plate used as a locked plate does not produce any additional compression between the plate and the bone.

- The unicortical insertion of a locking screw causes no loss of stability.

Depending on the desired functional the locking compression plate (LCP) can be applied in **three different ways**:

- ➢ LCP as a conventional dynamic compression plate.
- ➢ LCP combining conventional and locked application.
- ➢ LCP as pure internal fixator (bridge plating)

LCP as conventional plate:

The LCP can be used as conventional plate with conventional screws. It may then have one of five function; i.e, compression, bridging, buttress, protection, and tension band. With the use of an accentric drill guide, axial compression can be obtained or a lag screw can be placed through any plate hole. This classical fixation is still applicable for articular fracture and in simple type A and B, fracture in the metadiaphyseal area, where anatomical reduction and absolute stability is recommended and can easily be achieved without wide exposure. Other indications are closed wedge osteotomies as well as delayed and nonunions, where absolute stability is recommended.

The LCP can also be used as a plate to protect a lag screw fixation. If only locking head screws are used then this could be considered to be a protecting internal fixator.

LCP combining conventional and locked application:

Here both techniques are employed (combination technique) using conventional lag screws as well as locked screws .In articular fractures requiring an anatomical reduction and fixation by interfragmentary compression, lag screws may be essential for the reconstruction of any articular components.

At the same time the locking head screw provides angular stability, helping to prevent secondary displacement in case of metaphyseal comminution or other bony deficiency.

The term “combination” describes the combination of the two described biomechanical principles use of a combination of interfragmentary compression and the internal-fixator method (bridging). A combination technique does not mean combining different type of screws.

Combination technique can be useful in :-

- Articular fracture with a multifragmentary fracture extension into the diaphysis: anatomical reduction and inter fragmentary compression of the articular component, bridging of the reconstructed joint block to the diaphysis (flexible by the internal fixator method).

- Segmental fracture with two different fracture patterns (one simple and one multifragmentary).Compression principle for simple fracture and internal fixator (bridging) principle for the multifragmentary fracture.

LCP as pure internal fixator (bridge plating)[58]

The LCP can be used as a pure locked internal fixator based on the principle of relative stability by bridging the fracture zone. Here, locking head screws are used exclusively. After indirect reduction, the complex type C fracture zone is not exposed but bridged by a long locking plate.Preserving vascularity in combination with internal splinting allows rapid fracture healing with external callus formation. The fracture bone should be appropriately aligned before the LCP is applied. While temporarily, inserted conventional cortex screws may be used as a reduction aid or to approximate a large fragment, little or no contouring of the plate is needed.

The typical indications for this technique are

- Multifragmentary fracture in the diaphysis and metaphysis.
- Open-wedge osteotomies (eg. proximal tibia)
- Periprosthetic fracture

Delayed change from external fixator to definite internal fixation. Using these different principle of fracture treatment leads to different types of fracture healing. Under certain circumstances, the two different principle of absolute and relative stability may be in compatible.

Therefore, it is advisable to use only one of the two method in one fracture zone, either in a compression method or as internal fixator. These locked internal fixators (PC fix, LISS, LCP) are ideal for the MIPO technique of fracture fixation.

The pre conditions for internal fixation by MIPPO are:

- Indirect closed reduction without exposure of the fracture.
- Small incision for insertion of implants
- Elastic bridging of fracture zone with a locked internal fixator
- Implants with minimal bone contact
- Self drilling and self tapping locking head screws for mono-cortical insertion.
- Self tapping screws for bicortical insertion.
- Relative stability increases callus formation.

The use of fixed-angle locking metaphyseal plate and screw construct for articular and periarticular injuries has become common place. Given the restraints of bone stock in the epiphyseal region or possibly with misplacement of the plate, the use of these fixed angle device may produce varus or valgus malalignment.

In that cases washers may be used to elevate the plate from the diaphyseal segment in order to correct alignment. After shimming washer(s) have been used to correct alignment, locking screws can be used further along the diaphysis to impart stability to the construct.

Other alternative to this technique would be bending the plate (not all plate materials are amenable to this) or use of a “polyaxial” locking fixation. The polyaxial locking plates that allow screw angulation and end-point locking have become available.

Studies says that the variable-axis locking plates performed well, with a high rate of fracture union and no evidence of varus collapse due to failure of the polyaxial screw fixation in a series of complex fractures about the knee.

CLINICAL BENEFITS OF LOCKING COMPRESSION PLATE : [7]

Locking the screw into the plate to ensure angular as well as axial stability, eliminate the possibility for the screw to toggle slide or be dislodged and thus strongly reduces the risk of post operative loss of reduction.

Multiple angle stable screw fixation in the epiphyseal and metaphyseal region, allows for fixation of many fractures that are not treatable with standard devices.

Improved stability in multifragmentary complex fractures, which have bone loss – double plating avoided.

The fixed angle stability avoids subsidence of fixation in metaphyseal areas. This allows for less precise contouring of the plate, as fixation depends of plate screw construct rather than friction between plate bone interface.

Improved biology for healing lead to better clinical outcome and faster healing.

Better fixation in osteoporotic bone, especially in epiphyseal and metaphyseal areas.

MATERIALS AND METHODS

Our study was a prospective study, conducted at the Department of Orthopedics and Traumatology, Government Mohan Kumaramangalam Medical College and Hospital, Salem between May 2012 and August 2014.

Inclusion Criteria:

- Schatzker type V and VI tibial plateau fractures
- Age > 18 years
- Closed fractures
- Grade I compound fractures

Exclusion criteria :

- Age < 18 years
- Grade II and III compound fractures
- Associated with vascular injury
- Pathological fractures

Preoperative management

Patients were given adequate analgesia on reception in casualty. The injured limb was temporarily immobilized in Thomas splint and patients were shifted for x ray. Anteroposterior and lateral views were taken. Manual traction was used where appropriate. CT scans were taken routinely to assess three dimensional fracture geometry.

Skeletal traction was applied to majority of patients in the form of calcaneal pin traction and weights applied with Bohler Braun splint. Ice fomentation was encouraged in the initial two days.

Skin over fracture was closely watched. Those presenting with severe soft tissue edema or blisters were taken up for surgery only after the appearance of ―wrinkle sign .

In case of severe soft tissue injury knee spanning external fixator was used upto the period of definitive surgery .

Soft tissue tension and distal neurovascular status checked periodically to rule out compartment syndrome .Anti –edema measures were instituted for all of our patients .

PREOPERATIVE INSTRUCTIONS :

- Patients were kept fasting for 6 hours before surgery.
- A written informed consent for surgery and anasthesia
- Transquilizers were given as advised by the anesthetist.
- A systemic antibiotics usually inj. cefotaxime 1gm intravenously were administered 30 minutes before surgery to all patients.

The patient was suitably anaesthetized-regional or general according to the patient. Surgery was performed in supine position with the leg support. Anterolateral ,posteromedial and anteromedial approaches were used for fixation . Recommended A-O technique of fracture fixation was used.

Implants required :

Anatomical lateral locking compression plate

3.5 mm locking plate (medial and lateral),3.5 mm reconstruction plate

6.5 mm locking cancellous screws (fully threaded,partially threaded)

5 mm ,3.5 mm locking cortical screws

IMPLANTS :

INSTRUMENTS :

Surgical procedure:

Under spinal anaestehesia Patient was placed in supine position, with leg support provided knee flexion . Under C arm fracture pattern was visualized ,in case of shortening and overriding of fracture fragments ,reuction was achieved with femoral distractor .Temporarily the reduced fragments were fixed with K wires .

Bicondylar fractures without coronal fracture in medial condyle were managed with lateral locking plate .Anterolateral approach was used for application of lateral locking plate .

ANTEROLATERAL APPROACH FOR MIPPO :

The lateral fracture was approached through anterolateral approach. For MIPPO technique curvilinear incision was made in between the Gerdy's tubercle and anterior to the head of fibula . Fascia was incised in line with the skin incision . Indirect reduction of fracture was done by femoral distractor or manual traction ,articular reduction maintained with reduction clamp . Fracture was temporarily fixed with K wires .

Extra periosteal plane were created using blunt dissector. Locking compression plate was introduced extra periosteally ,plate position was checked under C-arm in both AP an Lateral views.

Plate was temporarily fixed with proximal and distal K wire to avoid helicopter effect .Before applying screw axial alignment was checked under C arm guidance by cable technique. First 6.5 mm locking cancellous screw was applied proximally parallel to the articular surface .

Depressed fragments were elevated and void was filled with bone grafting or bone substitutes ,distal most 5 mm cortial locking screw was applied through mini incision.In case of difficulty in reducing the distal fragment (varus or valgus) we have used 4.5.mm non locking cortical screws for reduction. K wires were removed, other screws were applied to the plate through multiple stab incision .

OPEN REDUCTION AND INTERNAL FIXATION :

For open reduction incision was started from five cm above the joint line and extended distally upto the fracture site. To expose the fracture site clearly part of the ilio tibial band released from Gerdy's tubercle .Further proceure as same as MIPPO technique . Wound was closed in layers with suction drain .Sterile dressing applied .

Medial condyle fracture in coronal plane and small sized posteromedial fragment were addressed through posteromedial approach and fixed with 3.5 mm reconstruction plate(locking or non-locking).Wound was closed in layers ,sterile dressing applied .

POSTEROMEDIAL APPROACH :

The patient's knee was positioned in figure of four manner ,incision was made posterior and parallel to the anterior tibial border . Incision was extended over the pes anserinus proximally .

Posteromedial fragment was exposed by retracting the pes anserinus anteriorly and popliteus and medial head of gastronemius posteriorly . Fracture was reduced and temporarily fixed with reduction clamp .

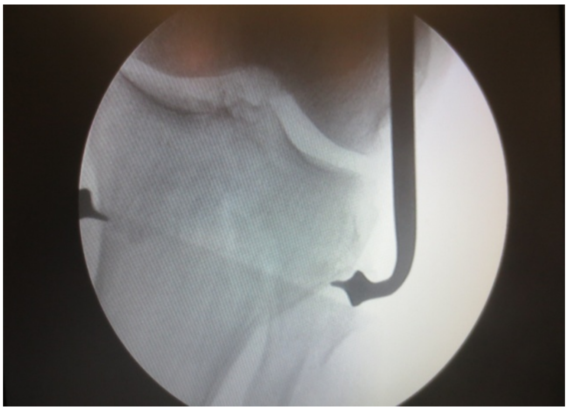
Fracture was fixed with 3.5 mm locking reconstruction plate posteromedially . Reduction was checked under C arm in both AP and Lateral views .

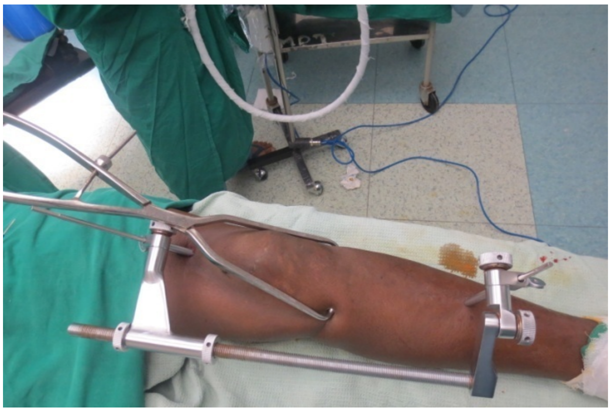
Thorough wash given .Wound was closed in layers . Sterile dressing applied .

POSITIONING OF THE PATIENT- SUPINE POSITION WITH LEG

C ARM VIEW OF FRACTURE AFTER APPLYING FEMORAL DISTRACTOR

ARTICULAR REDUCTION WITH REDUCTION CLAMP





LCP Was introduced by MIPPO technique and fixed with temporary K Wires

After application of proximal scerws

Proximal most screw applied parallel to the joint surface

Post operative X ray

POST OPERATIVE PROTOCOL :

Patients were maintained in a well padded dressing postoperatively. Slabs were not used for immobilization. Drain was removed on second postoperative day. Antibiotics were used for 5 days. Suture removal was done on 12^{th} postoperative day. Patients were advised on non weight bearing crutch walking.

Knee mobilization was encouraged as soon as the patient was able to tolerate motion. 90 degrees active knee flexion was achieved in all cases within 10 days post surgery .

FOLLOW UP :

The first follow up was usually between 4-6 weeks and later on patients were followed up at regular interval of 4-6 weeks till complete fracture union. Partial weight bearing was started after 8 weeks when the fracture showed union.

Full weight bearing was achieved only after solid fracture union usually between 12-14 weeks. Further follow up was done once every 3 months.

ASSESSMENT :

Radiological assessment was performed taking into account two parameters:

1.Medial proximal tibial angle

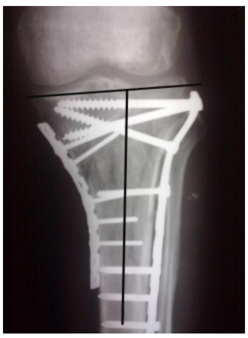
2.Articular step off

Functional assessment was done using **Knee Society Score**.

Radiological assessment:

Medial proximal tibial angle:

Measured between proximal tibial knee joint orientation line (drawn connecting the concave surfaces of both tibial plateaus) and the mechanical axis of tibia . Medial proximal tibial angle (MPTA) – 87+/- 5 degrees



2.Articular step off :

Measured in plain x ray , < 2mm is acceptable

FUNCTIONAL ASSESSMENT :

Knee society score

Criteria	Points
1. Pain	
None	- 50
Mild or occasional	- 45
Stairs only	- 40
Walking and stairs	- 30
Moderate occasional	- 20
Continual	- 10
Severe	- 0
2. Range of motion (5 degrees = 1 point)	- 25

3. **Stability** (maximal movement in any position)

Anteroposterior

< 5 mm	- 10
5 – 10 mm	- 5
> 10 mm	- 0

Mediolateral

< 5 degrees	- 15
6 – 9 degrees	- 10
10 – 14 degrees	- 5
> 15 degrees	- 0

Deductions

1. **Flexion contracture**

5 – 10 degrees	- 2
10 – 15 degrees	- 5
16 – 20 degrees	- 10
> 20 degrees	- 15

2. Extension lag

< 5 degrees	- 5
5 – 10 degrees	- 10
> 10 degrees	- 15

3. Alignment

$5 – 10^0$	- 0
$0 – 4^0$	- 3 points each degree
$11 – 15^0$	- 2 points each degree
Other	- 20

Interpretation :

85 – 100 points	: Excellent
70 – 84 points	: Good
60 – 69 points	: Fair
< 60 points	: Poor

OBSERVATIONS AND RESULTS

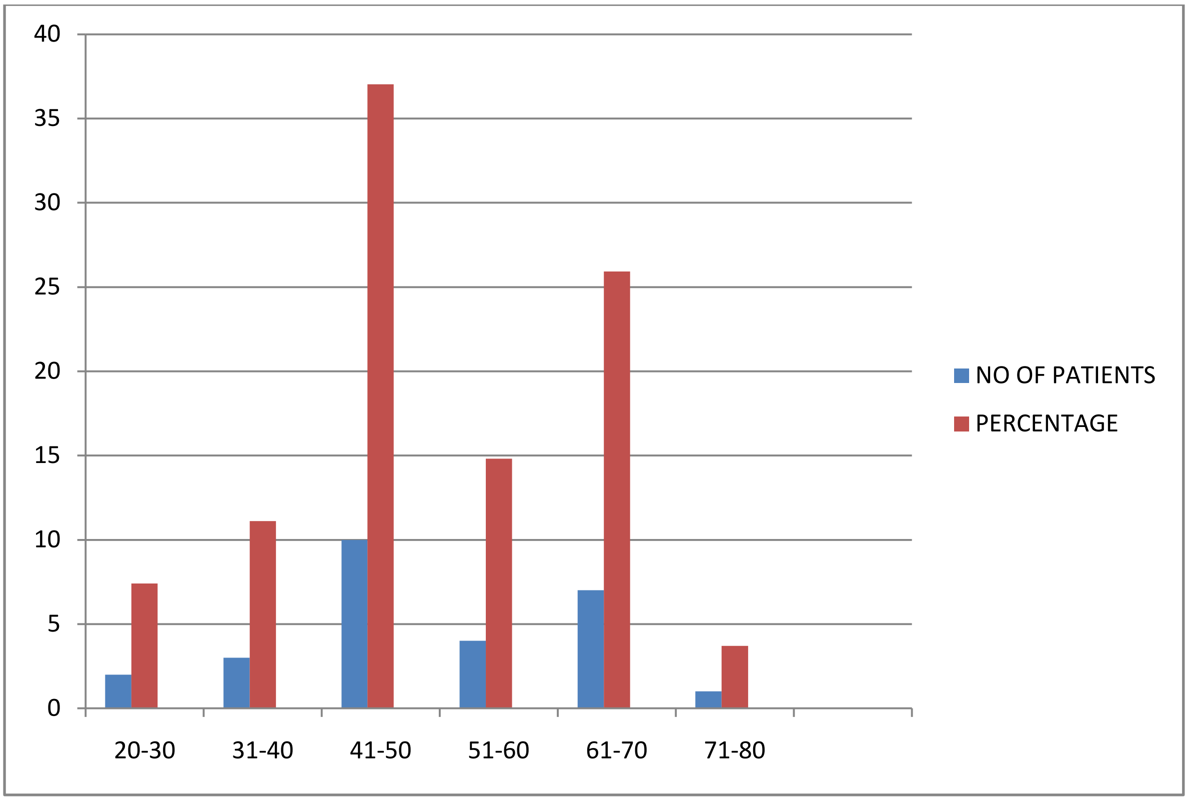
We studied 27 patients with proximal tibial fracture who were treated with locking compression plate .

AGE DISRIBUTION :

TABLE:1

AGE IN YEARS	NO OF PATIENTS	PERCENTAGE (%)
20-30	2	07.40
31-40	3	11.11
41-50	10	37.03
51-60	4	14.81
61-70	7	25.92
71-80	1	03.70
TOTAL	27	100

GRAPH : 1

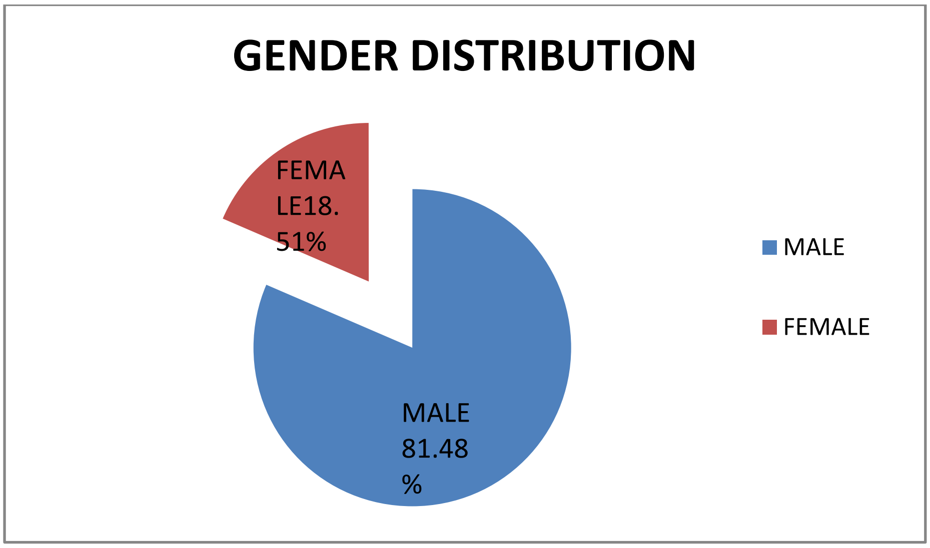


In our study most of the patients belong to 41-50 years . Out of 27 cases incidence in > 40 years was 81% . Age range between 23-75 years . Average age group is 51.25 years .

GENDER DISTRIBUTION :   TABLE:2

GENDER	**NO OF PATIENTS**	**PERCENTAGE(%)**
MALE	22	81.48
FEMALE	5	18.51
TOTAL	27	100

GRAPH : 2

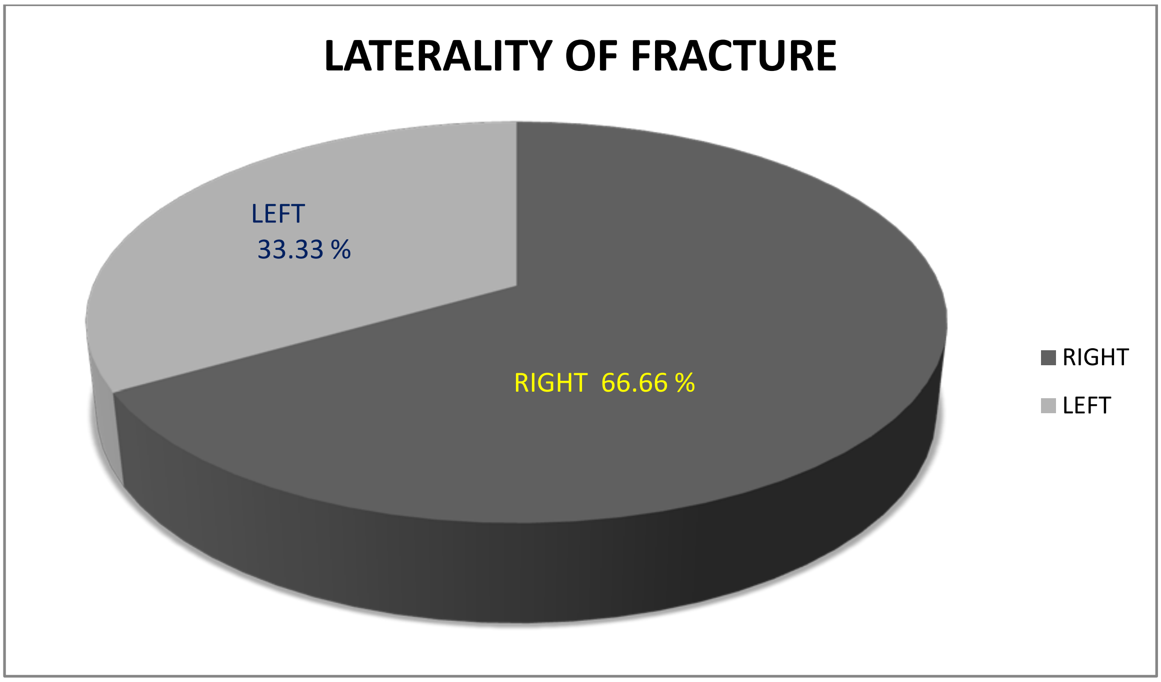


In our study 81 % were male patients. Male to female ratio - 4.4:1

LATERALITY OF FRACTURE : TABLE:3

SIDE INVOLVED	NO OF PATIENTS	PERCENTAGE (%)
RIGHT	18	66.66
LEFT	9	33.33
TOTAL	27	100

GRAPH : 3

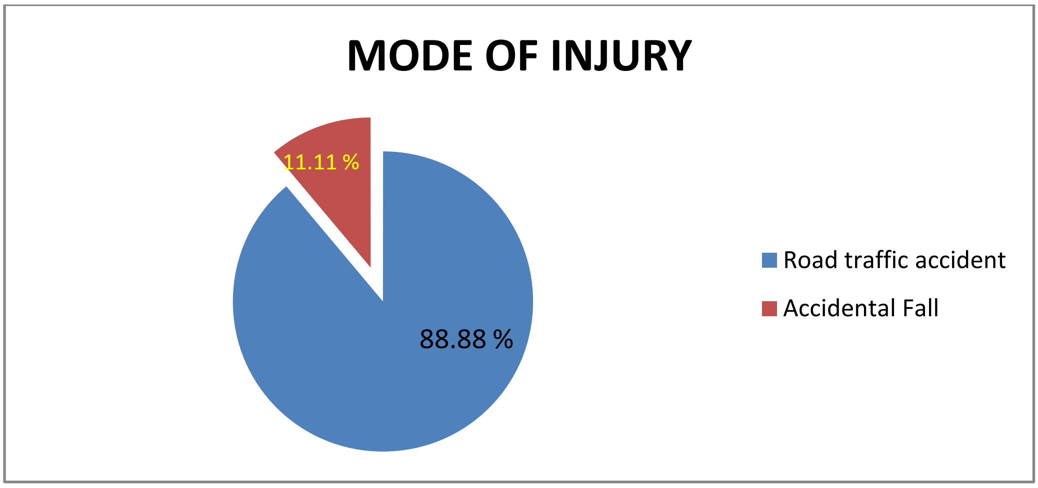


In our series there right side predominance compared to left side.

MODE OF INJURY : TABLE:4

MODE OF INJURY	NO OF PATIENTS	PERCENTAGE
Road traffic accident	24	88.88
Accidental Fall	3	11.11
TOTAL	27	100

GRAPH : 4

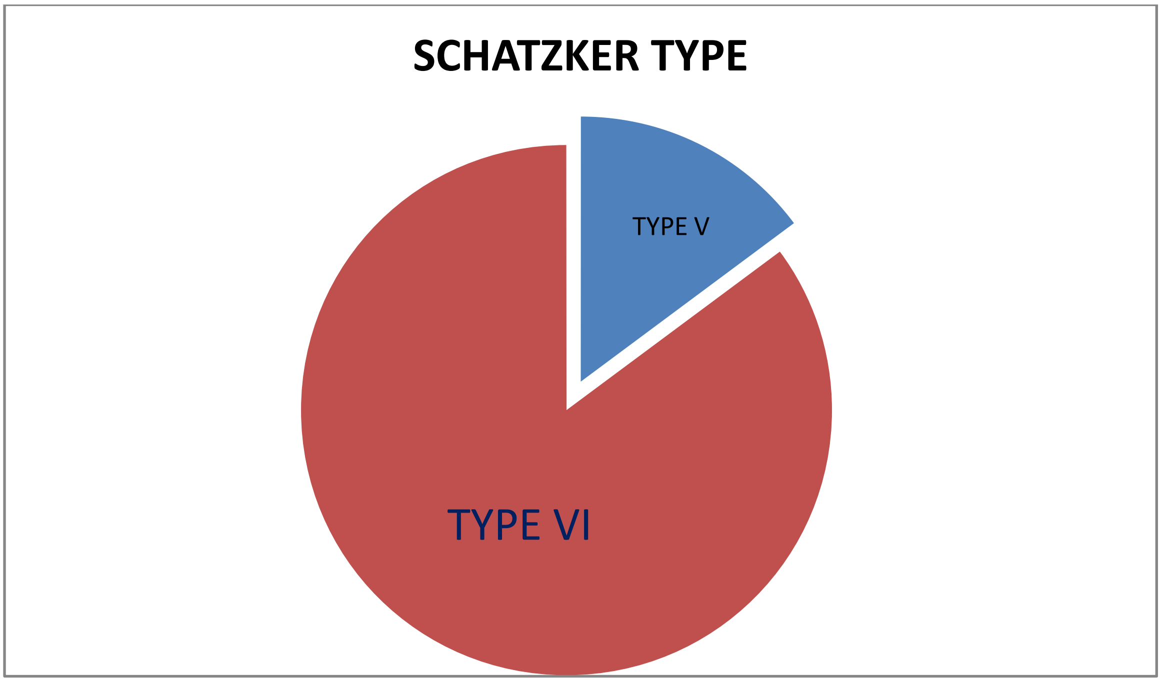


In our study more common mode of injury is road traffic accidents compared to accidental fall .It indicates the high energy nature of bicondylar tibial plateau fractures .

FRACTURE PATTERN DISTRIBUTION : TABLE:5

TYPE OF FRACTURE	NO OF PATIENTS	PERCENTAGE(%)
SCHATZKER TYPE V	4	14.81
SCHATZKER TYPE VI	23	85.18
TOTAL	27	100

GRAPH : 5



Majority of cases were Schatzker type VI (85.18 %) compared to type V

.

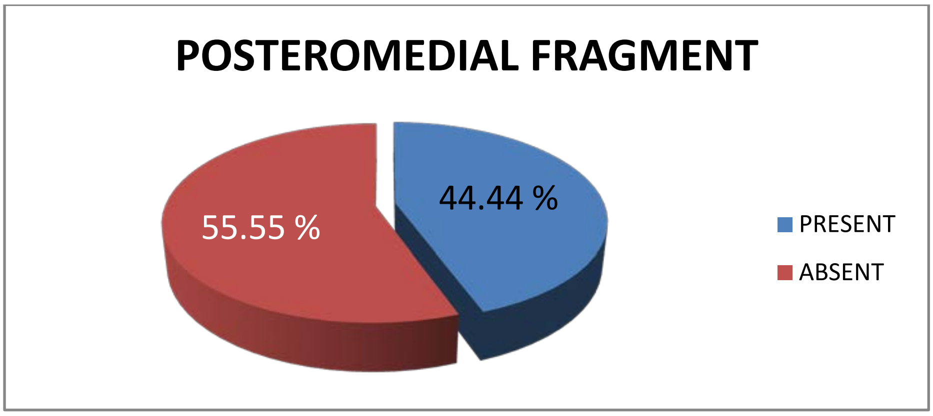
POSTEROMEDIAL FRAGMENT :

We have done 3D CT scan to evaluate the fracture pattern and presence of posteromedial fragment .

TABLE: 6

POSTEROMEDIAL FRAGMENT		NUMBER OF PATIENTS	PERCENTAGE(%)	
Present	In coranal plane	4	18.51	44.44
	In sagittal plane	8	25.92	
Absent		15	55.55	
Total		27	100	

GRAPH : 6

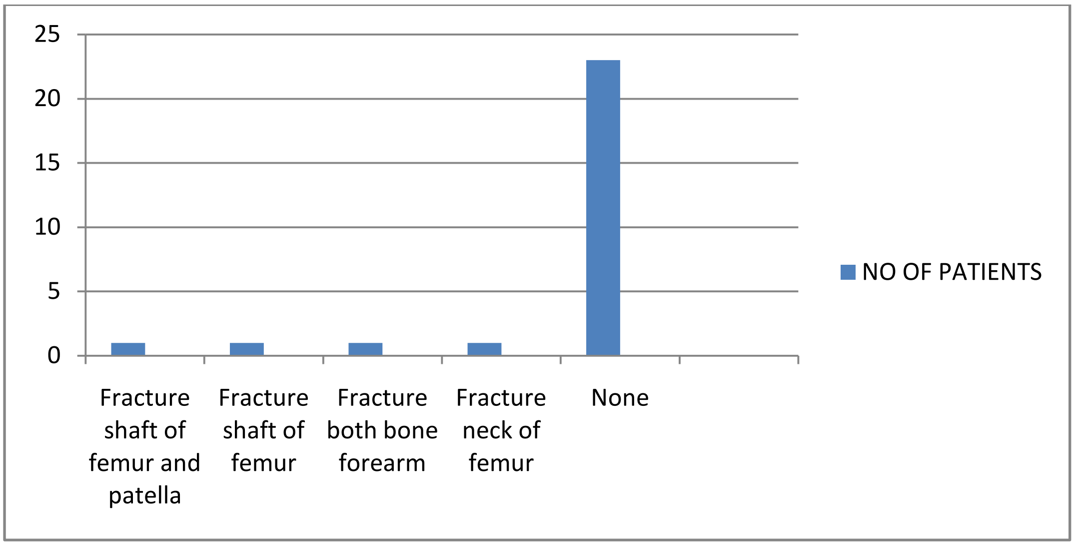


In our series 12 cases (44.44%) had posteromedial fragment of which 4 patients had posteromedial fragment in coronal plane .

ASSOCIATED INJURIES : TABLE:7

ASSOCIATED INJURIES	NO OF PATIENTS	PERCENTAGE (%)
Fracture shaft of femur and patella	1	3.70
Fracture shaft of femur	1	3.70
Fracture both bone forearm	1	3.70
Fracture neck of femur	1	3.70
None	23	85.18
Total	27	100

GRAPH : 7



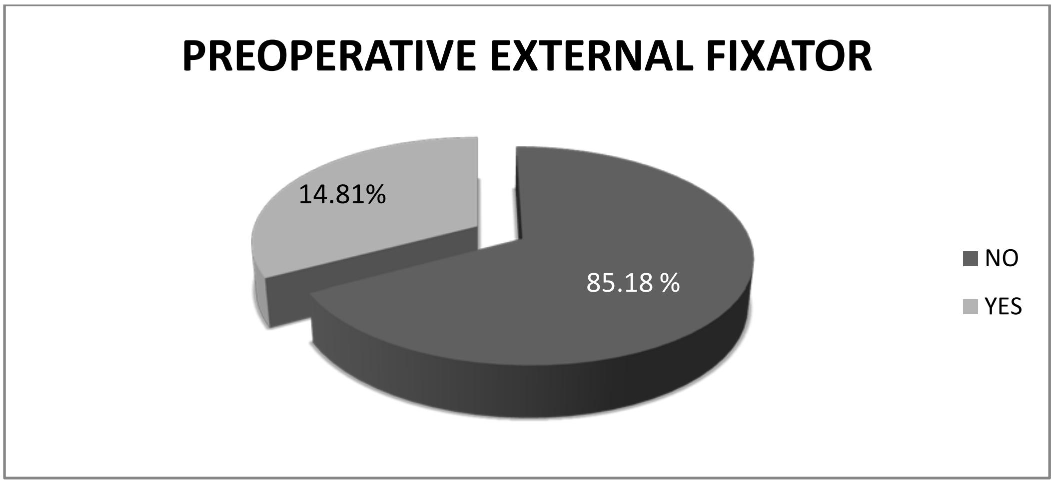
BB-both bone , NOF-neck of femur

PRE OPERATIVE EXTERNAL FIXATOR :

TABLE : 8

EXTERNAL FIXATOR	NO OF CASES	PERCENTAGE(%)
YES	4	14.81
NO	23	85.18
TOTAL	27	100

GRAPH : 8

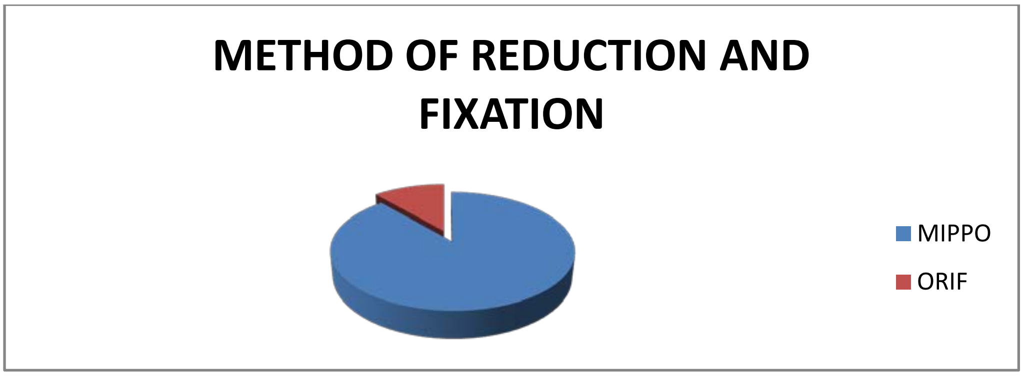


Usually we have used calcaneal pin for skeletal traction .Pre –operative external fixator was used for four patients admitted with tense compartment and blebs over the leg. Surgery was delayed until appearance of wrinkle sign .

METHOD OF REDUCTION AND FIXATION : TABLE : 9

Method of reduction	No of patients	Percentage(%)
MIPPO	25	92.59
Open reduction	2	07.40
TOTAL	27	100

GRAPH : 9



In our series > 90 % cases fixed by MIPPO technique to avoid soft tissue damage and enhance the biological bone healing .

TYPE OF LOCKING PLATE USED : TABLE:10

Type of locking plate	Number of patients	Percentage (%)
Anatomical lateral	24	88.88

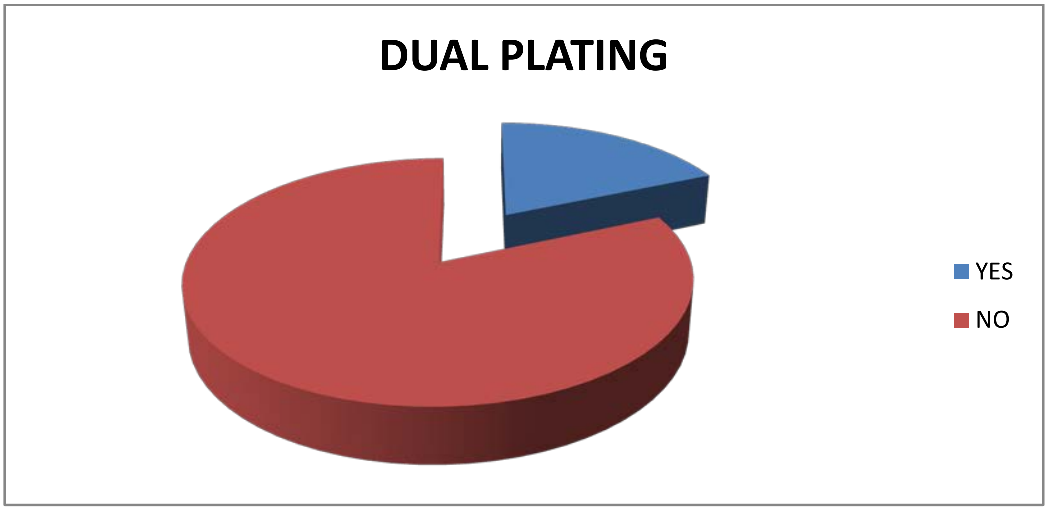
LCP		
3.5 mm Locking plate	3	07.40
Total	27	100

DUAL PLATING :

TABLE : 11

DUAL PLATING	NO OF CASES	PERCENTAGE(%)
YES	5	18.51
NO	22	81.48
TOTAL	27	100

GRAPH : 10



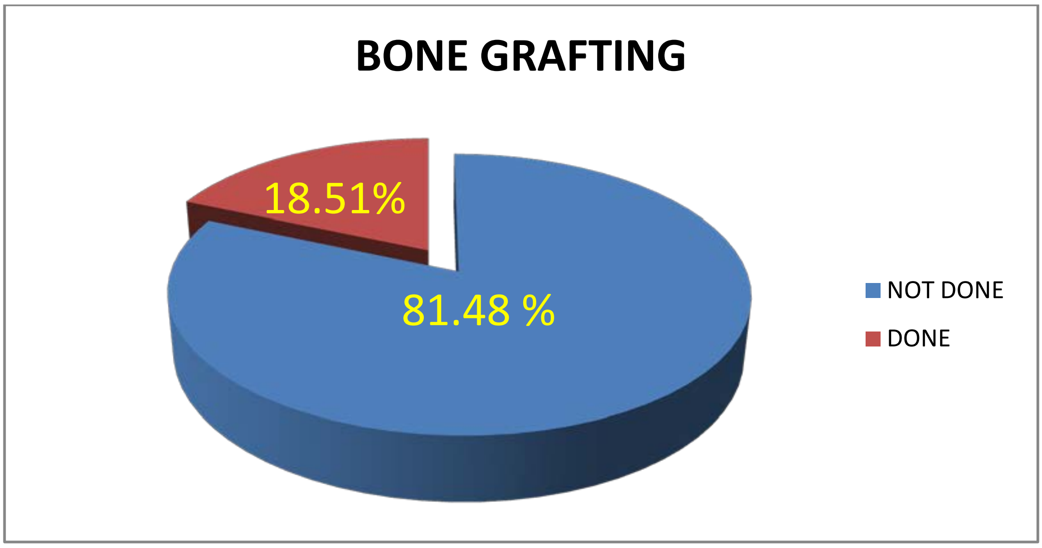
In our series we have used posteromedial buttress plating for five cases of which 4 cases had posteromedial (coronal) fragment and 1 case in which posteromedial (small) fragment was not reduced with single lateral locking plate .

PRIMARY BONE GRAFTING :

TABLE- 12

Bone Grafting	No of patients	Percentage (%)
Done	5	18.51
Not done	22	81.48
Total	27	100

GRAPH : 11



In our series we have done primary bone grafting for 5 cases only . Most of our cases well united with out bone grafting .

OPERATIVE TIME : TABLE : 13

Operative time (in minutes)	Number of patients	Percentage (%)
< 60	5	18.51
61-90	18	66.66
91-120	4	14.81

Mean duration of surgery = 77 minutes (50-120)

AVERAGE BLOOD LOSS = 70 ml (40-200)

INTRAOPERATIVE COMPLICATIONS: TABLE :14

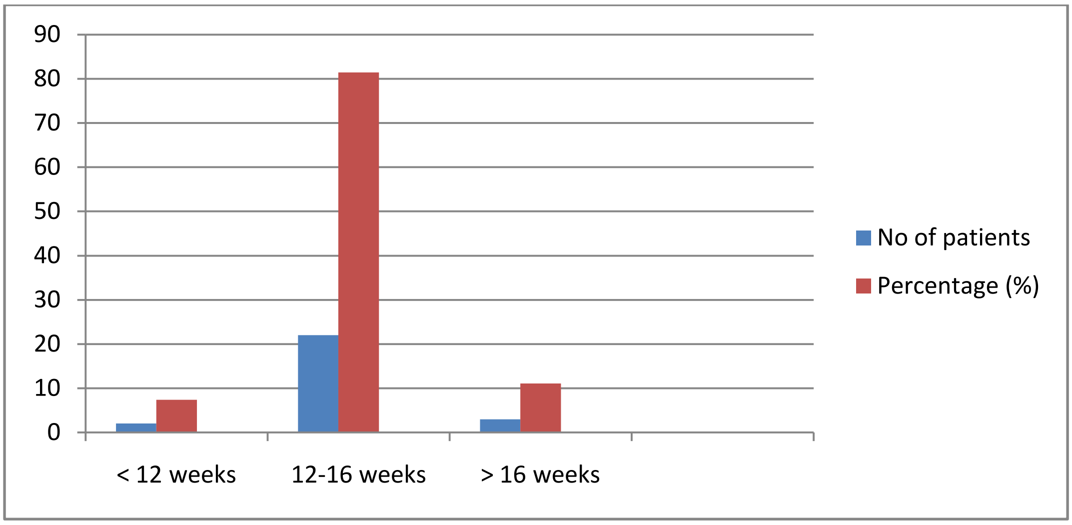
Complication	**Number of cases**
K wire breakage	4

Difficulty in reducing the distal fragment	3

FRACTURE UNION : TABLE - 15

Duration- in weeks	No of patients	Percentage (%)
< 12	2	07.40
12-16	22	81.48
> 16	3	11.11
Total	27	100

GRAPH : 12



In our cases majority of cases (> 80%) united between 12-16 weeks . All of our cases were united in average of 13.70 weeks .

Radiological analysis :

Medial proximal tibial angle (MPTA) measurement was undertaken to assess varus/valgus malunion postoperatively. The normal value of MPTA is 87+/-5 degrees. In our series, the average value was 85.4 degrees (range 83 – 91degrees). Thus, we found that the normal proximal tibial joint orientation is maintained after application of LCP .

Articular stepoff was assessed with less than or equal to 2 mm stepoff kept as acceptable limit. In our series, 2 cases had articular stepoff more than 2 mm (range 3 – 5 mm) and 25 cases had the acceptable result of less than or equal to 2 mm stepoff.

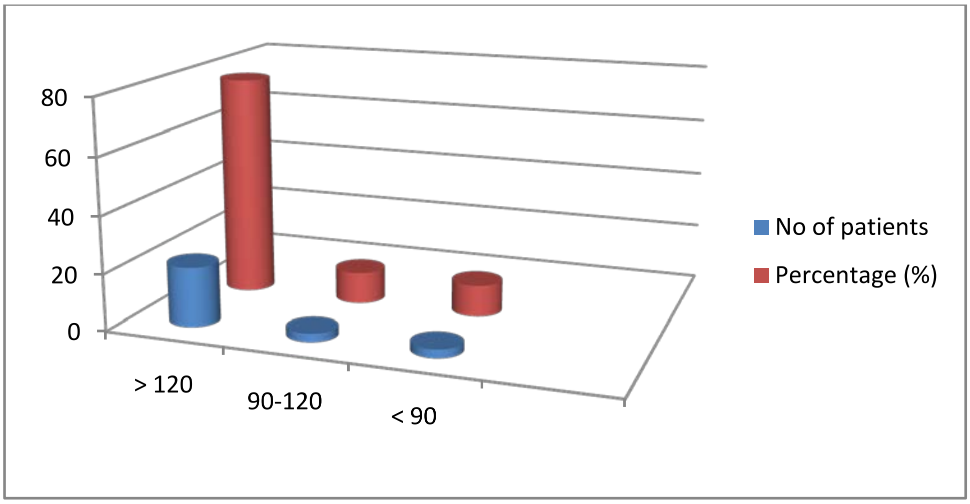
TABLE : 16

Articular stepoff >2 mm	No of patients	Percentage (%)
Yes	2	07.40
No	25	92.59
Total	27	100

RANGE OF MOTION : TABLE-17

Range of motion in degrees	No of patients	Percentage (%)
> 120	21	77.77
90-120	3	11.11
< 90	3	11.11
Total	27	100

GRAPH : 13



RANGE OF MOTION

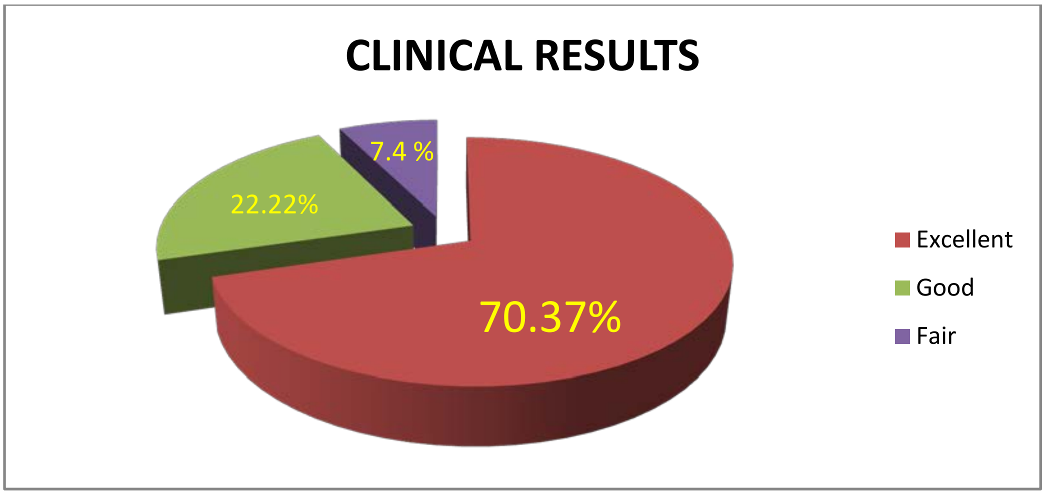
In our study most of our patients had range of motion > 120 degree . Two patients were developed knee stiffness due to poor adherence to physiotherapy .

CLINICAL RESULTS BASED ON KNEE SOCIETY SCORE :

TABLE-18

Interpretation	No of patients	Percentage (%)
Excellent	19	70.37
Good	6	22.22
Fair	2	07.40
Total	27	100

GRAPH : 14



In our study the clinical outcome of most of the patients (19) was excellent ,which was based upon Knee society score . 06 patients had good and two patients with fair results.

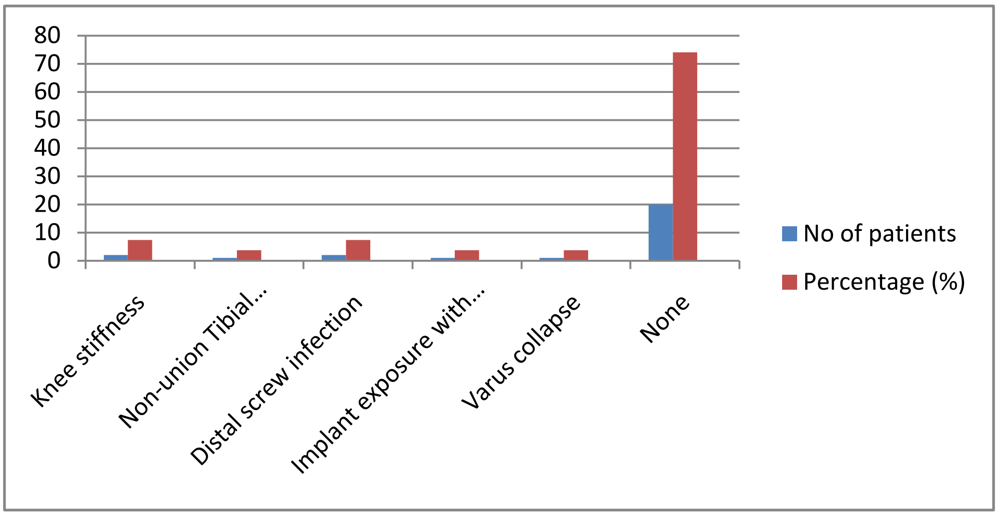
POST OPERATIVE COMPLICATIONS :

TABLE – 19

Complications	No of patients	Percentage (%)
Knee stiffness	2	07.40
Non-union distal part of Tibial tuberosity fragment	1	03.70
Distal screw infection	2	07.40
Implant exposure	1	03.70

with deep infection		
Varus collapse	1	03.70
None	20	74.07
Total	27	100

GRAPH:15



In out study we had 20 patients with no complications .

- Two patient developed knee stiffness due to poor compliance for physiotherapy .
- One patient with Non-union of distal part of tibial tuberosity fragment which was not fixed primarily .

- Two patients developed distal screw infection for that one patient was treated with oral antibiotics and screw exit was done for another patient .

- One patient came with implant exposure after 10 weeks of post operative period . Implant removal was done and put an knee spanning external fixator .Fracture was united in 14 weeks & external fixator was removed .

- One patient developed varus collapse post operatively due to secondary loss of reduction .

TABLE :20

PERIOPERATIVE PARAMETERS	VALUES
Average Time To Surgery(Days)	7.5 (3-28)

Mean Operative Time (Min)	77 (50-120)

Name	Vijiganesh

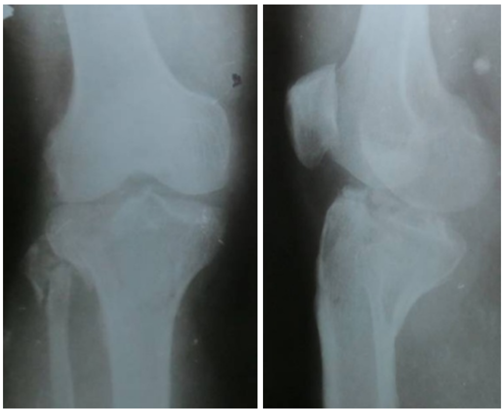
Average Blood Loss (Ml)	70 (40-200)
Average Period Of Union(Weeks)	13.70 (11-18)
Average Period Of Follow Up(Months)	13.85 (04-22)
Average Period For Full Weight Bearing(Weeks)	16.52(14-28)
Return To Work (Weeks)	17.42 (15-28)
Mean Range Of Movement(Degrees)	102.4 (60-130)
Mean Knee Society Score	83.03 (Good results)

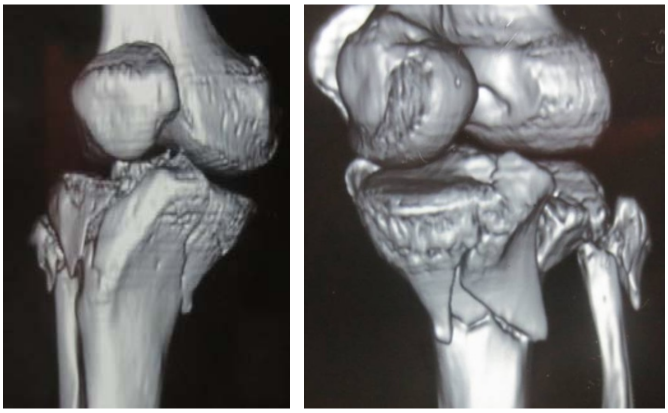
Age/sex	42/M
Mode of injury	RTA
Laterality of fracture	Right
Open/closed fracture	Closed
Associated injury	Nil
Schatzker classification	V
Time interval between admission and surgery	6 days
Time of union	11 weeks
complications	Nil
Functional outcome	Excellent

CASE :I

PRE OPERATIVE X-RAYS (AP& LAT)

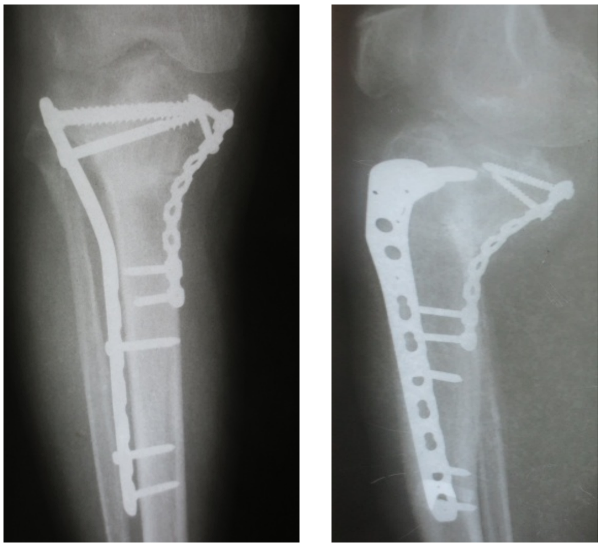
PREOPERATIVE 3D CT SCAN





IMMEIATE POST OPERATIVE X-RAYS(AP&LAT)

FOLLOW UP -8 MONTHS



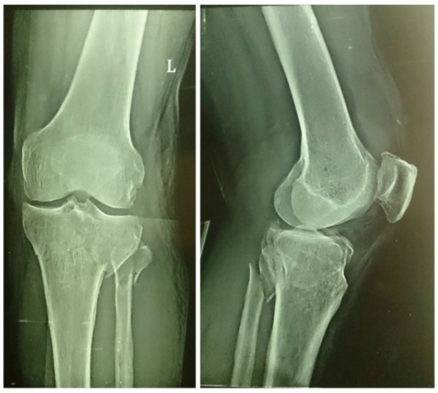
KNEE EXTENSION

KNEE FLEXION

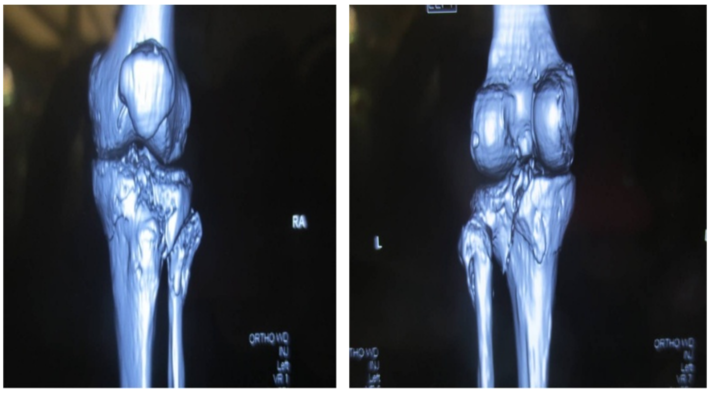
CASE :II

Name	Govindaraj
Age/sex	52/M
Mode of injury	RTA
Laterality of fracture	Left
Open/closed fracture	Closed
Associated injury	Nil
Schatzker classification	V
Time interval between admission and surgery	5 days
Time of union	12 weeks
complications	Nil
Functional outcome	Excellent

PRE OPERATIVE X-RAYS (AP & LAT)



PREOPERATIVE 3D CT SCAN



IMMEIATE POST OPERATIVE X-RAYS(AP&LAT)

FOLLOW UP -8 MONTHS

KNEE EXTENSION

KNEE FLEXION

CASE :III

Name	Ramachandran
Age/sex	65/M
Mode of injury	RTA
Laterality of fracture	Left
Open/closed fracture	Grade I open
Associated injury	#both bone forearm Left
Schatzker classification	VI
Time interval between admission and surgery	8 days
Time of union	14 weeks
complications	Nil
Functional outcome	Excellent

PRE OPERATIVE X-RAYS (AP & LAT)

PREOPERATIVE 3D CT SCAN

IMMEIATE POST OPERATIVE X-RAYS(AP&LAT)

FOLLOW UP -1 YEAR

KNEE EXTENSION

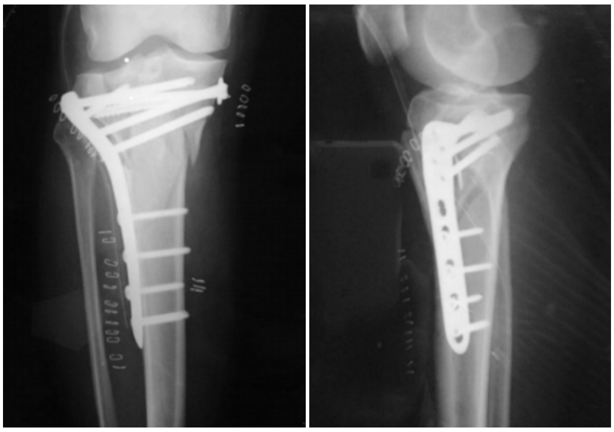
KNEE FLEXION

CASE :IV

Name	Rathinappa
Age/sex	48/M
Mode of injury	RTA
Laterality of fracture	Right
Open/closed fracture	Closed
Associated injury	Nil
Schatzker classification	VI
Time interval between admission and surgery	8 days
Time of union	16 weeks
complications	Nil
Functional outcome	Excellent

PRE OPERATIVE X-RAYS (AP & LAT)

IMMEIATE POST OPERATIVE X-RAYS(AP&LAT)



FOLLOW UP -1 YEAR

KNEE EXTENSION

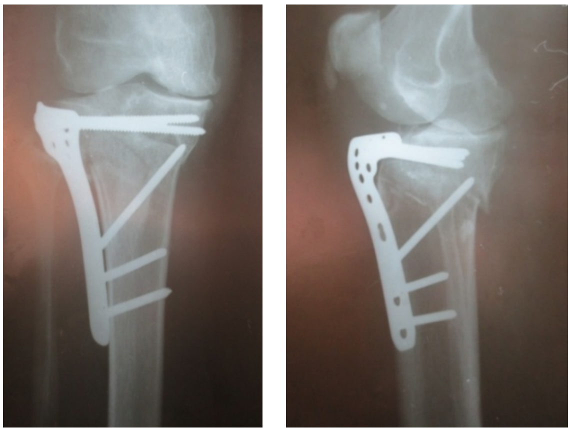
KNEE FLEXION

CASE:V

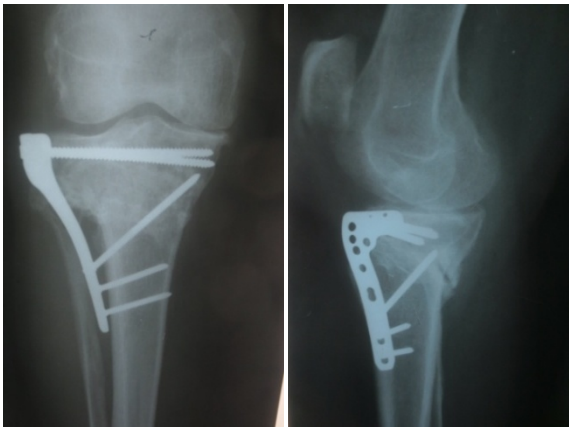
Name	Arasan
Age/sex	68/M
Mode of injury	RTA
Laterality of fracture	Right
Open/closed fracture	Closed
Associated injury	Nil
Schatzker classification	VI
Time interval between admission and surgery	15 days
Time of union	12 weeks
complications	Nil
Functional outcome	Good

PRE OPERATIVE X-RAYS (AP & LAT)

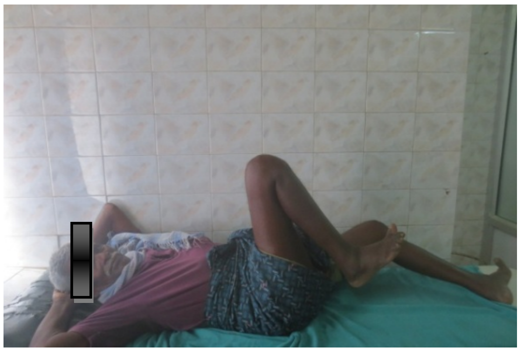
IMMEDIATE POST OPERATIVE X-RAYS (AP & LAT)



FOLLOW UP -8 MONTHS



KNEE EXTENSION



KNEE FLEXION

COMPLICATIONS

INTRAOPERATIVE COMPLICATIONS:

Complication	Number of cases
K wire breakage	4
Difficulty in reducing the distal fragment	3

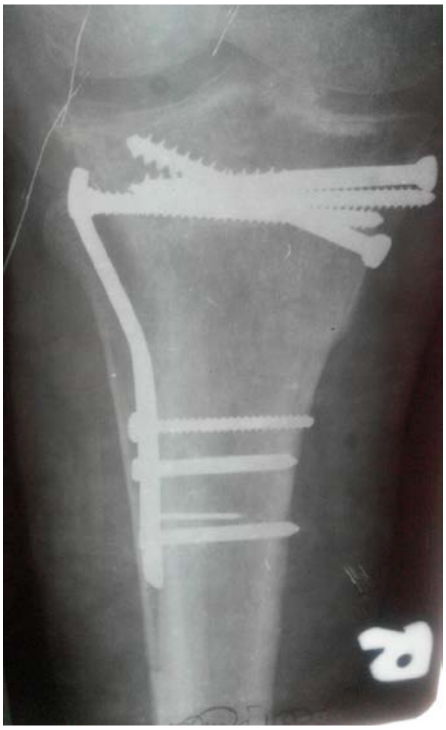
POSTOPERATIVE COMPLICATIONS:

Complications	Name of the patient
Varus collapse	Mandheswaran
Implant exposure with deep infection	Manoharan
Non-union distal part of Tibial tuberosity fragment	Mani
Distal screw infection	Sasikumar,Sekar

I.INTRA OPERATIVE COMPLICATIONS

K WIRE BREKAGE – IMMEDIATE POST OP X RAY

FOLLOW UP X RAY - NO MIGRATION



II. POST OPERATIVE COMPLICATIONS

MADHESWARAN Varus collapse due to secondarv loss of reduction

MANOKARAN

IMPLANT EXPOSURE WITH DEEP INFECTION

IMPLANT REMOVAL AND EXTERNAL FIXATION

HEALED WOUND

X RAY SHOWS SOLID UNION

MANI- NON-UNION OF DISTAL PART OF TIBIAL TUBEROSITY

MANI - FUNCTIONAL OUTCOME

SASIKUMAR -DISTAL SCREW INFECTION

SEKAR -DISTAL SCREW INFECTION

SEKAR -AFTER DISTAL SCREW REMOVAL

DISCUSSION

We presented the clinical study of surgical treatment of 27 proximal tibial plateau fractures treated with locking compression plate ..The analysis of the results made in terms of age of patients, gender distribution , Laterality of fracture ,mode of injury , analysis of the types ,medial condyle fracture planes ,primary bone grafting ,method of reduction and fixation ,pre operative external fixation , dual plating , associated injuries and complications .

In our study maximum incidence involving tibial plateau fracture >40 yrs (81%) . Average age group in our study was 51.25 years compared to Gosling et al 2005 study (Average age group 51.5 years) .[27]

TABLE:21

Study group	Age group (years)
Honkonen et al [59]	20-60
Pun et al[60]	21-60
Lee et al [61]	40-60
Albuquerque et al[62]	30-60
Our study	40-70

In our study ,males were most commonly affected compared to females . Male to female ratio is 4.4:1 .This may be explained by active lifestyle of males and higher chances of road traffic accidents .

This is in accordance with the series of 14 patients reported by Eggli et al., in which 10 were male and 4 female [64]

TABLE:22

Study group	Incidence in males
Lee et al [61]	65.71 %
Manidakis et al [63]	58.60 %
Albuquerque et al[62]	70.30 %
Our study	81.48 %

Accidental fall was the cause for three patients , all of them were old age patients(>60) with osteoporotic bones In our study road traffic accidents were the cause of injury in 24 patients out of 27 .In most of the clinical studies more common cause of tibial plateau fracture in younger individuals was motor vehicle accidents .

In laterality of the fracture right being 66.66% .

We had only 4 cases of type V Schatzker tibial plateau .

TABLE:23

Study group	**Incidence of Schtzker type V**
Mukharjee et al[65]	14.28 %
Our study	14 .81 %

Out of 27 cases 12 cases had posteromedial fragment in their CT scans. In which 4 cases had medial condyle fracture in coronal plane . Barei et al evaluated incidence of medial coronal farcture in Schatzker type V ,VI and it was found to be 29%.

TABLE:24

Study group	Incidence of medial coronal farcture
Mukharjee et al[65]	19.04 %
Barei et al [22]	29 %
Our study	14.81 %

In our series the indications for the surgery were the same standard indications as for the tibial plateau fractures .Four of our cases associated with other injuries like fracture shaft of femur with patella ,fracture shaft of femur ,fracture both bone forearm and fracture neck of femur .

We have done Interlocking nail for shaft of femur cases ,Tense band wiring for patella , ORIF with plating for both bone forearm and Hemiarthroplasty for neck of femur fracture .

In our study we used pre operative temporary knee spanning external fixator in four of our patients came with tense compartment and blebs over the leg .Surgery was deferred until wrinkle sign to appear .Temporary external fixator enhances the soft tissue healing potential and reduces deep infection(Damage control orthopaedics).[22]

In our study we used MIPPO technique for reduction and fixation in 25 cases (92%) .In which both duration of procedure and surgical insult to the soft tissues are very less compared to open reduction and internal fixation .[35] Wound healing also better and faster compare to ORIF technique but it demands challenging surgical techniques .[29,45]

Biological healing will not be disturbed in MIPPO technique . MIPPO technique is recommended for high energy tibial plateau fracture associated with severe soft tissue injury . [66-73]

Indirect reduction of fracture and maintenance of axial alignment before the application of plate is very essential to achieve good functional outcome .

In our study we used femoral distractor for indirect reduction[74-76] in all of our cases and axial alignment was checked under C-arm in both ap and Lat direction.[27]

In our study we have done single lateral locking compression plate for 22 patients and Dual plating for 5 patients. Dual plating was done for 4 cases with medial condyle fracture in coronal plane and one case which was not reduced after application of lateral locking plate due to small size of the fragment. All of our patients had stable soft tissue condition allows us to do dual plating .We have used posteromedial approach for medial buttressing(antiglide effect) .[77,78]

Single lateral locking plate alone not sufficient to stabilize the medial condyle coronal fracture and small posteromedial fragment .[22,23] Single lateral LCP results in collapse of medial condyle .[79-82],Course of locking screw is predetermined (monoaxial configuration) and parallel to the fracture line which does not give any compression at fracture site .[83]

In our study primary bone grafting was done only in 18.5% of cases mainly to fill the metaphyseal defects after the elevation of depressed lateral condyle .

TABLE:25

Study group	Primary bone grafting(% of cases)
Gosling et al 2005 using LCP [27]	19%
Barbary et al using Ring fixator[84]	16.6%
Jang et al using dual plates[85]	51.2%
In our study using LCP	18.5%

Routine bone grafting not necessary with LCP [27] because it provides absolute articular stability which gives the hematoma and cancellous bone chance to fill the defects .

In our study fracture union in 81 % of cases occurred in between 12-16 weeks .The mean time to union was 13.70 weeks ranging from 11-18 weeks.In our study no cases of non-union in primary fracture lines.

TABLE:26

Study group	Time interval for bone union
Ehlinger et al [86]	10 weeks
Yu et al [83]	15.4 weeks
Our study	13.7 weeks

In our study 77.77% of cases had range of motion >120 degrees . The mean range of motion was 102.4 degrees ranging from 60-130 degrees .Our results comparable with Ehlinger et al mean ROM-107.6^0 .

Average period for return to work in our study was 17.42 weeks .

TABLE:27

Study group	Time interval for bone union
Ehlinger et al [86]	18 weeks
Yu et al [83]	18.1 weeks
Rosario spanglono et al [35]	17.2 weeks
Our study	17.42 weeks

Two of our patients developed knee stiffness due to poor adherence to physiotherapy.

One of our patient developed non-union of distal part of tibial tuberosity which was not primarily fixed .In spite of non-union patient had 0-110 degree of movement without any pain. Bicondylar fracture associated with tibial tubercle fracture should be fixed .If the tibial tubercle is a large fragment that should be fixed with either 2.7 or 3.5 mm cortical lag screws.If the fragment is small that should be fixed with ¼ or 1/3 tubular plate or 2.0 mm dynamic compression plate .[89]

Two of our patients developed distal screw site infection .One patient was treated with wound debridement and oral antibiotics according to culture and sensitivity .One patient was treated by I.V antibiotics with removal of infected screw.

One of our patient came with implant exposure with infection after 10 weeks of post operative period .Which necessitates Implant removal and it was done with application knee spanning external fixator .Fracture was united in 14 weeks & external fixator was removed .[86]

In our study the deep infection rate was 3.7 %.This is explained by MIPPO technique associated with reduced deep infection and Overall deep infection rate in LCP group is 4-8%.[27]

TABLE:28

Study group	Precentage (%) of deep infection
Rosario Spagnolo et al using LCP[35]	0%
Gosling et al 2005 using LCP[27]	4-8%
Our study	3.7 %

One of our case developed varus deformity due to secondary loss of reduction .In our case we didn’t use lag screw for fixation .Post operative varus collapse can be prevented by accurate reuction, proper positioning of the implant ,lag screw application and posteromedial buttress plating.We have planned for corrective osteotomy for our patient but our patient didn’t come for follow up.

Out Of 27 patients , 19 had excellent functional outcome, six had good functional outcome and only two cases had a fair outcome. In the study by Eggli et al of 14 patients 11 had very good functional outcome and three had good functional outcome by Lyshom knee score.

TABLE:29

Study group	Excellent functional outcome
Oh et al [88]	21 out of 23
Eggli et al[64]	11 out of 14
Our study	19 out of 27

Medial proximal tibial angle (MPTA) measurement was undertaken to assess varus/valgus malunion postoperatively. The normal value of MPTA is 87+/-5 degrees.[23] In our series, the average value was 85.4 degrees (range 83 – 91degrees). Thus, we found that the normal proximal tibial joint orientation is maintained after application of LCP . [87]

Articular stepoff was assessed with less than or equal to 2 mm stepoff kept as acceptable limit. In our series, 2 cases had articular stepoff more than 2 mm (range 3 – 5 mm) and 25 cases had the acceptable result of less than or equal to 2 mm stepoff. This is comparable to the result published by Eggli et al. they reported 85% accurate articular reconstruction in their series of 14 patients.

CONCLUSION

At the end of our study, following conclusions could be drawn from the treatment of proximal tibial fracture with locking compression plate.

- Early mobilization is possible with LCP because of absolute stability given by the implant and this contributes to better knee range of motion .
- Medial condyle coronal fracture and small posteromedial fragment should be buttressed by posteromedial plating .
- LCP gives the promising results in osteoporotic bones .It prevents collapse of fracture both intraoperatively and postoperatively .
- Not all bicondylar fractures are same ,treatment should be precise to individual fracture pattern .
- Bicondylar tibial plateau fractures treated with locking compression plate have an excellent to good functional outcome with very minimal wound complications

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MASTER CHART

S.No	Name	Age	Sex	I.P.No	Mode of injury	Side	Schatzker type	Closed or open	Associated injuries	Time delay before surgery	Additional fixation on medial side	Bone grafting	Follow up months	Time to union weeks	Knee society score	Complications
1	Kamaraj	42	M	31522	RTA	Left	VI	closed	-	7 days	-	No	22	14	85	Nil
2	Thirumal	28	M	34624	RTA	Right	VI	closed	-	4 days	-	No	20	12	90	Nil
3	Ilayapillai	42	M	45092	RTA	Right	VI	closed	-	6 days	-	Yes	18	12	85	Nil
4	Mani	50	M	48420	RTA	Right	VI	closed	#SOF (R) # patella	8 days	Yes	No	18	14	85	Non-union –tibial
5	Muniyan	70	M	1126	FALL	Right	VI	closed	-	10 days	-	Yes	18	18	80	Nil
6	Kaliyan	64	M	4246	RTA	Left	VI	Open I	-	7 days	-	No	18	15	75	Nil
7	Marakkal	75	F	8734	FALL	Right	V	closed	-	5 days	-	No	18	14	65	Knee stiffness
8	Palanisamy	63	M	8882	RTA	Left	VI	closed	-	3 days	-	No	18	16	85	Nil
9	Madheswaran	58	M	10222	RTA	Right	VI	closed	-	6 days	-	No	18	14	85	Varus collapse
10	Mathiyalagan	23	M	12528	RTA	Right	VI	Open I	# SOF	4 days	-	No	18	11	85	Nil
11	Perumayee	63	F	13036	RTA	Right	VI	closed	-	8 days	-	Yes	16	16	80	Nil
12	Manokaran	50	M	19488	RTA	Right	VI	closed	-	5 days	-	No	18	14	75	Implant exposure
13	Subramani	42	M	22176	RTA	Left	VI	closed	-	6	-	No	18	12	90	Nil
14	Sekar	57	M	23440	RTA	Right	VI	closed	-	4 days	-	No	16	14	85	Distal screw infection
15	Malliga	60	F	25116	FALL	Left	VI	closed	#P/3Shaft of tibia	6 days	-	No	16	18	65	stepoff >2mm
16	Rathinappa	48	M	29100	RTA	Right	VI	closed	-	8 days	-	No	16	12	90	Nil

S.No	Name	Age	Sex	I.P.No	Mode of injury	Side	Schatzker type	Closed or open	Associated injuries	Time delay before surgery	Additional fixation on medial side	Bone grafting	Follow up months	Time to union weeks	Knee society score	Complications
17	Murugesan	42	M	30564	RTA	Right	VI	Open I	-	6 days	-	No	16	12	85	Nil
18	Madhal	55	F	31206	RTA	Right	VI	closed	-	10 days	-	No	16	12	90	Nil
19	Kandhayee	70	F	41766	RTA	Left	VI	closed	-	5 days	Yes	No	10	17	75	Knee stiffness
20	Elango	45	M	49298	RTA	Left	VI	closed	-	8 days	-	No	10	12	90	Nil
21	Ramachandran	65	M	52682	RTA	Left	VI	Open I	# BB Lt forearm	10 days	Yes	No	8	14	85	Nil
22	Sasikumar	34	M	55342	RTA	Right	VI	closed	-	8 days	-	Yes	8	14	87	Distal screw infection
23	Vijiganesh	42	M	25224	RTA	Right	V	closed	-	6 days	Yes	No	8	11	85	Nil
24	Kumar	35	M	29434	RTA	Right	VI	closed	-	10 days	Yes	No	8	12	85	Nil
25	Manivannan	40	M	39324	RTA	Right	V	closed	-	8 days	-	No	8	12	90	Nil
26	Arasan	68	M	32330	RTA	Right	VI	closed	# NOF Lt side	15 days	-	No	8	14	75	Nil
27	Govindaraj	52	M	48618	RTA	Left	V	closed	-	5 days	-	No	8	12	90	Nil