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Less Invasive Management of Closed, Grade I & II Compound Proximal Tibial Fractuers with Locking Compression Plates – A Clinical Study

Dr. K Meenakshi Sundaram, D. Ortho, DNB Ortho, MNAMS, M.Ch (UK)
Co-authors:
Dr. K G Kandaswamy, D. Ortho, DNB Ortho
Dr. R.Sathish kumar, Junior resident.
Department of Orthopaedics & Trauma Care
Vinayaka Mission's Kirupananda Variyar Medical College & Hospitals, Salem ,Tamilnadu.
Corresponding Author: Dr. K Meenakshi Sundaram

Abstract
Background
Fractures around the knee are one of the commonest fractures encountered in high velocity trauma which are associated with high morbidity and mortality. Isolated fractures itself may lead to complications such as ARDS and pulmonary embolism.
Being one of the major weight-bearing joint of the body, fracture around it will be of paramount importance. This necessitates early stabilization of fractures. Internal fixation is the choice of treatment in fractures around the knee and Locking Compression Plate (LCP) has shown to give the best results in terms of wound healing, early good range of motion, fracture union, early return to work and functional outcome. The aim of this study is to prospectively evaluate the outcome of locking compression plate fixation in proximal tibia fractures.
Materials & Methods
We prospectively reviewed 81 cases of proximal tibial fractures who were treated by closed reduction in fracture table and internal fixation by LCP between August 2013 and March 2017 at Vinayaka Mission's Kirupananda Variyar Medical College & Hospitals. The patients were evaluated clinically and radiologically for the outcomes.
Results & Conclusion
All the patients were followed up for an average of 6 months. Outcome was assessed using Knee Society Clinical Ratings and radiographic analysis. Clinical evaluation according to the D' Aubigne - Postel scoring system gave 58 excellent (71.9%), 15 good (18.8%), 5 fair (6.3%) and 3 poor (3.1%) results. Early postoperative complications included 1 case of unexplained bleeding through drain tube for 8 days and superficial wound infection in another 3 patients.
The locking compression plate system with its various type of fixation act as a good biological fixation even in difficult fracture situations especially when fracture is severely comminuted and in situations of osteoporosis.
Key words: *Proximal tibia fractures, Locking compression plate, biological fixation.*
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I. Introduction

The knee joint is one of the major weight bearing joints in the lower extremity. The proximal tibial fractures are one of the commonest intra articular fractures and they present a difficult treatment challenge with historically high complication rates. Generally these injuries fall into two broad categories, high energy fractures and low energy fractures.

The majority of proximal tibial and tibial plateau fractures are secondary to high velocity accidents and fall from height[1] where fractures results from direct axial compression, usually with a valgus (more common) or varus moment and indirect shear forces[2].

Extra-articular fractures of the proximal tibia usually secondary to direct bending forces applied to the metadiaphyseal region of the upper leg, older patients with osteopenic bone are more likely to sustain depression type fracture because their subchondral bone is less likely to resist axial directed loads[3].

In the early 1960s, there was a great reluctance towards operative management of these fractures because of high incidence of infection, non-union, malunion, inadequate fixation and lack of proper instruments, implants as well as antibiotics. Then the traditional management comprised of skeletal traction, manipulation of fracture and external immobilization in the form of casts and cast bracings. These methods however met with problems like deformity, shortening, knee stiffness, angulation, malunion, knee instability, and post traumatic osteoarthritis.

The trend of open reduction /closed reduction and internal fixation has become evident in the recent years with the improvement in understanding of fracture personality. The aim of surgical treatment of proximal tibia fracture is to restore congruent articular surfaces of the tibial condyles maintaining the mechanical axis and restoring ligamentous stability eventually can achieve functional painless and good range of motion in the knee joint[4].

So there was the birth of a new concept of biological fixation using the plates, otherwise called minimally invasive plate osteosynthesis (MIPO) where a percutaneously inserted plate is fixed at a distance proximal and distal to the fracture site through minimal exposure. Various clinical studies established that bone beneath a rigid conventional plate are thin and atrophic which are prone for secondary displacement due to insufficient buttressing and secondary fractures after removal of plate. Fracture site takes longer period to osteosynthesis due to interruption of vascular supply to bone following soft tissue and periosteal stripping. Elderly patients with severe osteoporosis add further to the difficulties in the management of these fractures. Loss of stable fixation in osteoporotic bones is of great concern in such elderly patients[5].

This leads to the development of the internal and external fixators like multiple K-wires, cancellous screw fixation, manually contoured plates, T and L Buttress plates, knee spanning external fixators and Ilizarov fixators. As more and more concepts about biological fixation become clearer the innovation of plates progressed to development of Less Invasive Stabilizing System (LISS). Research to combine these two methods has lead to the development of the AO locking compression plate (LCP)[6].

LCP fixation under MIPO technique using locking screws as a fixed angle device allows much greater load bearing than conventional plating. The LISS uses unicortical locking screws to allow more elastic deformation than conventional plating systems.

Locked implants are typically indicated in patients with osteoporosis where pull-out of the screws is problematic, fractures with metaphyseal comminution where the medial cortex can not be restored, or a short articular segment.

ADVANTAGES OF LCP

1. Anatomically pre-contoured: which reduces soft tissue problems and eliminates the need for plate contouring
2. LCP combi-hole: Intraoperative choice between angular stability and / or compression
3. Guiding blocks: enable easy and correct mounting of the threaded drill guides on the plate.
4. Limited contact plate design: reduces plate-to-bone contact, thus limiting vascular injury.
5. Osteoporotic bones: better fixation of fracture in elderly patients
6. Unicortical fixation option: unlike cortical screws which requires bicortical fixation
7. Better preservation of blood supply of bone due to minimal soft tissue dissection
8. Maintaining better articular congruency
9. Length of bone is maintained in comminuted fractures
10. Shorter stay in hospital

INDICATIONS

1. Multifragmentary fractures of proximal tibia
2. Intraarticular fractures (Schatzker type I to V)
3. Metaphyseal fracture (Schatzker type VI)
4. Grade I & Grade II compound fractures
5. Periprosthetic fratures

FRACTURE CLASSIFICATION

SCHATZKER'S CLASSIFICATION

Type - I -- PURE CLEAVAGE

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 -- CLEAVAGE COMBINED 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.
Type – V – BICONDYLAR FRACTURES
Both tibial plateaus are split off. The distinguishing feature is that the metaphysis and diaphysis retain continuity.
Type – VI – PLATEAU FRACTURE WITH DISSOCIATION OF METAPHYSIS AND DIAPHYSIS
A transverse or oblique fracture of the proximal tibia is present in addition to a fracture of one or both tibial condyles and articular surfaces.
This study was designed to study the functional results of closed and Grade I & II compound proximal tibial fractures by closed reduction and internal fixation with LCP.

II. Materials & Methods

In this study, 81 patients with closed , open grade I & II fracture of upper end of tibia were selected. All the cases were treated at VMKVMC & H between August 2013 and March 2017 and followed for a minimum of 6 months.
The method used for fracture fixation was closed or open reduction and internal fixation with locking compression plate. The duration of follow-up ranged from 6 months to 24 months.
All the fractures in this series were post-traumatic.
Study design – Prospective observational study
Study location – VMKVMCH , Salem.
Study Duration – 3 ½ years (August 2013-March 2017).

Inclusion criteria

- Patients presenting with traumatic proximal tibial fractures with or without osteoporotic changes
- All types of upper end of tibia fractures (Schatzker Type I to VI)
- Patients above the age of 20 years
- Compound fractures (Type 1 and 2)

Exclusion criteria

- Patients with open proximal tibial fractures (Type 3)
- Children with proximal tibial fractures in whom growth plate is still open
- Patients with pathological proximal tibial fractures other than osteoporosis
- Patients managed conservatively or fixed with other fixation systems like AO plate or condylar buttress plate.

On admission demographic data was recorded and thorough history and clinical examination was done. We assessed the soft tissue injuries even in the closed fractures followed by radiological assessment of the fracture with Schatzker's classification. If blisters were present, the surgery was delayed for 7-10 days.

All cases received first aid in casualty with thorough examination to find out associated injuries. Patients were subjected to routine pre-anaesthetic investigations and additional investigations when indicated. Standard antero-posterior and lateral radiographs were taken and the fracture classified according to AO group classification.

The antero-posterior and lateral X-rays were evaluated for the extent of comminution and the likely length of the plate was calculated. Since usually long plates are required to span the comminuted area and such long plates are not readily available, a prior calculation is must.

All surgeries were performed under regional anaesthesia and with a tourniquet in the supine position. In our series, all fractures are reduced with traction in fracture table with C- arm guidance. The approach was either anteromedial parapatellar or anterolateral parapatellar incision. A small incision is taken on either ends of the fractured comminuted area without disturbing the soft tissue envelope of the fractured fragments. The incision is extended right up to the bone with the periosteal tube opened. A sub-periosteal tract is made along the surface where the plate is going to be applied and extended across the fracture to the other side. The tract is done with a special doubly angled periosteal elevator available in different sizes. The plate used depended on the anatomy and location of fracture. It is inserted well beneath the depressed articular fragments, and by slow and meticulous pressure the articular fragments and compressed cancellous bones are elevated as one large mass. Unless this is done, redisplacement and settling can occur. We preferred packing cancellous

bones which were obtained from the iliac crest into the defect as this conforms much more nearly to the defect cavity.

As the fragments are elevated and reduced, it was temporarily fixed with multiple small Kirschner wires. Locking compression plate was used for fixation which was applied to the anterolateral tibial condyle which is precontoured to confirm to the condyle and proximal metaphysis. When properly contoured, it was secured to the condyle with appropriate locking / plain cancellous screws of sufficient length to engage the opposite medial cortex. Locking / cortical screws were used to attach the plate to the shaft of the tibia.

After stable fixation, wound was closed in layers. LCP was used as LISS with minimal incision over the lateral aspect when closed reduction is done.

If closed reduction could not be achieved or maintained, an open approach was required.

LCP for upper end of tibia are available in 3.5 mm, 4.5 mm thickness, 4 holed to 12 holed. The locking screws are self-tapping and available in 4 mm and 4.5 mm thickness.

Postoperative period:

In the immediate postoperative period care was given to the general condition, fluid balance, IV antibiotic and analgesics as per the protocol. This helped us to mobilize the patient faster.

Mobilization:

Whenever stable internal fixation was achieved, the patient was mobilized after 48 hrs after removal of the drains. For 2-3 days the range of motion allowed was $0\text{-}20^0$ .From the 5^{th} day the range of motion was gradually allowed to be increased to 90^0 or more and after suture removal full range of movement was allowed.

Whenever there was doubt about the stable fixation external splinting in the form of plaster of Paris slab was given for support and advised to do static quadriceps exercises. Continuous passive motion exercise (CPM) was done daily with temporarily removal of slab under carefully supervision and splint reapplied. Partial weight bearing was delayed until 6 weeks and full weight bearing allowed after 12-16 weeks (Table-3).

III. Result

In this study, 81 patients with traumatic proximal tibial fracture were treated. All cases were fresh and there were 68 males and 13 females. The mean age was years ranging from 21 to 65 years (Table-1). 49 patients were with fracture on their right side and 32 on left side. 72 of cases were caused by road traffic accidents and 9 were due to fall.

Of the 81 proximal tibial fractures, 36 were Schatzker type III, 15 was Schatzker type IV, 19 were of Schatzker type V and remaining 11 were Schatzker type VI. All were closed fractures. 68 out of 81 were treated by MIPO and remaining 13 by open reduction. All patients were operated within 1-5 days of injury. The size of the plate was selected based on the type of fracture. 8 & 9 holed plates were used more commonly.

Out of 81 patients, 68 patients showed radiological union within 6 weeks (Table-2). Average flexion of knee was 105 degree with more than 89% patients having knee range of motion more than 110^0. Average knee extensor lag was 8 degrees. Out of 81 patients 5 had limb shortening. 3 patients had varus / valgus malalignment..

Clinical & functional outcome

Both knee scores and functional scores (KSCRS[8,9]) calculated with each mounting to a total of 100 points.

Clinical score : **(Table-4)**

Total 100 points [Pain – 50 points + ROM – 25 points + Stability – 25 points]

At the time of latest follow-up, pain was adequately relieved in 75 knees (92.59%) and the average range of flexion was 131 degrees (range 124 to 138 degrees) and all the knees (100%) had normal anteroposterior and mediolateral stability.

Functional score: **(Table-5)**

Total 100 points [Walking distance – 50 points + Stair climbing – 50 points]

Out of 81 cases treated, 58 cases gave excellent result, 12 cases came out with good result, fair in 8 cases, and 3 cases of poor results (Table-6).

IV. Discussion

Proximal tibial fractures, one of the commonest intra articular fractures, incidence of this fractures are increasing regularly due to RTA and at the same time surgical treatment options for the same are also being modified continuously.

In this series, 81 patients with proximal tibial fractures were included, and the overall final outcome of the surgical management with LCP was assessed in terms of regaining the lost knee function using Knee Society Clinical Rating System[8,9].

The recent development of LCP has revolutionized the treatment by overcoming the few drawbacks of conventional buttress plate such as wound gaping, infection, implant failures, deformities like varus and repeated surgeries like flap cover, implant removal etc. The LCP is an internal fixation system which is a hybrid of LC-DCP and LISS.

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 requires 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 consists of[7]

- Indirect reduction
- Adequate stability
- Reservation of osteogenic potential
- Limited bone – plate contact

The period of immobilization was again individualized depending on the security of stable fixation. The benefits of early knee motion include reduction of knee stiffness and improved cartilage healing (regeneration) and promote good callus formation and remodelling.

The LISS is akin to an internal fixator, which provides comparable stability than double plating constructs .

V. Conclusion

Thus we conclude that the locking compression plate system with its various type of fixation act as a good biological fixation including difficult fracture situations especially when fracture is severely comminuted and in situations of osteoporosis. It provides rigid fixation of the fracture fragments and surgical exposure for the plate placement requires significantly less periosteal stripping and soft tissue exposure than that of other techniques.

We also suggest that the proper understanding principles of LCP and MIPO technique with proper preoperative planning of surgery can give good biological fixation for proximal tibial fractures.

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Table-1 AGE DISTRIBUTION

Age group (year)	Number of patients
21-30	22
31-40	26
41-50	19
51-60	12
> 60	2
Total	81

Table-2 RADIOLOGICAL UNION

Union (Weeks)	No. of cases
< 16	60
16 – 18	11
19 – 20	5
21 – 22	NIL

Delayed Union	NIL
Non-Union	5

Table-3 TIME AT WHICH FULL WEIGHT BEARING ACHIEVED

FWB ACHIEVED TIME (Weeks)	No.
8 – 10	42
11 – 13	26
14 – 16	10
➢ 15	3
Total	81

TABLE-4 CLINICAL SCORE

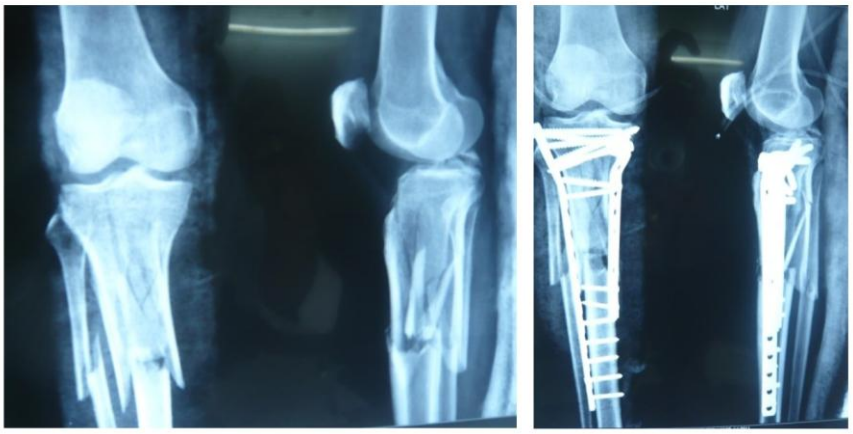
Pre-op mean	Post-op mean
28.33	91.52

TABLE-5 FUNCTIONAL SCORE

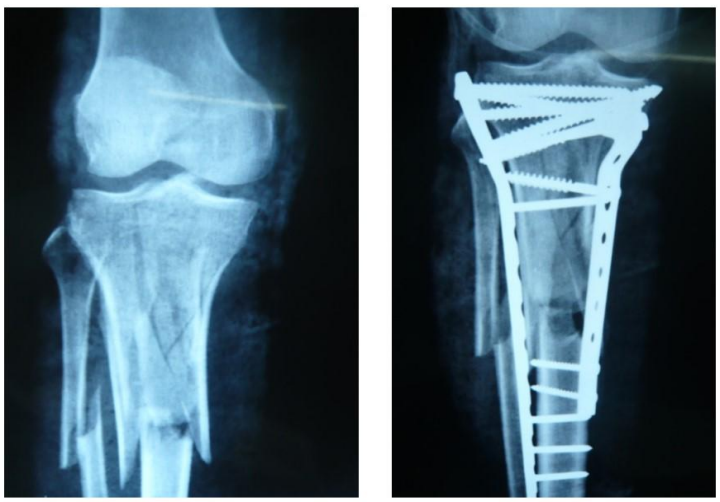
Pre-op mean	Post-op mean
18.34	87.26

TABLE-6 GRADING OF RESULTS BASED ON KSCRS

Grade – Score	No. of knees (%)
Excellent (>85)	58 (71.6)
Good (70-84)	12 (14.81)
Fair (60-69)	8 (9.88)
Poor (<60)	3 (3.7)



Case-1



Case-2


Case-3

Dr. K Meenakshi Sundaram, et. al. "Less Invasive Management of Closed, Grade I & Ii Compound Proximal Tibial Fractuers with Locking Compression Plates – A Clinical Study." *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*, 19(7), 2020, pp. 05-11.