A PROSPECTIVE STUDY ON FUNCTIONAL OUTCOME ANALYSIS OF BICOLUMN PLATING IN BICONDYLAR TIBIAL PLATEAU FRACTURES

Dissertation submitted to

M.S. DEGREE-BRANCH II

ORTHOPAEDIC SURGERY

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

CHENNAI-TAMILNADU

APRIL 2013

CERTIFICATE

This is to certify that this dissertation titled **“Functional Outcome Analysis of bicolumn plating in bicondylar tibial plateau fractures”** is a bonafide record of work done by **DR.YUVARAJA.M ,** during the period of his post graduate study from May 2010 to November 2012 under guidance and supervision in the INSTITUTE OF ORTHOPAEDICS AND TRAUMATOLOGY, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai-600003, in partial fulfilment of the requirement for **M.S.ORTHOPAEDIC SURGERY** degree examination of The Tamilnadu Dr. M.G.R. Medical University to be held in April 2013.

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DECLARATION

I declare that the dissertation entitled **"FUNCTIONAL OUTCOME ANALYSIS OF BICOLUMN PLATING IN BICONDYLAR TIBIAL PLATEAU FRACTURES"** *submitted by me for the degree of M.S is the record of work carried out by me during the period of* ***May 2010 to November 2012*** *under the guidance of* ***PROF.V.SINGARAVADIVELU*** **M.S.Ortho.,D.Ortho.,** *Associate Professor of Orthopaedics, Institute of Orthopaedics and Traumatology, Madras Medical College, Chennai. This dissertation is submitted to the Tamilnadu Dr.M.G.R. Medical University, Chennai, in partial fulfillment of the University regulations for the award of degree of M.S.ORTHOPAEDICS (BRANCH-II) examination to be held in April 2013.*

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ACKNOWLEDGEMENT

I express my thanks and gratitude to our respected Dean **Dr. KANAGASABAI M.D.,** Madras Medical College, Chennai **–** 3 for having given permission for conducting this study and utilize the clinical materials of this hospital.

I have great pleasure in thanking **Prof.M.R.RAJASEKAR M.S, Ortho., D.Ortho**. Director, Institute of Orthopaedics and Traumatology, for this valuable advice throughout this study

My sincere thanks and gratitude to, P**rof. N.DEEN MUHAMMED ISMAIL.M.S.Ortho.,D.Ortho.,** Additional Professor, Institute Of Orthopaedics and Traumatology, for his constant inspiration and advise throughout the study.

My sincere thanks and gratitude to**, Prof.V.SINGARAVADIVELU, M.S.Ortho., D.Ortho**. Associate Professor, Institute Of Orthopaedics and Traumatology, for his guidance and constant advice provided throughout this study.

My sincere thanks and guidance to **Prof.A.PANDIASELVAN, M.S.Ortho., D.Ortho**. Associate Professor, Institute Of Orthopaedics and Traumatology, for his valuable advice and support. .

I am very much grateful to **Prof. R. SUBBIAH, M.S.Ortho., D.Ortho**, for his unrestricted help and advice throughout the study period.

I sincerely thank **Prof. NALLI R. UVARAJ, M.S.Ortho**., **D.Ortho.** for his advice, guidance and unrelenting support during the study.

My sincere thanks to**Prof. R.H. GOVARDHAN.M.S,Ortho., D.Ortho**., former director**,** **Prof.V.THULASIRAMAN M.S,Ortho., D.Ortho**., and **Prof. S.SUBBAIAH., M.S,Ortho., D.Ortho**., retired professors, Institute Of Orthopaedics and Traumatology, for their valuable advice and guidance.

My sincere thanks and gratitude to my co-guide **Dr.P.KANNAN,M.S.Ortho,** for his constant advice and guidance provided throughout this study.

I sincerely thank **Dr. S.Shanmugasundaraam**, **Dr.Velmurugan, Dr.Manimaran, Dr.Karunakaran, Dr.Prabhakaran, Dr.Senthil Sailesh, Dr.Kingsly, Dr.Mohammed Sameer, Dr.Nalli R. Gopinath, Dr.Pazhani, Dr.Muthalagan, Dr.Hemantha Kumar, Dr.Kaliraj** Assistant Professors of this department for their valuable suggestions and help during this study.

I thank all anaesthesiologists and staff members of the theatre and wards for their endurance during this study.

I am grateful to all my post graduate colleagues for helping in this study. Last but not least, my sincere thanks to all our patients, without whom this study would not have been possible.

INTRODUCTION

Fractures of tibial plateau involve the articular surface of proximal tibia. The injuries span a wide spectrum, ranging from low energy unicondylar fractures to high energy bicondylar and comminuted fractures. The surrounding soft tissues are severely damaged in high energy injuries and this complicates management of these challenging lower limb fractures.

The treatment of bicondylar tibial plateau fractures still remains a highly demanding surgical procedure with a wide variety of perioperative complications. The goal of treatment of high energy tibial plateau fractures are to restore joint line congruity, joint stability and alignment with minimal soft tissue dissection to allow for early mobilization and establishment of good function.

The optimal treatment for these fractures has always been mired in controversy. There have been proponents for both operative and non operative methods. Good functional results were reported with either modality in low energy fractures but the ideal treatment for high energy injuries is still being debated. Various options like conservative management, hybrid external fixation, open reduction internal fixation, etc., have been put forth. Bicondylar fractures were initially treated successfully with bicolumn plating. But this technique fell out of favour due to the high incidence of wound complications. Use of lateral plating and hybrid external fixators came into vogue with reduced complications and improved functions. This trend has seen a change recently following reports of the superiority of bicolumn plating in complex fractures using a dual incision technique.

Reports of a consistent posteromedial fragment in several cases of bicondylar tibial plateau fractures has been at the heart of this change. The high frequency of its occurrence has been attributed to the anatomical peculiarities of proximal tibial articular surface and the differing effects the deforming force has on both medial and lateral articular surfaces. As a result, bicolumn plating for complex tibial plateau fractures has seen a resurgence, albeit with newer surgical techniques with plate placement on anterolateral and posteromedial surfaces.

AIM OF THE STUDY

The aim of our study is to analyze prospectively the functional outcomes of Schatzker type V and type VI tibial plateau fractures treated by dual incision bicolumn plating at the Institute of Orthopedics and Traumatology, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai between May 2010 and November 2012.

HISTORY AND REVIEW OF LITERATURE

Various modalities for the treatment of tibial plateau have been proposed. Earlier the treatment of these fractures was mostly by closed reduction and immobilization with plaster cast. Since early 20th century, the balance has slowly tipped towards operative management of these injuries.

Keetley[38] in 1899 described open reduction and wires for lateral condylar fractures.

Sir Robert Jones[39] (1920) first stressed the need for elevating the depressed fragments from the tibial metaphysis.

Graham Apley [40] (1956) recommended early motion with traction as a satisfactory method for the management of lateral condyle fractures without the need for internal fixation.

Moore and Harvey [41] in 1974 demonstrated the use of tibial plateau view with 10° caudal tilt. This permits more accurate assessment of the initial depression of the articular surface.

Schatzker and McBroom [22] (1979) concluded that open reduction with anatomical restoration of articular cartilage produces best results. In their study of 70 patients they obtained 78% acceptable results in the operated group as compared 58% in the non operated group.

Bowes in 1982 and Hohl [42] reviewed 52 tibial plateaus out of 110 fractures for more than one year. Non surgical treatment was used in 72% of fractures; ORIF was used in 28%. Overall results were acceptable in 84% of patients. They mentioned the use of cast bracing in 31% of cases either as a primary treatment or after open reduction.

Blokker et. al [43] in1984 reviewed 60 tibial plateau fractures of which 75% patients had satisfactory results. They considered that the single most important factor in predicting the outcome in a patient with tibial plateau fracture was adequacy of reduction.

J. J. Dias et. al [25] (1987) recommended CT scanning for evaluation of the degree of comminution, for classifying and measuring the displacement of fracture.

Jensen S et al [44] (1990) reported that conservative treatment is valid alternative to surgery in cases where operation is not feasible.

Honkonen S. E and Jarvienen M.J [45] in1992 analyzed 131 fractures of tibial condyles in 130 patients. In conservatively treated cases (55) subjective results were acceptable in 49% of cases, functional results in 60% and clinical result in 52.7% cases. In operative cases(76) they were 57.9%, 73.7% and 52.6% respectively. This study utilized single midline incision for open reduction.

Tscherene and Lobenhoffer [46] 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.

Marsh J. L et al [47] in 1995, treated 21 complex fractures of the tibial plateau with closed reduction, inter fragmentary screw fixation of the articular fragments and application of unilateral half pin external fixators. They considered this external fixation as a satisfactory treatment for complex plateau fractures.

In 2002 Dennis P. Weigel and J. Lawrence Marsh [48], studied the long-term outcomes of treatment of high-energy fracture of the tibial plateau. They concluded that patients with a high-energy fracture of the tibial plateau treated with external fixation have a good prognosis for satisfactory knee function in five years after injury.

In 2002, Gosling et al.[18], 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 plates.

In 2003 Ali, Ahmad M., Burton, Maria [34] studied the outcome of the surgical treatment of displaced bicondylar tibial plateau fractures in patients >60 years old. They concluded that ring external fixation, as a beam-loading system applied in a neutralizing mode, is a safe, stable, and reliable technique for the treatment of displaced bicondylar tibial plateau fractures in elderly patients.

In 2004, Barei, Nork, Mills, Henley and Benirschke [2], in their series of 83 patients concluded that comminuted bicondylar tibial plateau fractures can be successfully treated with open reduction and medial and lateral plate fixation using 2 incisions. The use of 2 incisions, temporary spanning external fixation, and proper soft-tissue handling may contribute to a lower wound complication rate than previously reported.

However, in the same year, Gosling et al.[50] 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.

In 2006, Barei D P, Nork S E, Mills W J , et al [4] studied 83 bicondylar fracture treated with medial and lateral plate fixation through two exposures. They concluded that satisfactory articular reduction was significantly associated with a better musculoskeletal functional assessment score. Medial and lateral plate stabilization of comminuted bicondylar tibial plateau fracture through medial and lateral surgical approach was concluded to be a useful treatment method.

Higgins et al.[31] (2007) published the results of their study of comparative strength of lateral-only locked plating to medial and lateral nonlocked plating in a cadaveric model of a bicondylar proximal tibial plateau fracture. They demonstrated that dual-plate fixation allows less subsidence in this bicondylar tibial plateau cadaveric model when compared to isolated locked lateral plates. They raised concerns about the widespread use of isolated lateral locked plate constructs in bicondylar tibial plateau fractures.

Steven N. Shah and Madhav A. Karunakar (2007) reported low rate of deep wound complications following dual incision bicolumn plating on following a treatment algorithm that required soft tissue envelope to recover before final surgery.

In 2008, Eggli et al. [1]studied 14 consecutive patients with bicondylar tibial plateau fractures and observed that most of the complex bicondylar fractures follow a regular pattern in that the medial compartment is split in a mediolateral direction with a posteromedial main fragment, combined with various amounts of multifragmental lateral compartment depression. They concluded that a 2-incision technique starting with the reduction of the posteromedial edge results in accurate fracture reduction with low complication rates and excellent knee function.

Mahadeva et al.(2008), in a systematic review of literature, concluded that bicondylar/Schatzker 6 type fractures are dificult to manage. Hybrid external fixation has theoretical advantages in terms of the soft tissues but the benefit over internal fixation is modest at best and has not demonstrated improved outcome.

Newer fixed angle screw and plate systems are increasingly in use and need comparative studies to determine their role in this complex group of fractures.

Weil et al [49] 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.

Musahl V et al [3](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.

APPLIED ANATOMY OF KNEE JOINT

The knee is the largest and most complex joint of the body. Being a synovial joint, it is of the modified hinge type: in addition to flexion and extension a small amount of rotation of leg is possible in flexed position. It is a compound joint consisting of two condylar joints between the femur and the tibia and a saddle joint between patella and femur.

The knee is composed of:

1. Osseous structures
2. Extra-articular structures
3. Intra-articular structures

OSSEOUS STRUCTURES

Femoral Condyles

The femoral condyles are two rounded prominences that are eccentrically curved, anteriorly the condyles are somewhat flattened, which creates a large surface area for contact and weight transmission.

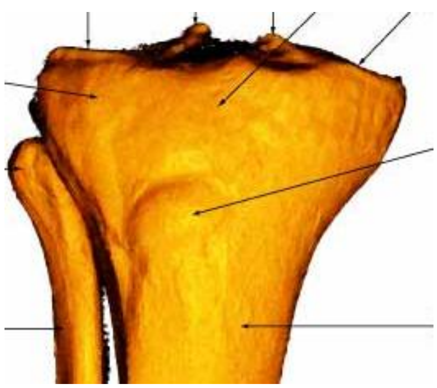
The condyles project very little in front of the femoral shaft but more so behind. The articular surface of the medial condyle is longer than that of lateral condyle but the lateral condyle is wider.

Tibial Plateau

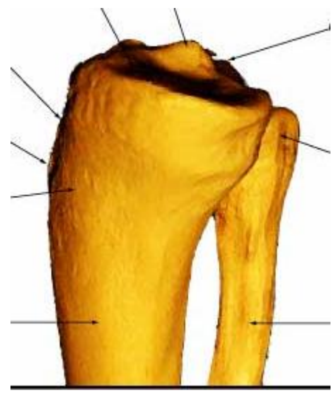
The proximal tibia is expanded in the transverse axis, providing an adequate bearing surface for the body weight transmitted through the lower end of femur. It comprises of two prominent masses, the medial and lateral condyles. Two condyles are separated by an irregularly roughened non-articulating intercondylar area consisting of the medial and lateral tibial spines. Anterior and posterior to the intercondylar eminence is the area that serves as attachment sites 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 especially at 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 convex to the tibial side 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[1]. 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 must alert the surgeon to an underlying severe violence and additional neurovascular injury must be surveyed for.



Anterior view of tibial plateau. The lateral surface is convex and the medial surface is concave



Medial view of tibial plateau. The concave medial surface is over ridden by the elevated convex surface in lateral radiographs

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 ACL. The posterior cruciate ligament 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.

The tibial tubercle is located over the anterolateral tibial crest about 2 cm below the anterior joint line and provides attachment for the patellar tendon. The Iliotibial band inserts along the lateral tibial flare into a protruberence known as

Gerdy’s tubercle. Gerdy’s tubercle forms an important landmark in anterolateral approach to proximal tibia. 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, a triangular sesamoid bone in the extensor mechanism, is situated between the quadriceps tendon and patellar tendon. The proximal wider portion is the base of the patella and the distal pole is narrow called the apex.

EXTRA ARTICULAR STRUCTURES

The extra articular structures comprises of musculotendinous units and ligamentous units.

Musculotendinous units:

These are made up of :

i) Quadriceps femoris - Anteriorly

ii) Gastrocnemius - Posteriorly

Popliteus

iii) Semimembranosus

Semitentendinosus - Medially

Gracilis

Sartorius

iv) Bicep femoris - Laterally

Iliotibial band

Ligamentous Structures:

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. The attachments to the bony structures are juxta articular. The menisci are firmly attached medially and less so laterally.

The medial capsule is more distinct and well defined than its lateral counterpart. The capsular structures along with the medial and lateral extensor expansions of the powerful quadriceps musculature are the principal stabilizing structures anterior to the transverse axis of the joint. The capsule is reinforced by the collateral ligaments and medial and lateral hamstring muscles as well as the popliteus muscle and the iliotibial band posterior to the transverse axis.

The tibial collateral ligament is long, rather narrow, well delineated structure lying superficial to the medial capsule inserting 7 to 10 cms below the joint line on the posterior one half of the medial surface of the tibial metaphysis deep to pes anserinus tendons. It provides the principle stability to valgus stress. The lateral or fibular collateral ligament attaches to the lateral femoral epicondyle proximally and to the fibular head distally. It is of prime importance in stabilizing the knee against varus stress with the knee in extension. As the knee goes into flexion, the lateral collateral ligament becomes less influential as a varus stabilizing structure.

INTRAARTICULAR STRUCTURES:

These consist of the cruciate ligaments and the menisci. The two cruciate ligaments, anterior and posterior provide stability in the sagittal plane. They are extra synovial in location but intracapsular.

Anterior Cruciate Ligament:

It is made up of bundles of fibres, which are taut in various degrees of knee flexion and extension. 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 is the primary stabilizer against anterior displacement of tibia.

Posterior Cruciate Ligament:

It is the primary stabilizer against posterior displacement of the tibia on the femur. 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 and is more robust.

Menisci

These are wedge shaped semicircular fibrocartilaginous structures, two in number; medial and lateral present between femoral and tibial condyles. The important function of Menisci is in load sharing by protecting the articular cartilage from upto 60% of the load encountered by the knee. The meniscotibial ligaments attach these structures to the tibia. These structures should be identified and incised horizontally to gain visualization of the joint through a submeniscal exposure.

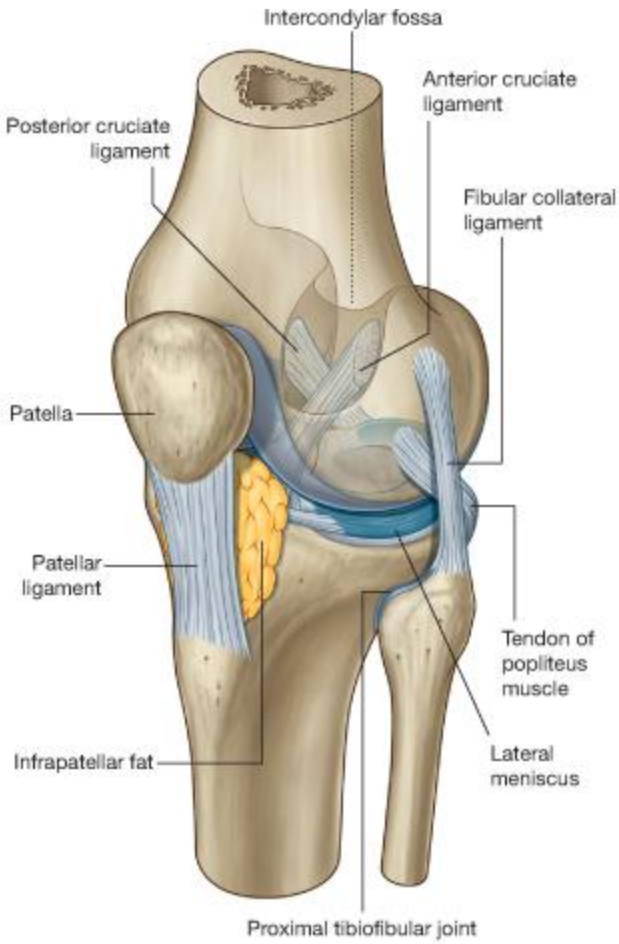


Fig : Knee joint after removal of joint capsule

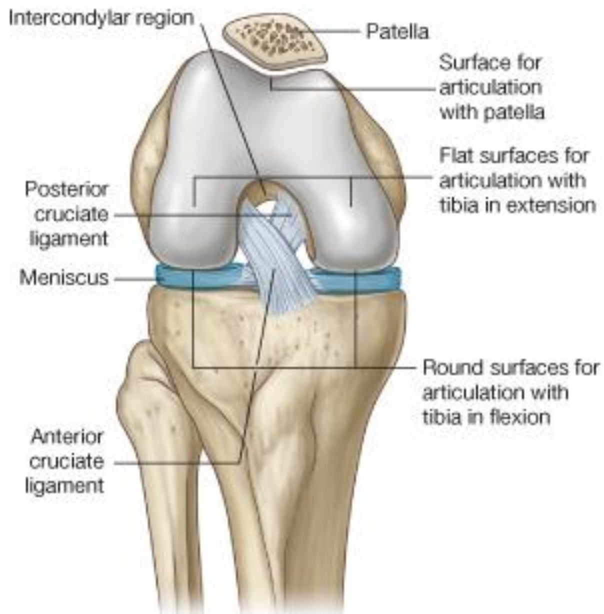


Fig: Flexed knee – seen from front

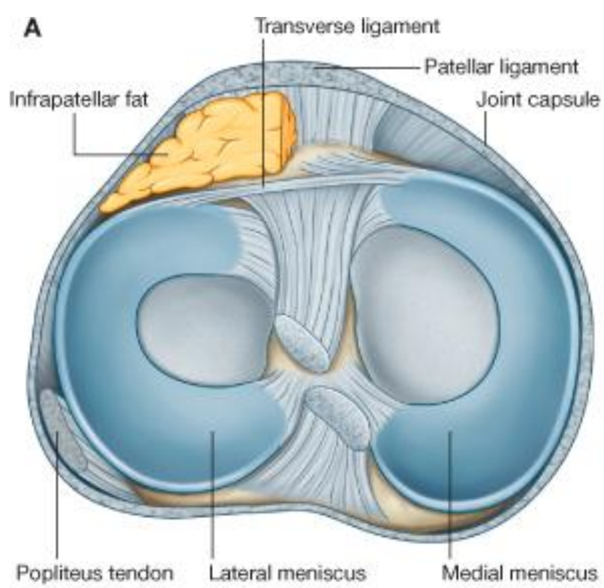


Fig: Articular surface of tibia – seen from above

MECHANISM OF INJURY

The fracture pattern depends on the force acting on proximal tibia and the energy of injury. Generally axial loads result in worse injury patterns.

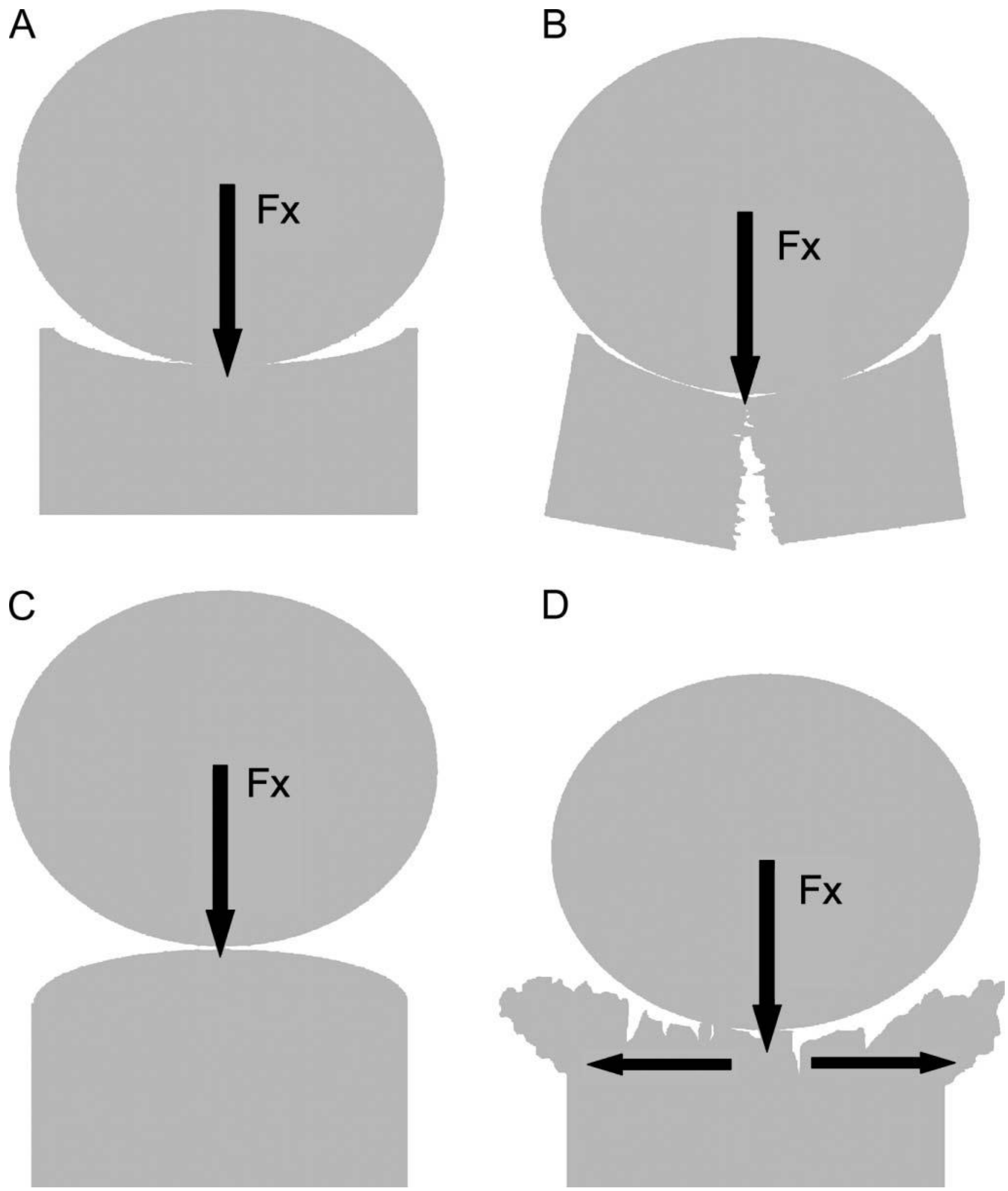
In elderly patients simple falls lead onto fractures and split depression of lateral condyle is seen commonly in these osteopenic bones. In young individuals, high energy injuries are the cause of proximal tibial fractures and split fractures and rim avulsion fractures with knee ligament injuries occur more often.

Valgus forces are common in knee and a combination of valgus and axial compression results in lateral plateau depression, spilt depression or less commonly split fractures. Cadaver studies have proven that intact MCL acts as a hinge for lateral condyle fractures. Posteromedial shearing fractures in medial plateau are common and result from knee flexion, varus and internal rotation.

Tibial plateau fractures occur with the leg in weight bearing position and axial loads usually constitute some part of the deforming force. Greater the axial load, greater is the energy of injury and more severe is the fracture. Bicondylar fractures result when axial load predominates in the deforming force.

Bumper injuries and direct blows cause metaphyseal fractures with a combination of axial loads and bending forces. Here the tibial shaft is separated from the condyles and intra articular fracture extension is seen. There are high rates of complications in this injury. Severe soft tissue injury, open fractures, vascular injury and compartment syndrome are seen in this pattern.

It has been found that lateral tibial plateau is more commonly fractured with severe comminution and joint widening, whereas medial plateau has characteristic fracture lines, the posteromedial shear fracture. An attempt has been made to explain this based on the anatomical features of the joint[1]. The medial joint is convex to the tibial side and the femoral condyle glides around a constant center of flexion. Axial loading from the femur to the tibial condyle leads to a blasting of the tibial tray. Due to the posterior slope of the tibial plateau, the resulting force vector mostly points posteriorly, resulting in a posterior split fragment. Likewise, the anatomic shape of the lateral compartment is convex to the side of femur and the joint does not have a consistent rotation center. During flexion, the rotation axis moves to the posterior border of the tibia. Axial load transmission leads to an impression similar to a push-in of an eggshell. Thus, the more the knee is flexed, the more posterior is the depression of the joint. Also, the flattening of the curved tibial compartment leads to an increase of the coronal joint surface, resulting in a broadening of the compartment.



<u>Fracture mechanics</u>: 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)

CLASSIFICATION

There are several classification schemes for tibial plateau fractures

1. Schatzker classification
2. Hohl and Moore classification
3. AO/OTA classification

1. Schatzker classification

Most widely used system and familiar to most. There are six types in this system. All six types are treated differently and hence this system proves quite useful.

Type I—pure split: Wedge-shaped uncomminuted fragment. This fracture is common in younger patients without osteoporotic bone.

Type II—split with depression : A lateral wedge with articular surface depression .

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 single wedge or may be comminuted and depressed. These fractures tend to angulate into varus.

Type V—bicondylar fractures: Both tibial plateaus are split off. The distinguishing feature is that the metaphysis and diaphysis retain continuity.

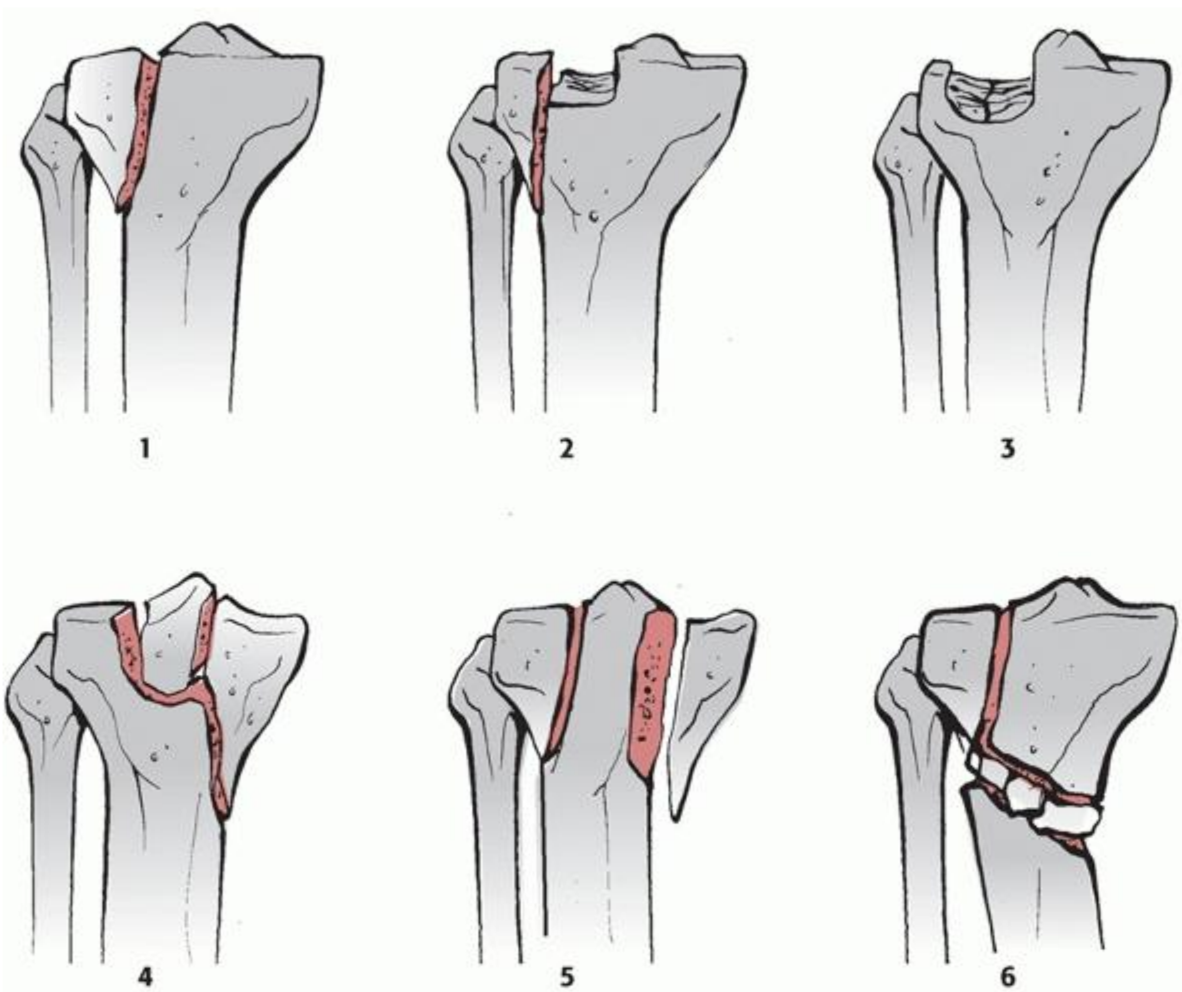
Type VI—bicondylar tibial plateau fracture with dissociation of metaphysis and diaphysis.

2. Hohl and Moore classification

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.

Type I coronal split fracture: Usually involves the medial condyle and is seen in lateral view. The fracture may extend to the lateral side.

SCHATZKER CLASSIFICATION



Type II entire condyle fracture: Fracture – dislocation of either the medial or lateral condyle. This is distinguished from the Schatzker type I and IV by fracture line extending into the opposite compartment under the intercondylar eminence.

Type III rim avulsion fracture: Severe valgus/varus stresses cause the capsular and ligamentous attachments to avulse from the rim of the respective plateaus. This is seen almost exclusively in lateral plateau.

Type IV rim compression fracture: Opposite side collateral ligament ruptures and causes opposite femoral condyle to compress the rim of the plateau.

Type V four part fracture: In this injury, there is bicondylar fracture, avulsion of both collateral ligaments and separation of intercondylar eminence. These are highly unstable. Neurovascular injuries are seen in almost 50% cases.

3. AO/OTA classification

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 articular fractures including the articular surface

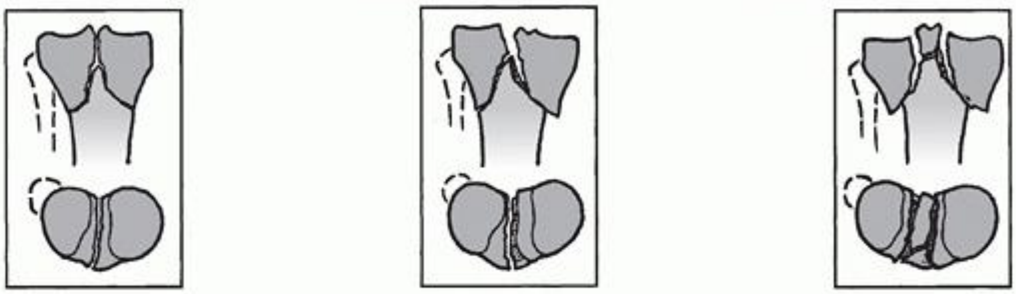
AO/OTA CLASSIFICATION – 41-C

Tibia/fibula, proximal, complete articular, simple articular, simple metaphysis (41-C1)

(1) intact anterior tibial tubercle and intercondylar eminence
(2) anterior tibial tubercle involved
(3) intercondylar eminence involved

1. Slight displacement (41-C1.1)
2. 1 condyle displaced (41-C1.2)
3. Both condyles displaced (41-C1.3)

C1



Tibia/fibula, proximal, complete articular, articular simple, metaphysis multifragmentary (41-C2)

1. Intact wedge (41-C2.1)
   (1) lateral
   (2) medial
2. Fragmented wedge (41-C2.2)
   (1) lateral
   (2) medial
3. Complex (41-C2.3)

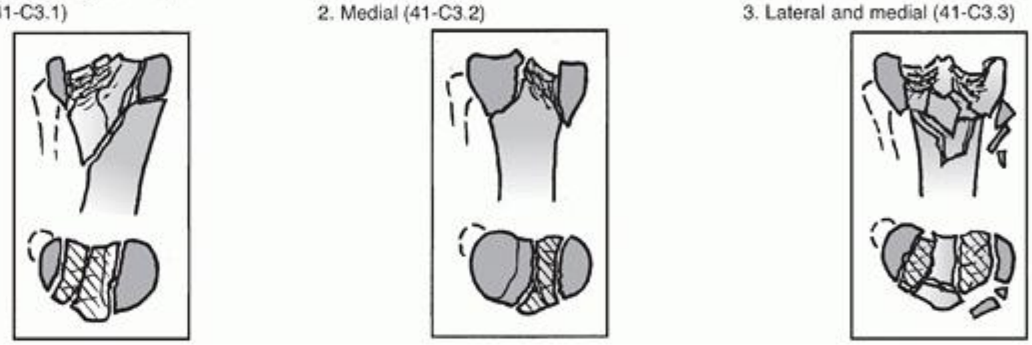
C2

Tibia/fibula, proximal, complete articular, articular multifragmentary (41-C3)

(1) metaphyseal simple
(2) metaphyseal lateral wedge
(3) metaphyseal medial wedge
(4) metaphyseal complex
(5) metaphysio-diaphyseal complex

1. Lateral (41-C3.1)
2. Medial (41-C3.2)
3. Lateral and medial (41-C3.3)

C3



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, etc. 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.

Radiography

Standard anteroposterior and lateral views were taken to assess fracture pattern.

A 10 degree caudal tilt view provides the profile of the fracture in the AP plane of tibial plateau and gives valuable information about the articular surface depression and split than a standard anteroposterior view.

Oblique views with the leg in internal and external rotation help in visualizing the fracture lines more clearly.

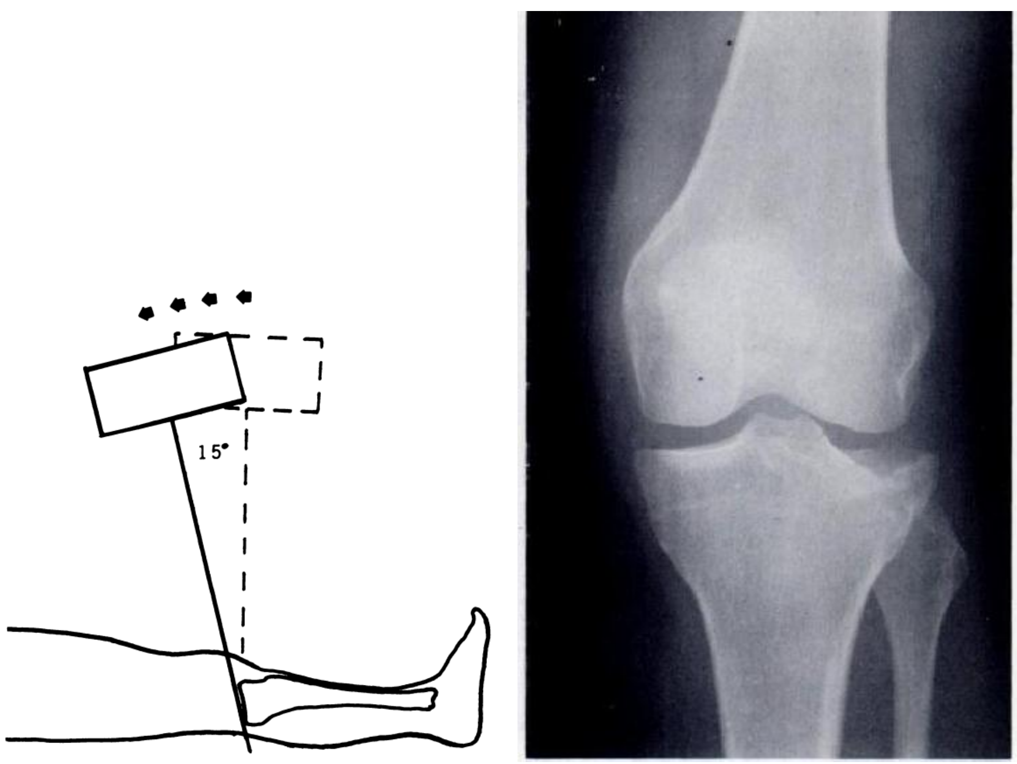
X rays taken with the leg in manual traction were the most accurate in describing the fracture pattern. Traction restores the gross anatomy of the limb and reduces overlap.

Computed Tomography

CT scans have joined the armamentorium of regular investigations in tibial plateau fractures of late. They provide the best assessment of articular surface depression, comminution and displacement. 3 D reconstructions have been shown to guide treatment strategies effectively [35,36]. CT scans prove valuable in clear assessment of fracture severity and guide preoperative planning, classification of the fracture and fixation strategies, thus making them invaluable in guiding the surgeon in the treatment of these complex injuries.

Magnetic Resonance Imaging

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.



Tibial plateau view : Technique and x ray picture

CT images of posteromedial fracture fragment

PRINCIPLES OF TREATMENT

Non operative treatment

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 poor surgical risk
- Co existent medical morbidities with poor surgical risk

Isolated lateral condyle fractures with mild to moderate articular depression (upto 10 mm)[27] 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 [1,3,33].

Given this background, it is usually unacceptable to treat bicondylar fractures in young, active adults non operatively as the functional results can be expected to be substandard.

<u>Operative treatment</u>

Indications:

- Bicondylar fractures
- Associated metaphysiodiaphyseal dissociations
- 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 are anatomical reduction, rigid fixation, anatomical and mechanical limb alignment and early joint mobilization.

The choice is between internal and external fixation, with proponents for each.

Plates and screws: The armamentorium of plates 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: 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.

High energy bicondylar fractures may be treated definitively using external fixators when there is severe soft tissue injury or as per the preference of the individual surgeon. 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 [37]. Hybrid fixators and joint sparing fixators are useful in this regard.

MATERIALS AND METHODS

Our study was a prospective study, conducted at the Institute of Orthopedics and Traumatology, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai between May 2010 and November 2012.

Inclusion Criteria:

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

Exclusion Criteria:

- Age < 18 years
- Grade III compound injuries
- Old fractures (> 4 weeks old)
- Extensive soft tissue injury with healing period more than 3 weeks

Twenty one patients, who satisfied the study criteria, were included in our study.

Age Distribution:

Age group	Numbers	Percentage
18-30	2	9.5
31-40	4	19
41-50	6	28.5
51-60	7	33.3
>61	2	9.5

Sex Distribution:

Male: 17

Female: 4

Mode of injury:

20 patients sustained injury as a result of road traffic accident, whereas one patient alone sustained train traffic accident

Mode of injury	Number	Percentage
RTA	20	95.3
TTA	1	4.7

Side of injury:

In our study, 10 patients had injury in right side and 11 patients had injury in left side.

Side of injury	Number	Percentage
Right	10	48
Left	11	52

Fracture types:

In our study, Schatzker type V was seen in one patient and Schatzker type VI was seen in 20 patients

Fracture type	Number	Percentage
V	1	4.7
VI	20	95.3

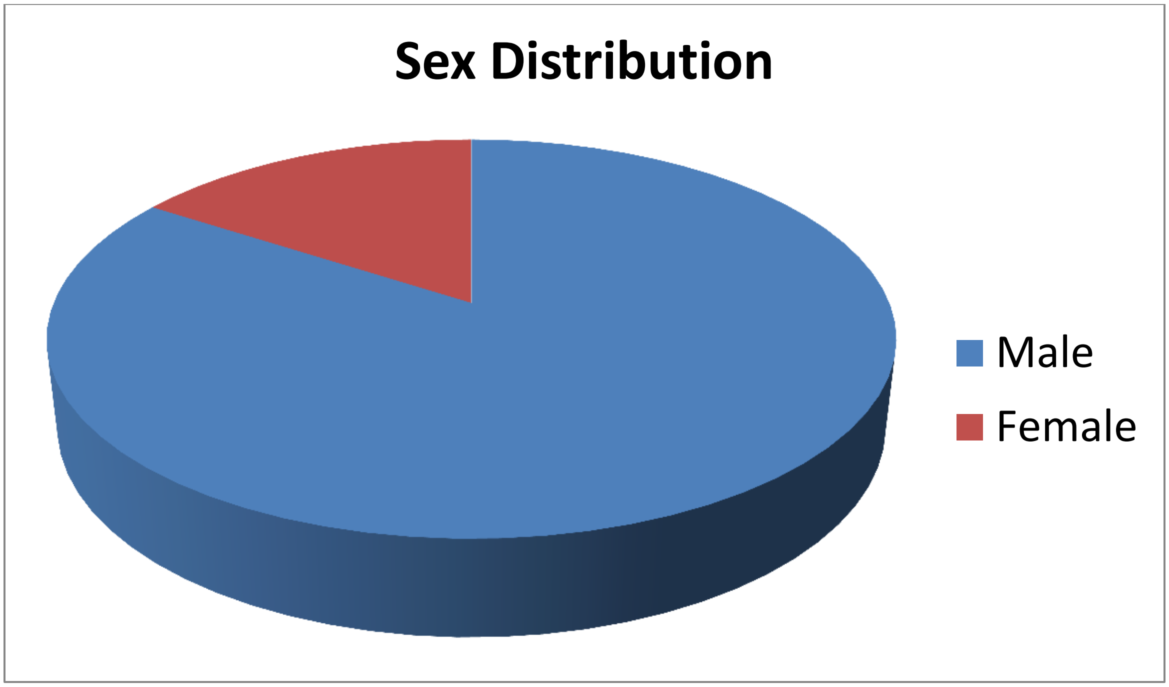
Associated injuries:

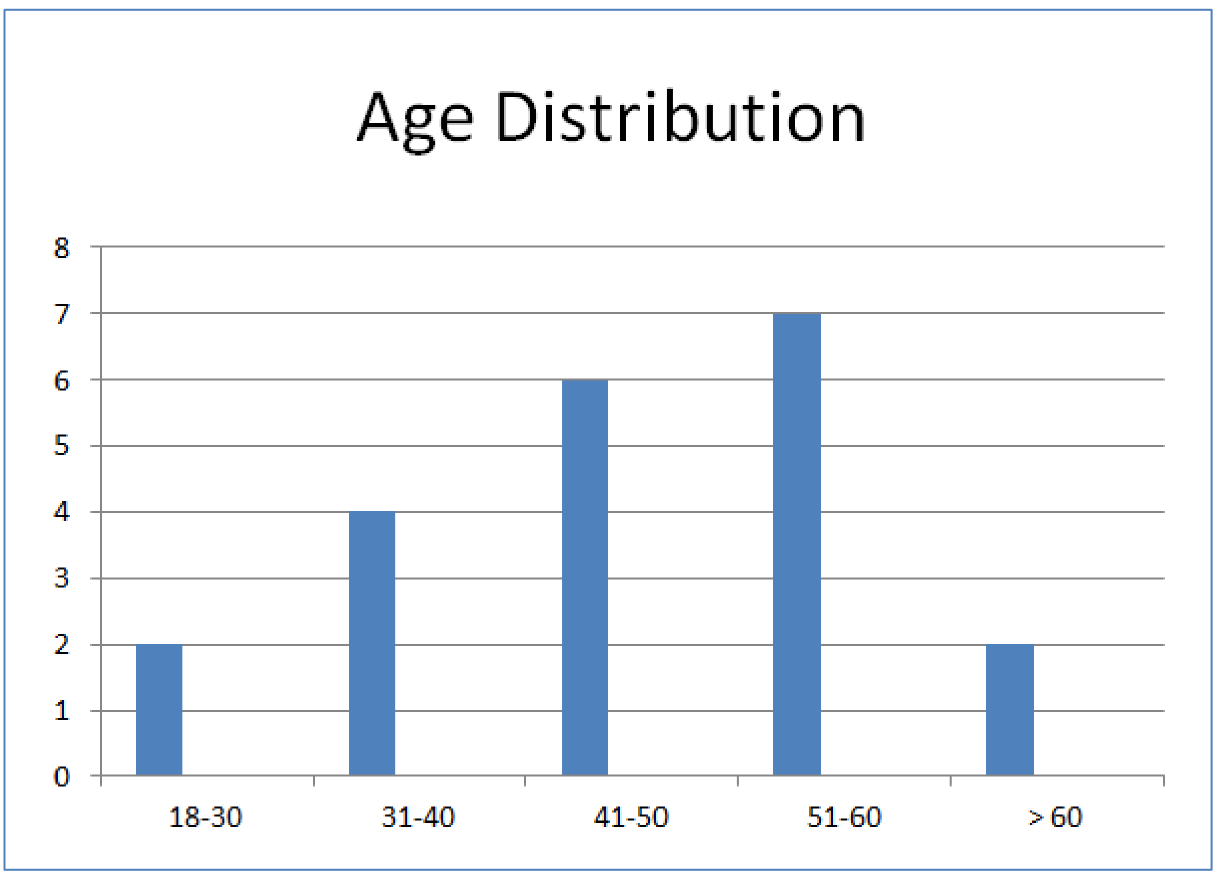
Of the 21 patients, four had associated injuries

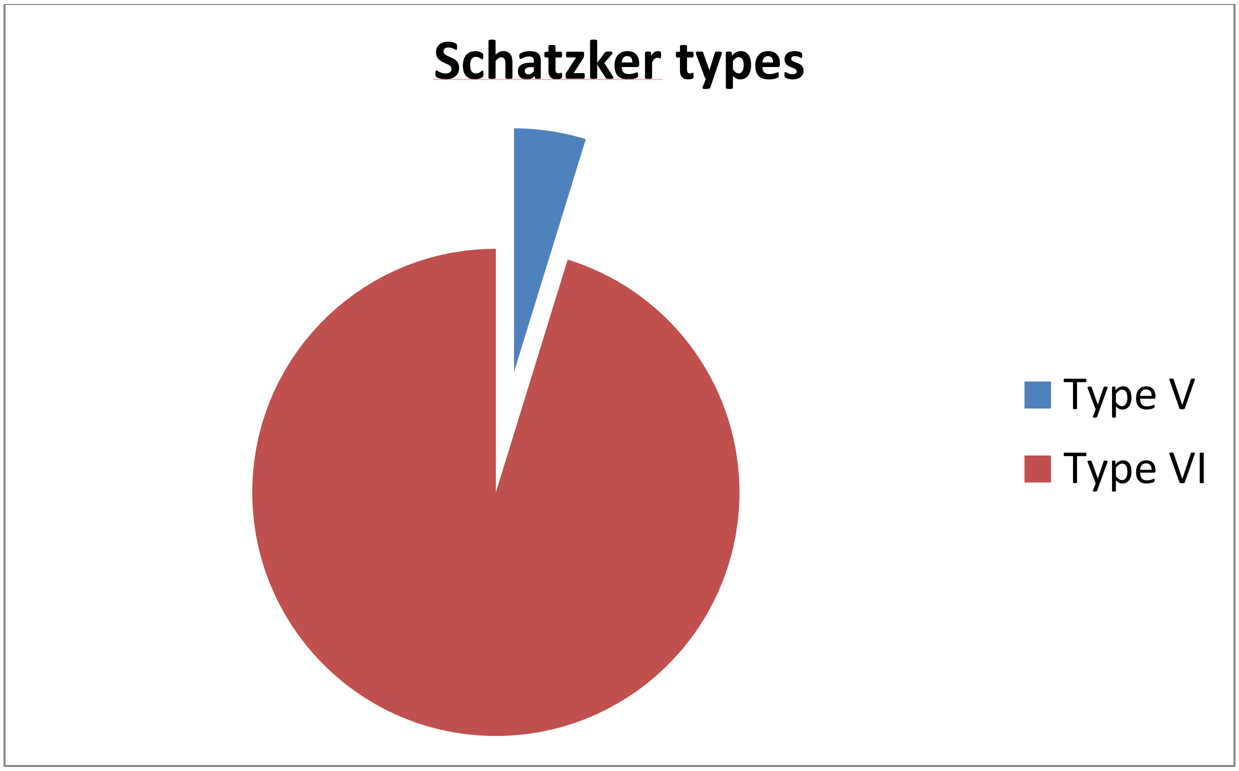
1. Contralateral fracture shaft of femur and fracture both bone leg
2. Ipsilateral fracture clavicle
3. Ipsilateral fracture distal radius
4. Ipsilateral fracture medial malleolus, contralateral fracture lateral malleolus

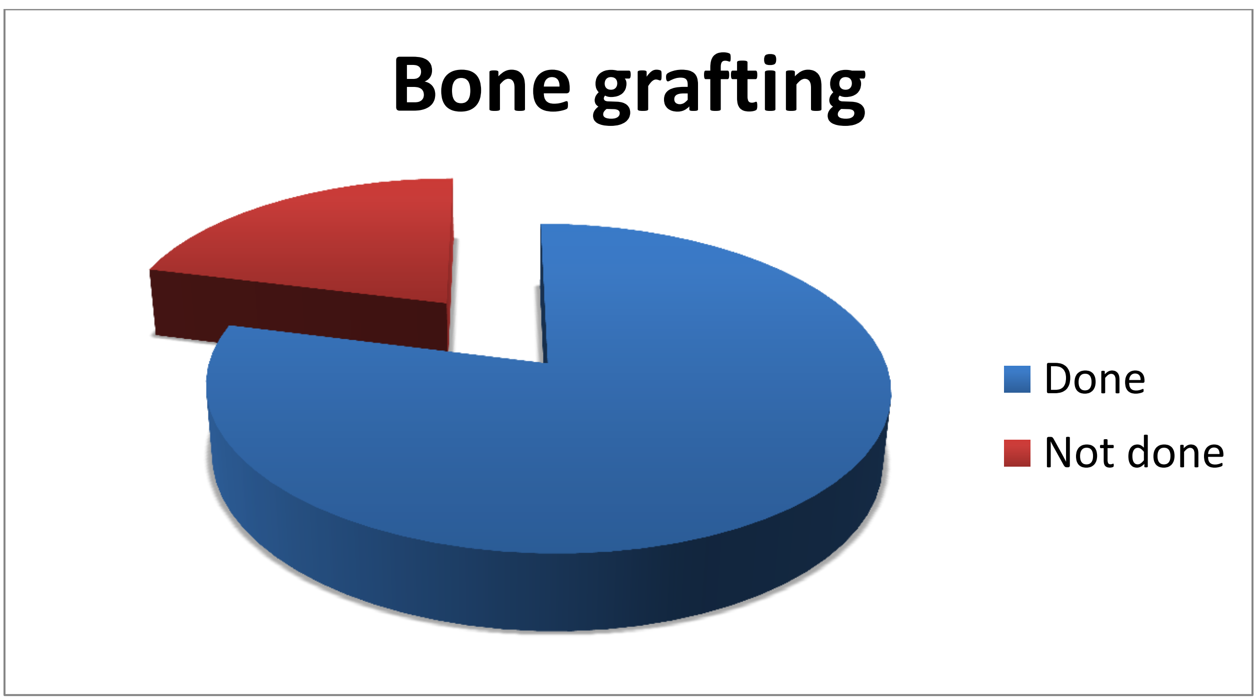
Time to surgery:

The average period from the day of injury to surgery was 10.57 days in our study, with a range between 3 to 20 days.


Sex Distribution
Male
Female


Age Distribution
8
7
6
5
4
3
2
1
0
18-30
31-40
41-50
51-60
> 60


Schatzker types
Type V
Type VI


Bone grafting
Done
Not done

Management protocol

Preoperative management

Patients were given adequate intramuscular analgesia on reception in casualty. The injured limb was temporarily immobilized in Thomas splint and patients were shifted for x ray. Anteroposterior, lateral, right oblique and left oblique 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 all patients in the form of calcaneal pin traction and weights applied. 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".

Surgical procedure

All patients received Inj.Cefotaxime 1g IV preoperatively as routine prophylaxis

Patient was placed in supine position, with folded pillow under knee to allow knee flexion. Femoral distractor was used whenever needed.

According to the specific anatomic form of the injury, there is almost always a coronal fracture in medial condyle coursing in mediolateral direction. Therefore, in most cases, the main fragment is dislocated posteriorly. Hence, fracture reduction was begun from the medial condyle.

The first incision was placed approximately 2 cm posterior to the posteromedial edge of the tibial shaft. The fascia overlying gastrocnemius was incised and the pes anserinus was retracted anteriorly. The intra-articular fracture dislocation was visualized with a submeniscal arthrotomy. The medial head of gastrocnemius was elevated from the tibia and the posteromedial wedge fragment was identified. The impacted fragment was then mobilized in flexion and external rotation, which offers the best view on the posterior aspect of the tibia, and reduced. In this position, a 3.5-mm dynamic compression plate was contoured and fixed with screws in distal fragment. The knee was then extended, and the posteromedial fragment is reduced with the 3.5-mm plate acting as a dorsal buttress and was finally fixed with compression screws in a postero-anterior direction.

The lateral fracture was approached through a lazy S incision centered over the Gerdy tubercle extending about 2 cm lateral to the tibial crest. With the knee flexed in a varus and internally rotated position, the intra-articular damage was evaluated through a submeniscal arthrotomy. The fracture was mobilized with a chisel and reduced directly under vision; the articular surface depression was elevated and fracture reduced. The resulting subchondral or metaphyseal defect was then grafted with autograft. A large compression clamp was applied and the transverse diameter of the tibia was controlled under fluoroscopy. Finally, a lateral compression plate or buttress plate was used to stabilize the lateral compartment. This allows the mediolateral direction of the screws to be oriented in a biomechanically favorable 90-degree angle to the posteroanterior screw orientation of the medial compartment. In addition, the lateral reduction was not compromised by screws used in fixation of the medial compartment.

Lateral locking plates were used in 11 patients and buttress plates were used in 10 patients. Autologous bone graft from iliac crest was used in 12 patients.

Postoperative 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. 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. Suture removal was done on 12^{th} postoperative day. Patients were discharged on non weight bearing crutch walking.

Follow up

Patients were reviewed in OPD every 4 weeks and radiographs were repeated for first 6 months. Partial weight bearing was started after 8 weeks when the fracture showed union. Full weight bearing was achieved only after solid fracture union. Further follow up was done once every 3 months.

Assessment

Functional assessment was done using Knee Society Score.

Radiological assessment was performed taking into account two parameters:

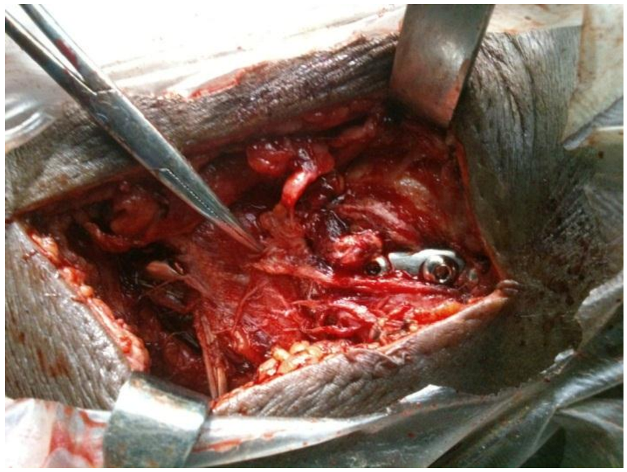
1. Medial proximal tibial angle: measured between proximal tibial knee joint orientation line (drawn connecting the concave surfaces of both tibial plateaus) and the mechanical axis of tibia
2. Articular stepoff : measured in plain x ray

Follow up

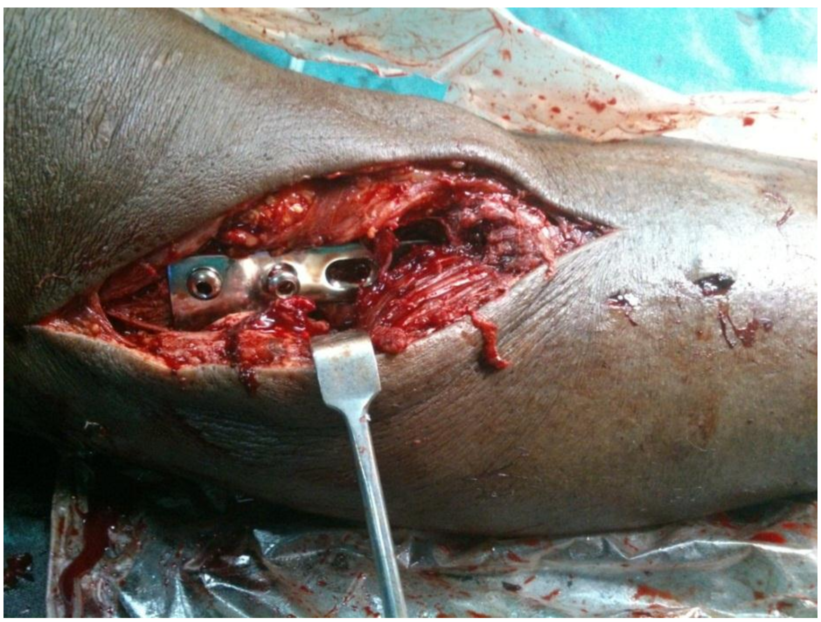
Our patients had an average follow up of 12.52 months, ranging from 4 to 26 months.

INTRAOPERATIVE PICTURES

Posteromedial incision



1/3rd tubular plate buttressing posteromedial fragment.



Lateral column buttress plate. Distal screws have been applied using mini incisions

Incisions closed with drain in situ

Intraoperative fluoroscopy

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

<u>Deductions</u>

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 degrees	-	0
0 – 4 degrees	-	3 points each degree
11 – 15 degrees	-	2 points each degree
Other	-	20

<u>Interpretation</u>

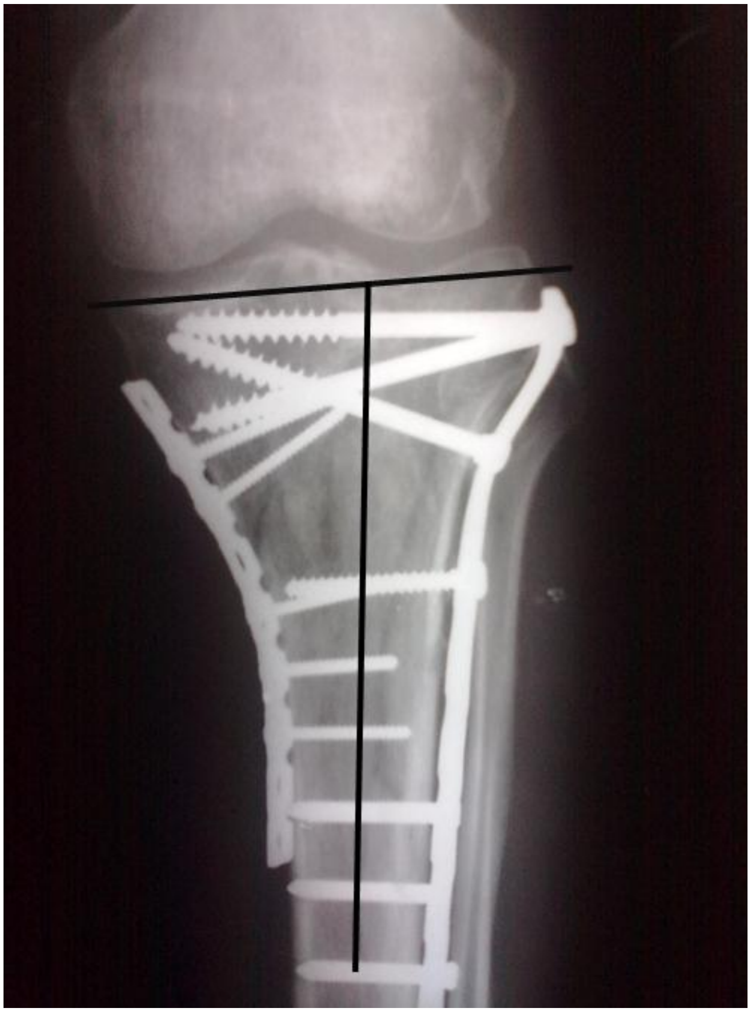
85 – 100 points	: Excellent
70 – 84 points	: Good
60 – 69 points	: Fair

< 60 points : Poor

Radiological assessment

We took two radiological parameters into account for assessment

1. Medial proximal tibial angle (MPTA) – 87+/- 5 degrees [1,4]
2. Articular surface stepoff – less than 2 mm [1,4]



Medial proximal tibial angle (MPTA): Illustration in patient 3.

The angle is measured between knee joint orientation line in proximal tibia (drawn connecting concavities of tibial plateau) and the mechanical axis of tibia.

OBSERVATIONS AND RESULTS

- Males had more incidence in our study compared to females – ratio 4.25:1
- Road traffic accidents were the causative factor in all cases, except one which was due to train traffic accident, and this explains the high energy nature of the injury.
- There was near equal incidence in both right and left sides – 48% in right side and 52% in left side.
- Out of 21 cases, incidence in > 40 years group was 76%
- All patients in our study had sustained injury due to road traffic accidents with high energy injuries. None had sustained injury as a result of trivial trauma. Old individuals with osteoporotic bones can be expected to sustain complex tibial plateau fractures resulting from low energy injuries, but we have not come across any such case in our series.
- Of 21 cases, only one patient(4.7%) had Schatzker type V fracture and all others had Schatzker type VI fracture. This is consistent with the rarity of Schatzker type V fractures.

- Associated injuries were present in four patients, all other 17 patients had isolated tibial plateau fractures.
- All patients underwent a standard surgical approach with anterolateral and posteromedial incisions.
- Lateral locking compression plate was used in 11 patients and lateral buttress plate was used in 10 patients.
- Bone grafting was performed in 12 patients (57%), to fill up metaphyseal defect after articular surface elevation.
- Time required for union ranged from 11 weeks to 16 weeks, with an average duration of 15.5 weeks.
- The average medial proximal tibial angle (MPTA) was 86.4 degrees, ranging from 83 – 88 degrees
- Articular stepoff more than 2 mm (range 3 – 5 mm) was seen in 4 patients
- We had three cases of knee stiffness, three cases of superficial infection, five cases of occasional pain.

COMPLICATIONS

1. Knee stiffness – Three cases in our series had knee stiffness. One patient had a knee ROM of 10 to 80 degree flexion, one patient had 0 to 90 degree flexion, one patient had 10 to 90 degree flexion. Stiffness was mainly due to poor adherence to physiotherapy.
2. Superficial wound infection was seen in three patients in the postoperative period. Prompt debridement, wound dressing and appropriate antibiotic care resolved all infections and patients had excellent functional result.
3. Occasional pain was observed in five of twenty one patients. Pain was not detrimental to patients' activities and excellent functional score was seen in two patients and good functional score in three patients
4. Articular incongruity – Articular stepoff more than 2 mm was seen in 4 patients. This translated to occasional pain but good functional score on KSS.

RESULT ANALYSIS

Functional analysis was done using Knee Society Score, which is a clinical scoring system filled by the surgeon.

Result analysis according to lateral column implant

Lateral locking compression plate was used in 11 patients and lateral buttress plates were used in 10 patients. All patients also had medial plating – buttress plates in two patients and reconstruction plates in all other patients. Due to incomparable group numbers, medial column implant was not analysed separately in our study.

Results in LCP group:

Of the 11 patients, eight had excellent score, two had good score and one had fair scoring according to Knee Society Score. The average score was 83.63.

Results in buttress plate group:

Of the 10 patients, six had excellent results and four had good results according to Knee Society Score. The average score was 83.3.

S.No.	Lateral column implant	No. of patients	Average knee society score	Grading			
				Excellent	Good	Fair	Poor
1.	LCP	11	83.63	8	2	1	-
2.	Buttress plate	10	83.3	6	4	-	-

Results according to age group:

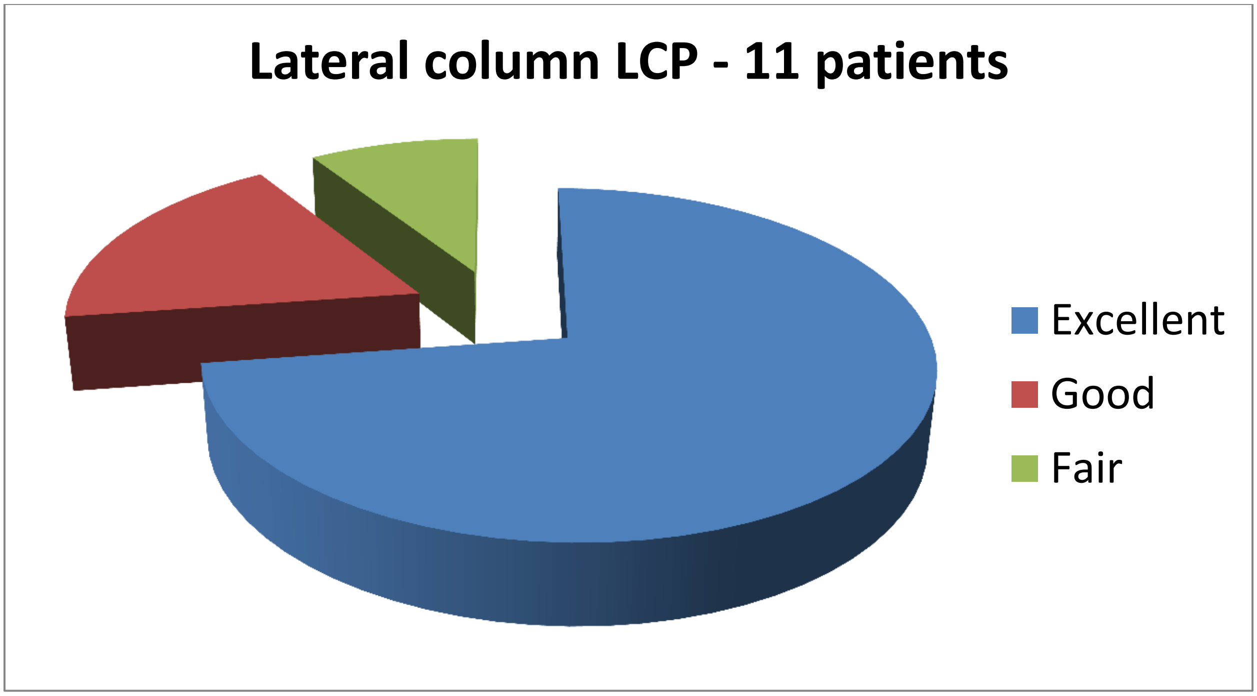
S.No.	Age group	Number of patients	Average Knee Society Score	Grading			
				Excellent	Good	Fair	Poor
1	18-30	2	75	1	-	1	-
2	31-40	4	79.5	1	3	-	-
3	41-50	6	85.83	5	1	-	-
4	51-60	7	86.14	6	1	-	-
5	> 60	2	82.5	1	1	-	-

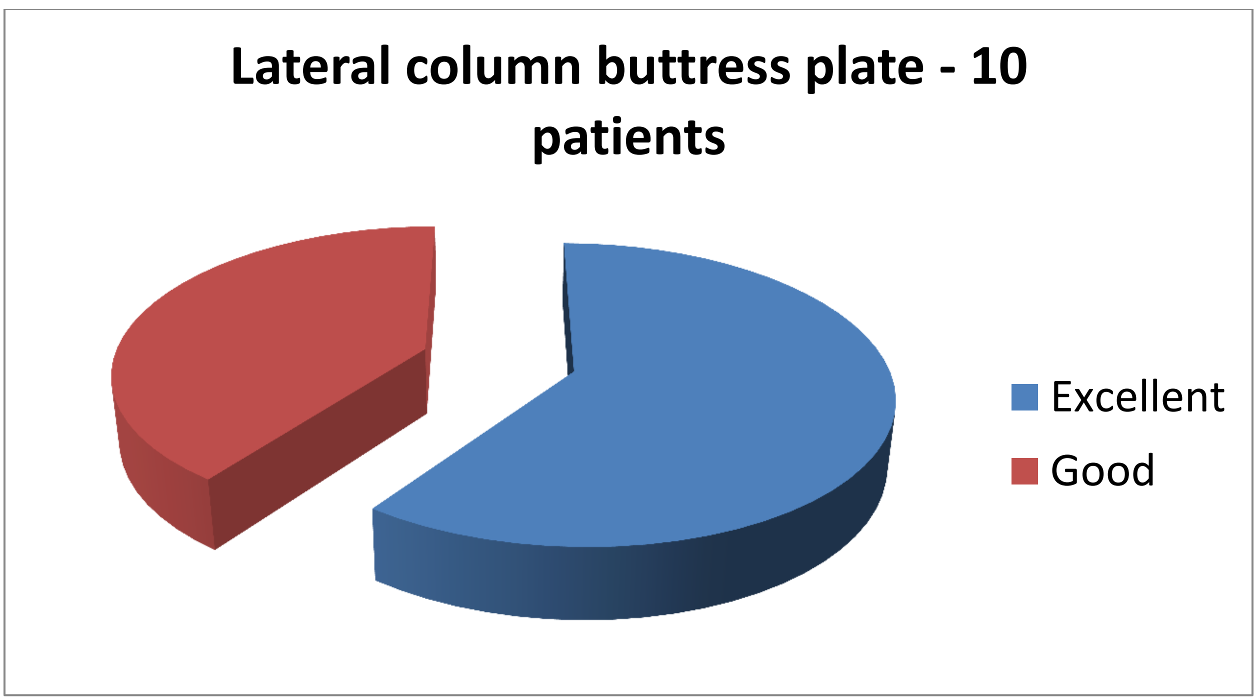
In total, of twenty one patients in our study, fourteen patients had excellent functional score, six patients had good functional score and one had fair functional outcome when analyzed using Knee Society Score.

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 86.4 degrees (range 83 – 88 degrees). Thus, we found that the normal proximal tibial joint orientation is maintained after bicolumn fixation in our study.

Articular stepoff was assessed with less than or equal to 2 mm stepoff kept as acceptable limit. In our series, 4 cases had articular stepoff more than 2 mm (range 3 – 5 mm) and 17 cases had the acceptable result of less than or equal to 2 mm stepoff.


Lateral column LCP - 11 patients
Excellent
Good
Fair


Lateral column buttress plate - 10 patients
Excellent
Good


Age wise functional scoring
6
5
4
3
2
1
0
18-30
31-40
41-50
51-60
> 60
Fair
Good
Excellent

DISCUSSION

Tibial plateau fractures form a very challenging entity for the orthopedic surgeon. The increasing incidence of road traffic accidents and high energy injuries resulting therewith contribute to the rising number of complex proximal tibial fractures presenting to the healthcare provider. In addition, in elderly with osteoporotic bones, even low energy injuries such as domestic falls may lead to complex tibial plateau fractures. The optimal treatment is difficult and giving the patient a painless, mobile joint needs a very strong technical knowledge and surgical expertise.

The initial disrepute of bicolumn fixation of complex tibial plateau fractures owes itself to poor surgical technique practiced earlier on[1]. The use of a single midline incision and extreme soft tissue handling led onto a high incidence of wound breakdown and infection and put the orthopedic fraternity on guard regarding bicolumn fixation [5,6,7]. The advent of locking plates shifted the spectrum towards isolated lateral plating using locking compression plates and stabilizing medial fragment through screws passed via the locking plate [13,18].

Several reports of excellent functional results from this technique were questioned later by the peculiar problem of varus collapse in a large subset of these patients [1,15,16]. Analysis revealed the consistent occurrence of a posteromedial fracture fragment in several patients and inadequacy of its stabilization when a lateral plate alone was employed [1]. This has paved the way for the present concept of dual incision bicolumn plating in complex proximal tibial fractures.

In our study, males outnumbered females in the ratio of 4.25:1. This may be explained by the more 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 [1]. Road traffic accidents were the cause of injury in 20 patients and train traffic accident was the cause in the other one. Surprisingly, we had no case of bicondylar fractures resulting from low energy injuries such as domestic falls. This may partly be due to the fact that our study population consisted of only two patients over the age of 60. Distribution of incidence between sides was near equal.

We only had one case of Schatzker type V fracture in our series, which may be explained by the rarity of occurrence of such a fracture pattern as described by Schatzker originally.

Lateral plating was done either using locking plates or buttress plates. Locking compression plate group had eight excellent scores, two good scores and one fair score. Buttress plate group had six excellent scores and four good scores. Medial column fixation was done using reconstruction plates in all cases except two where buttress plates were used. There have been several reports of locking plates providing superior outcomes in proximal tibial fractures [13,18] . There has been a huge development in the field of locking plates and precontoured plates. However, in our series, we have found identical results in both locking plate and buttress plate groups. It may be due to the superior stability provided by medial buttressing and better functional outcome resulting from early mobilization. Studies comparing lateral column locking plates and buttress plates in bicolumn fixation are lacking in literature and this could an avenue for further research. Results may also vary with further follow up as ours is a short term study.

Bone grafting was employed in 12 patients out of 21 (57%), mainly to fill up metaphyseal defect after elevation of depressed lateral articular surface fragment. The mean time to union was 15.5 weeks, ranging from 11 to 16 weeks. Bone grafting did not contribute to faster healing as metaphyseal fractures can be expected to heal fast even without grafting. In the report published by Eggli et al., bone grafting was employed in 11 of 14 patients [1].

Knee stiffness and movements less than 90 degrees was noted in three patients and was treated with physiotherapy. Superficial wound infection occurred in three patients and was treated with debridement, regular dressing and appropriate antibiotics. All three cases healed well.

Occasional pain while doing activities, climbing stairs was reported by five patients. All were managed conservatively with analgesics and local heat therapy.

Of 21 patients, fourteen had excellent functional outcome, six had good functional outcome and only one case had a fair outcome. In the study by Eggli et al.,[1] of 14 patients 11 had very good functional outcome and three had good functional outcome by Lyshom knee score.

The patient with fair functional score (patient 4) had faulty medial plate placement which did not buttress the posteromedial fracture fragment and she had resultant constant knee pain, but was not willing for repeat surgery.

Associated injuries were observed only in four patients in our series – one patient had contralateral shaft of femur and both bone leg fracture, one patient had ipsilateral medial malleolus fracture, one patient had ipsilateral clavicle fracture and one patient had contralateral distal radius fracture.

Radiological analysis revealed maintenance of normal proximal tibial knee joint orientation in all cases in our series. The normal value of medial proximal tibial angle is 87+/-5 degrees, and the average value in our series was 86.4 degrees with range between 83 – 88 degrees. This is further proof of the superior stability provided by bicolumn plating in bicondylar tibial plateau fractures and the prevention of late varus collapse, which is seen to result in isolated lateral plating. This is an improved result in comparison with the series of Eggli et al[1]., who had one case of varus collapse (83 degrees) and one case of valgus collapse (91 degrees) in their series of 14 patients with an average 25 months follow up. In the series of Barei et al. [4], of 31 patients studied, 28 had satisfactory coronal alignment, but two patients developed varus malalignment and one developed valgus malalignment.

Accurate articular reconstruction (articular stepoff </= 2 mm) was achieved in 17 of 21 patients in our series; which corresponds to 81% accurate reduction. This is comparable to the result published by Eggli et al.[1]; they reported 85% accurate articular reconstruction in their series of 14 patients.

CONCLUSION

From our study, we conclude that

- Bicondylar tibial plateau fractures have an excellent to good functional outcome with dual incision bicolumn plating with very minimal wound complications
- Early joint mobilisation is possible with this technique and this contributes to better final knee range of motion
- Posteromedial plating provides buttressing against late varus collapse in patients with posteromedial fracture pattern
- Anatomical joint reduction and internal fixation provides the best outcome in patients with good soft tissue status, and this should not be deferred for fear of wound complications in cases with closed injuries with healthy soft tissue cover.
- There is no significant difference in functional outcome between use of locking plate or buttress plate in lateral column for bicondylar fractures when medial plating has been done. This observation will have to be validated with longer follow up.

CASE ILLUSTRATIONS

Case 1

Name : Dhanavandhan

Age/Sex : 57/M

Mode of Injury : RTA

Side injured : Right

Schatzker type : Type VI

Time Interval between injury and surgery : 3 days

Procedure : ORIF with lateral and medial buttress plate

Post-op period : Superficial infection, treated with antibiotics

Knee mobilization : 2 days

Partial weight bearing :12 weeks

Full weight bearing :18 weeks

At follow-up : 26 months

Knee Society Score : 85

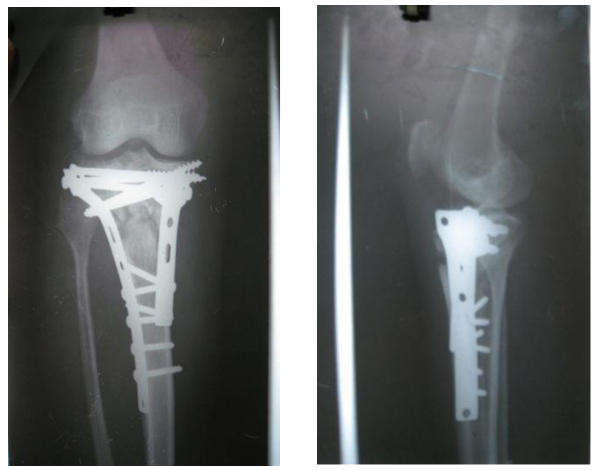
KSS Result : Excellent

MPTA: 85 degrees

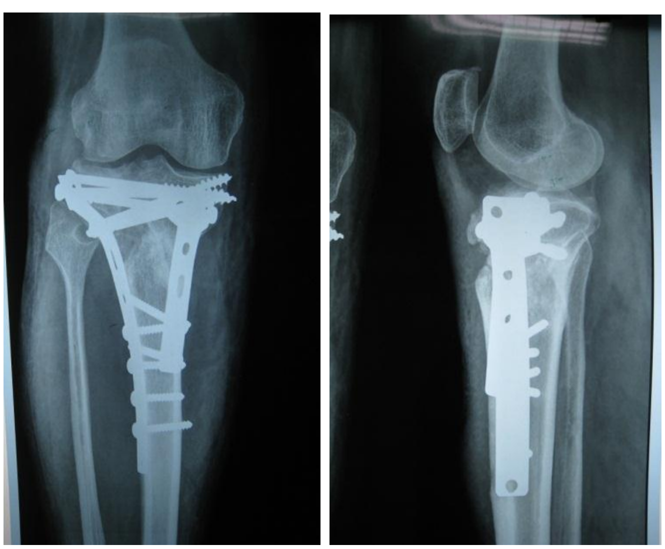
Articular stepoff: < 2 mm

Preoperative imaging

Immediate postoperative



26 months follow up



Case 2

Name : Manivel

Age/Sex : 37/M

Mode of Injury : RTA

Side injured : Left

Schatzker type : Type VI

Time Interval between injury and surgery : 3 days

Procedure : ORIF with lateral LCP and medial recon plate

Post-op period : Uneventful

Knee mobilization : 3 days

Partial weight bearing :14 weeks

Full weight bearing : 20 weeks

At follow-up : 22 months

Knee Society Score : 80

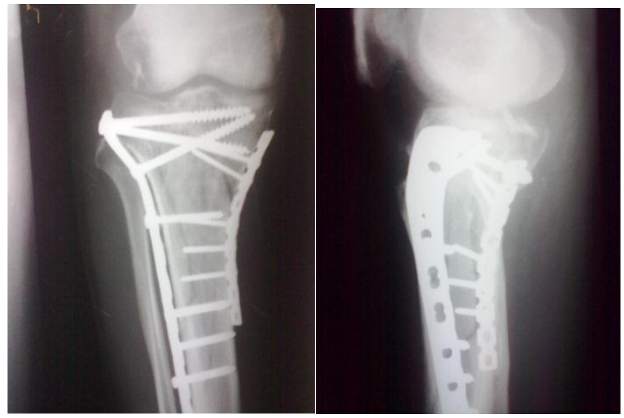
KSS Result : Good

MPTA: 85 degrees

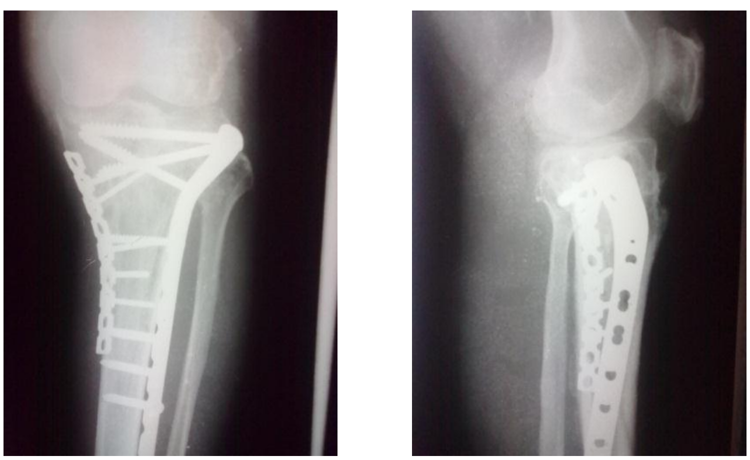
Articular stepoff: < 2 mm

Preoperative imaging

Immediate postoperative



22 months follow up



Case 3

Name : Murugan

Age/Sex : 60/M

Mode of Injury : RTA

Side injured : Right

Schatzker type : Type VI

Time Interval between injury and surgery : 20 days

Procedure : ORIF with lateral LCP and medial recon plate

Post-op period : Uneventful

Knee mobilization : 2 days

Partial weight bearing :12 weeks

Full weight bearing : 18 weeks

At follow-up : 5 months

Knee Society Score : 88

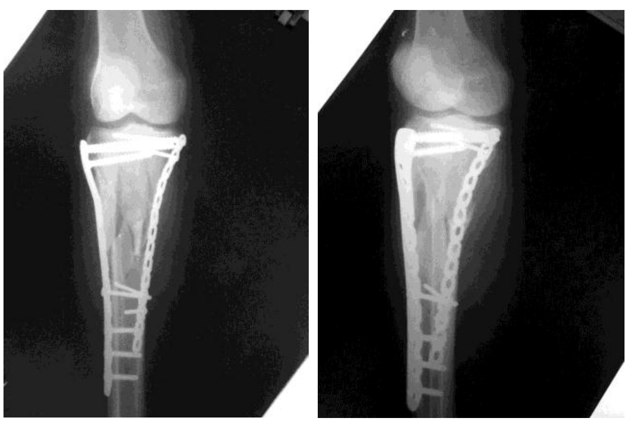
KSS Result : Excellent

MPTA: 87 degrees

Articular stepoff: < 2 mm

Preoperative imaging

Immediate postoperative



5 months follow up

Case 4

Name : Alex Rayan

Age/Sex : 48/M

Mode of Injury : RTA

Side injured : Right

Schatzker type : Type VI

Time Interval between injury and surgery : 5 days

Procedure : ORIF with lateral buttress plate and medial recon plate

Post-op period : Uneventful

Knee mobilization : 2 days

Partial weight bearing :13 weeks

Full weight bearing : 17 weeks

At follow-up : 7 months

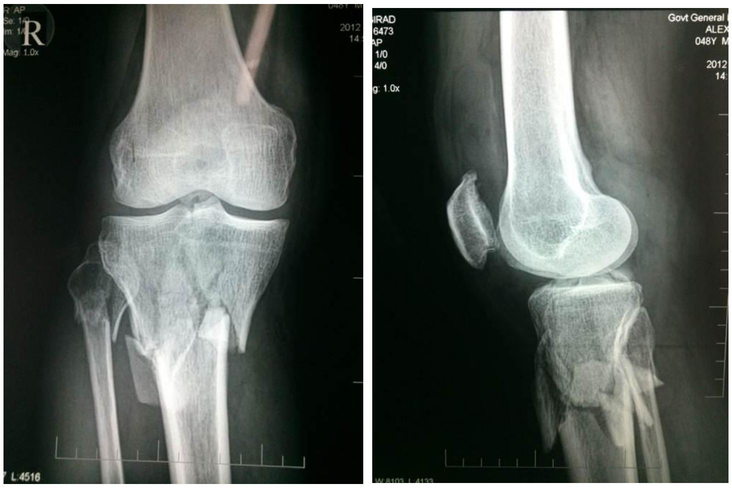
Knee Society Score : 90

KSS Result : Excellent

MPTA: 88 degrees

Articular stepoff: < 2 mm

Preoperative imaging



Immediate postoperative

7 months follow up

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PATIENT EVALUATION PROFORMA

Preoperative

Name:

Age: Sex: IP no:

Date of admission:

Time from injury to admission:

Mode of injury:

Diagnosis:

Associated injuries:

Co morbidities:

X ray finding:

CT finding:

Classification:

Distal neurovascular status:

Intraoperative

Time form injury to surgery:

Position:

Anesthesia:

Approach:

Procedure done:

Plate placement:

Plates used:

Blood loss:

Duration of surgery:

Postop immobilization:

<u>Postoperative</u>

Drain collection:

Day of drain removal:

Postoperative x ray:

Wound status at discharge:

Suture removal:

IV antibiotics:

Oral antibiotics:

Details of associated injury treatment:

Distal neurovascular status:

<u>Follow up</u>

Date: Visit number:

Postoperative month:

Wound status:

X ray:

Weight bearing:

Knee society score:

1. Pain
2. Range of motion
3. Stability: Anteroposterior

   Mediolateral

4. Deductions

   Flexion contracture

   Extension lag

   Alignment

Medial proximal tibial angle:

Articular stepoff:

S.No	Name	Age	Sex	IP no	Mode of injury	Side injured	Associated injuries	Time delay before surgery	Schatzker type	Procedure	Follow up	Complications	KSS	Time to union	Lateral column implant
1	Subburayulu	58	M	55390	RTA	Left		3 days	VI	Bicolumn	20 mths	Knee stiffness	75	15 weeks	Buttress plate
2	Dhanavandhan	57	M	56415	RTA	Right		6 days	VI	Bicolumn	26 mths	Superficial infection	85	12 weeks	Buttress plate
3	Manivel	35	M	65815	RTA	Left		7 days	VI	Bicolumn	22 mths	Occasional pain	80	14 weeks	LCP
4	Veerammal	24	F	57392	TTA	Left	# SOF right, # BB leg rt	10 days	VI	Bicolumn + BG	25 motnhs	Knee stiffness	65	16 weeks	LCP
5	Palanisamy	60	M	9573	RTA	Left	# clavicle lt	12 days	VI	Bicolumn + BG	24 mths		85	13 weeks	LCP
6	Ramarajan	63	M	15100	RTA	Right		20 days	VI	Bicolumn + BG	21 mths	Occasional pain	80	13 weeks	Buttress plate
7	Sekar	38	M	27539	RTA	Right		17 days	VI	Bicolumn	20 mths	Knee stiffness	75	14 weeks	Buttress plate
8	Muniyappan	45	M	56943	RTA	Left		12 days	VI	Bicolumn	12 mths	Superficial infection	85	16 weeks	Buttress plate
9	Rajan	42	M	47812	RTA	Right		10 days	VI	Bicolumn	17 mths		90	12 weeks	Buttress plate
10	Muniyammal	50	F	50178	RTA	Left	# distal radius rt	16 days	VI	Bicoumn + BG	10 mths	Occasional pain	80	14 weeks	LCP
11	Kantha	56	F	30145	RTA	Right		10 days	VI	Bicolumn	10 mths		90	13 weeks	LCP

S.No	Name	Age	Sex	IP no	Mode of injury	Side injured	Associated injuries	Time delay before surgery	Schatzker type	Procedure	Follow up	Complications	KSS	Time to union	Lateral column implant
12	Alex rayan	47	M	88396	RTA	Right		5 days	VI	Bicolumn + BG	7 mths		90	12 weeks	Buttress plate
13	Janaki	30	F	61853	RTA	Right	# med. malleolus rt, # lat. malleolus lt	19 days	VI	Bicolumn	6 mths	Occasional pain	85	14 weeks	LCP
14	Murugan	60	M	84738	RTA	Right		20 days	V	Bicolumn	5 mths		88	11 weeks	LCP
15	Selvakumar	40	M	93296	RTA	Left		10 days	VI	Bicolumn + BG	4 mths		78	13 weeks	Buttress plate
16	Krishnamoorthy	32	M	107958	RTA	Left		8 days	VI	Bicolumn + BG	4 mths		85	12 weeks	LCP
17	Velu	45	M	107668	RTA	Left		6 days	VI	Bicolumn + BG	4 mths		85	14 weeks	LCP
18	Vengaiyah	70	M	109229	RTA	Right		9 days	VI	Bicolumn + BG	5 mths		88	14 weeks	LCP
19	Veerasamy	52	M	30554	RTA	Right		11 days	VI	Bicolumn + BG	9 mths	Superficial infection	90	16 weeks	LCP
20	Gaurishankar	58	M	42890	RTA	Left		9 days	VI	Bicolumn + BG	12 mths		90	15 weeks	Buttress plate
21	Murthy	45	M	67992	RTA	Left		10 days	VI	Bicolumn + BG	13 mths	Occasional pain	85	14 weeks	Buttress plate

final dissertation

BY YUVARAJA 22101513 M.S. ORTHOPAEDIC SURGERY

A PROSPECTIVE STUDY ON FUNCTIONAL OUTCOME ANALYSIS OF BICOLUMN PLATING IN BICONDYLAR TIBIAL PLATEAU FRACTURES

Dissertation submitted to

M.S. DEGREE-BRANCH II

ORTHOPAEDIC SURGERY

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

CHENNAI-TAMILNADU