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Functional outcome of proximal Tibial fracture treated with locking plates

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Abstract

Introduction: Fractures of proximal tibia are common & serious injuries involving major weight bearing joint surface of the knee. These are difficult to treat because of its subcutaneous location of the anteromedial surface of the tibia. The aim of surgical treatment of proximal tibial fractures is to restore and preserve normal knee function. The incidence of malunion, non-union and infections are relatively high causing significant long term disability. Recently more attention has been paid to the condition of soft tissue envelope. Treatment of these injuries using minimally invasive percutaneous plate osteosynthesis (MIPPO) techniques minimize soft tissue injury and damage to vascular integrity of fracture fragments. Locking compression plate has added advantage of the ability to manipulate and reduce the small and often osteoporotic fracture fragments directly. This coupled with biological advantage of percutaneous insertion of plates has resulted in high union rate. We present our series of cases to evaluate the radiological and functional outcome of locking plates in proximal tibial fractures.

Material & Methods: This study was a hospital based prospective study centred in department of orthopaedics, 25 patients with proximal tibia fractures were treated with locking compression plate (LCP).

Results: Assessment of clinical outcome was made according modified Hohl and Luck evaluation method, end results showed out of 25 cases, 18 (72%) cases showed excellent results, 5(20%) showed good results, 2 (8%) fair

Conclusion: It was concluded that locking compression plate offer a good treatment option for proximal tibia fractures achieving excellent results with almost full range of movements and with no residual disability.

Keywords: fracture proximal tibia, locking compression plates, Schatzker classification, modified hohl and luck evaluation.

Introduction

Fractures of proximal tibia are common & serious injuries involving which are difficult to treat because of its subcutaneous location of the anteromedial surface of the tibia. If it's not treated, it may results in significant functional impairment.

The Schatzker classification system for tibial plateau fractures is widely used by orthopedic surgeons to assess the initial injury, plan management, and predict prognosis. it divides tibial plateau fractures into six types: lateral plateau fracture without depression (type I), lateral plateau fracture with depression (type II), pure central depression the auricular surface is driven into plateau, the lateral cortex is intact (type III), medial plateau fracture (type IV), bicondylar plateau fracture (type V), and plateau fracture with diaphyseal discontinuity (type VI). Management of type I, II, and III fractures centers on evaluating and repairing the articular cartilage. The fracture-dislocation mechanism of type IV fractures increases the likelihood of injury to the peroneal nerve or popliteal vessels. In type V and VI fractures, the location of soft-tissue injury indicates the surgical approach and the degree of soft-tissue swelling dictates the timing of definitive surgery and the need for provisional stabilization with an external fixator^[1].

Latest implants and technique of minimal incision and reduction for articular surface restoration and using Locking Compression Plate (LCP) have provided better option for treatment.

Among the factors which determine the outcome; the degree of comminution, as well as the

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severity of accompanying soft-tissue damage is the most important [2, 3]. The aim of surgical treatment of proximal tibial fractures is to restore and preserve normal knee function. Management of high energy intra-articular fractures of the proximal tibia, associated with marked soft-tissue trauma, can be challenging, requiring the combination of accurate reduction and minimal invasive techniques [4].

The incidence of malunion, non-union and infections are relatively high causing significant long term disability. Recently more attention has been paid to the soft tissue friendly approaches and minimally invasive techniques. Treatment of these injuries using minimally invasive percutaneous plate osteosynthesis (MIPPO) techniques minimize soft tissue injury and damage to vascular integrity of fracture fragments [5].

LCP has become popular for the treatment of proximal tibial fractures. This coupled with biological advantage of percutaneous insertion of plates has resulted in high union rates. It offers biomechanical advantage over other methods by, better distribution of forces along the axis of bone, can be inserted with minimal soft tissue stripping using MIPPO, reduces the risk of a secondary loss of intraoperative reduction by locking with screws to the plate, better preservation of blood supply to the bone as a locked plating does not rely on plate bone compression, provides stable fixation by creating a fixed angle construct and angular stability and allows early mobilization [5].

Material and Methods

This study was carried out on twenty five patients in the department of orthopaedic surgery at Shri Ram Murti Institute of Medical Sciences, Bareilly over a period of 2 years. Patients having periarticular fracture of proximal tibia were included in study

Inclusion criteria:

1. Patients of age 18 yrs and above both males and females.
2. Schatzker classification type III-VI
3. Osteoporotic proximal tibial fractures
4. Open fracture grade I (according to Gustillo Anderson n classification)

Exclusion criteria:

1. Schatzker classification type I and II
2. Gustillo Anderson type II and III open fractures
3. Patients with associated tibial shaft and distal tibial fractures of same limb.
4. Patients with pathological fractures.
5. Non-union / malunion and previously treated fractures of same limb.

Thorough history regarding mode and mechanism of injury and clinical examination were undertaken.

In emergency, primary attention was given to the airway, breathing and circulation, compartment syndrome, neurovascular injury and associated injuries. It was followed by adequate analgesic and tetanus prophylaxis and the limb was splinted with above knee POP slab

The diagnostic workup of the patient included:-

1. Haemoglobin estimation
2. Total leucocyte count
3. Differential leucocyte count
4. Erythrocyte sedimentation rate
5. Bleeding time
6. Clotting time

7. Blood group
8. Random blood sugar
9. blood urea
10. Serum sodium
11. Serum potassium
12. Roentgenogram of affected limbs and chest, Three dimension computed tomography of the affected limb if required

Implant used

Locking compression plate (LCP)

LCP is a further refinement of internal fixator systems, with screw heads locked firmly into the plate hole, has now been devised. There is a new design, the "combi-hole" plates which can accommodate either a conventional screw or the new "locking head screw (LHS)" which has a conical threaded head.

LCP Proximal Tibial Plate 3.5

The LCP Proximal Tibial Plate 3.5 has a limited-contact profile. The head and neck portions of the plate accept 3.5 mm Stardrive or hexagonal locking screws. The screw hole pattern allows a raft of subchondral locking screws to buttress and maintain reduction of the articular surface. This provides resistance to local depression loads in addition to the stability of the fixed-angle construct created by locking the screws into the plate.

The Locking Compression Plate (LCP) has combi-holes in the plate shaft which combine a dynamic compression unit (DCU) hole with a locking screw hole. The combi-hole provides flexibility of axial compression and locking capability throughout the length of the plate shaft

Features:

1. Plate tapers from 3.4 mm to 1.9 mm thick
2. Available with 1, 2, 4, 6, 8, or 10 holes in the plate shaft
3. Available in implant-quality 316L stainless steel or titanium alloy

The 3.5 mm LCP Posteromedial Proximal Tibia Plate is available in stainless steel or titanium and has a limited-contact shaft profile.

The head and neck portions of the plate accept 3.5 mm locking, conical and cortex screws or 4.0 mm cancellous bone screws.

Screw divergence- two proximal screw holes have 10° divergent trajectories. (Each diverges 5° from the plate midline).

Preoperatively

Soft tissue condition was looked into and if abrasion and blisters, swelling were present surgery was delayed. Fractures were classified according to Schatzker classification after radiographic evaluation, Size of the plate and screws were determined by templating on X-Ray. The patient was then shifted to the operation theatre as soon as vitals were stabilized and was fit for anesthesia

Radiographic evaluation included series of an anterior-posterior, lateral, and both oblique views and 10 to 15 degrees caudally tilted plateau view were used. The axial images are often the most useful for determining the fracture configuration and planning of lag screw placement as well as surgical incision placement.

Postoperatively

Drain was removed on the second postoperative day and the

drain tip sent for culture and sensitivity analysis. Intravenous antibiotics were continued for 3 days. If the cultures were positive for bacterial growth then antibiotics were continued till the cultures were negative. Physiotherapy was instituted from the second postoperative day. Mobilization was started as soon as the pain permitted

Follow-up

The patients were followed up after, 6 weeks, 3 months, 6 months, 9 months. In every follow up, the functional and radiological assessment of the patients was done according to modified hohl and luck evaluation



Fig 1: Preoperative X-ray

Fig 2: Postoperative X-ray

Modified HOHL and luck evaluation method

Table 1: Functional assessment

| Grade | Lack Extension (degrees) | Range of Movement (degrees) | Varus or Vagus Instabiltry (degrees) | Walking Distance (m) | Pain |
|---|-----------------------------|-----------------------------|--------------------------------------|----------------------|---|
| Excellent all of the following | 0 | >120 | <5 | >3000 | None |
| Good Not More than One of the following | <10 | <90 | >5 | <1000 | Mild On Activity |
| Fair not more than Two of the following | >10 | <75 | >10 | <100 | Moderate on activity Intermittent at rest |
| Poor | All results worse than fair | | | | |

Table 2: Radiographic grading

| GRADE | Valgus/varus deformity (Degree) | Depression of articular surface (mm) |
|---|---------------------------------|--------------------------------------|
| Excellent (All of the following) | ≤ 5 | < 5 |
| Good (Not more than one of the following) | > 5 | > 5 |
| Fair (Not more than one of the following) | >10 | > 5 |
| Poor All results worse than fair | | Severe |

Results

Functional and radiological outcome of 25 patients was evaluated.

Table 1: Age distribution

| Age group (years) | Number of cases | Percentage age (%) |
|--------------------|-----------------|--------------------|
| Below 30 | 6 | 24 |
| 31-40 | 7 | 28 |
| 41-50 | 10 | 40 |
| 51-60 | 2 | 8 |
| Total cases | 25 | 100 |

The average age group in the study was 41.92, year, The maximum numbers of cases 40% were in age group 41-50 years.

Table 2: Sex incidence

| Sex | No. of cases | Percentage |
|--------------|--------------|------------|
| Males | 19 | 76 |
| Females | 6 | 24 |
| Total | 25 | 100 |

Male to female ratio was 3.1:1, since males are more involved in outdoor activities & most of the motor vehicles are driven by them.

Table 3: Side involved

| Side | Number |
|--------------|-----------|
| Right | 13 |
| Left | 12 |
| Total | 25 |

Out of 25 cases of fracture of proximal tibia right to left ratio was 1:1.08

Table 4: Mode of injury

| Mode of injury | No of cases | Percentage |
|-----------------------|-------------|------------|
| Road traffic accident | 21 | 84 |
| Fall from height | 4 | 16 |
| Total | 25 | 100 |

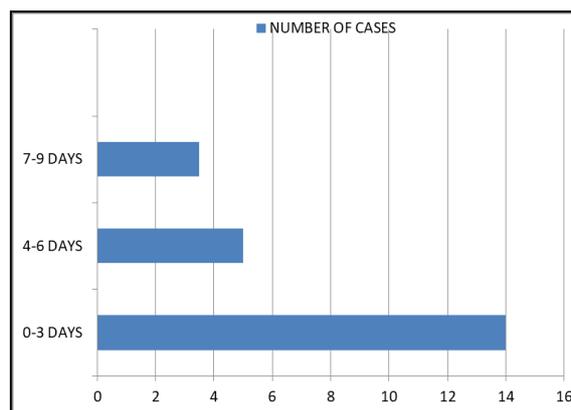
The mode of injury was road traffic accident in 84% cases

Table 5: Schatzker classification distribution of cases

| Schatzker type | Number of cases | Percentage |
|----------------|-----------------|------------|
| Type iii | 10 | 40 |
| Type iv | 05 | 20 |
| Type v | 04 | 16 |
| Type vi | 06 | 24 |
| Total | 25 | 100 |

Type I and type II were exclude from the study, out of 25 cases total percentage for type III were 40%, for type IV were 20%, type V were 16%, type VI were 24%.

Table 6: Time interval between date of injury surgery



56% cases were operated within 3 days of injury. Cases delayed either presented late into the hospital or had associated injuries or having massive swelling and due to skin condition like superficial wounds, blisters formation and abrasions.

Table 7: Duration of full weight mobilization following surgery

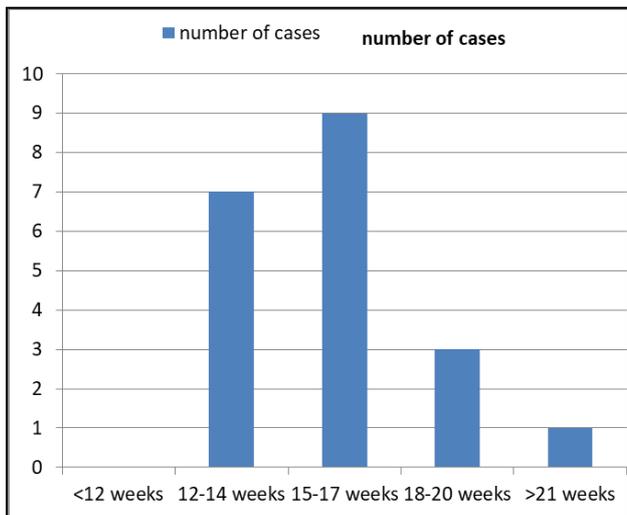


Table 8: Functional evaluation for Range of motion

| Range of motion in degree | No. of cases | Percentage |
|---------------------------|--------------|------------|
| ≥ 120 | 21 | 84 |
| 119-90 | 4 | 16 |
| 89-75 | 0 | 0 |
| < 75 | 0 | 0 |
| Total | 25 | 100 |

84% attained ≥ 120 ROM. None of the case below 90%, the average ROM of 124.4%.

Table 9: Walking distance

| Distance in meter | number of cases | Percentage |
|-------------------|-----------------|------------|
| ≥ 3000 | 14 | 56 |
| 1000-2900 | 11 | 44 |
| 100-900 | 0 | 0 |
| < 100 | 0 | 0 |
| Total | 25 | 100 |

56% patient were able to walk without any difficulty for more than 3000 m & 44% were able to walk for more than 1000 meter but after that they experienced mild pain, after 9 months of follow-up.

Table 10: Pain at 9 months of follow up

| Pain | Number of Patient |
|----------------------|-------------------|
| None | 20 |
| Mild on activity | 4 |
| Moderate on activity | 1 |

Table 11: Combined functional grading for all patients

| Grade | Cases | Percentage |
|-----------|-------|------------|
| Excellent | 18 | 72 |
| Good | 5 | 20 |
| Fair | 2 | 8 |
| Poor | 0 | 0 |
| Total | 25 | 100 |

Table 12: Time to clinical union

| Clinical Union (weeks) | No. of cases | Percentage% |
|------------------------|--------------|-------------|
| 6 weeks | 6 | 25 |
| 3 months | 13 | 55 |
| 6 months | 6 | 20 |
| Total | 25 | 100% |

Maximum number of cases united clinically at 3 months.

Table 13: Time to radiological union

| Clinical Union (weeks) | No. of cases | Percentage% |
|------------------------|--------------|-------------|
| 6 weeks | 5 | 25 |
| 3 months | 15 | 55 |
| 6 months | 5 | 20 |
| Total | 25 | 100% |

Maximum number of cases united in 3 months

Table 14: Depression of articular surface

| Depression(mm) | Number of patient | Percentage |
|----------------|-------------------|------------|
| < 5 | 25 | 100 |
| > 5 | 0 | 0 |
| Total | 25 | 100 |

None of the patient showed more than 5 degree of depression

Table 15: Combined radiological grading for all patients

| Grade | Cases | Percentage |
|-----------|-------|------------|
| Excellent | 18 | 72 |
| Good | 5 | 20 |
| Fair | 2 | 8 |
| Poor | 0 | 0 |
| Total | 25 | 100 |

Most of the cases showed excellent results.

Table 16: Complications following surgery

| Complications | No. of cases | % |
|--|--------------|----|
| Deep infection | 2 | 8 |
| Superficial infection | 1 | 4 |
| Malunion | 0 | 0 |
| Delayed Union | - | - |
| Non-union | - | - |
| Secondary Loss of reduction | - | - |
| Skin necrosis | 3 | 12 |
| Stiffness | 0 | 0 |
| Extension lag | 0 | 0 |
| Acl and meniscal tear | 2 | 8 |
| Post operative stiffness (following surgery) | 5 | 20 |

Discussion

The goals of proximal tibial fracture fixation are anatomical reduction and stable fixation of the intra-articular fragments along with ability to restore normal mechanical alignment of the limb.

Locking plate fixation technique is a landmark advance in this direction as it has all the advantages with the added benefit of allowing percutaneous /minimally invasive technique. With reduction and fixation of periarticular fracture of tibia with locking plate device fragments can be easily reduced and joint movements can be started as early as in the post op recovery room.

The average age in the present study was 41.92 years (ranging from 21 to 60 years), which was comparable to other studies. Lee JA *et al* in their study found an average age to be 42 years (range 18 to 82 years) ^[6]. Raza *et al* in their series reported average of 40 years (19-75 years) ^[7]. This reflects that the periarticular fracture around knee joint is common in middle-aged adults who are commonly involved in outdoors activities and road traffic accidents.

These fractures exceedingly occur in the male population as supported by the studies of Lee JA *et al* and even Raza *et al* in their study reported male to female ratio of 6:1. who reported male to female ratio of tibial plateau fracture to be 1.9: 1. ^[6,7] All these results are comparable to our series of patient with ratio of 3.1: 1, where male were affected more than double in number than females. In our present study 13 cases had right-sided injuries and 12 cases had left sided injuries. The ratio of right: left lower limb was 1:1.08. Ryan JK *et al* noted right to left leg ratio of 1.4:1. ^[8] Mathur H *et al* noted right to left ratio of 1.25:1. ^[9]

Involvement of both sides are same in our study indicating both sides can get involved during road traffic accidents and also during fall from height with same ratio. Majority of our cases (21) were caused by RTA and mode of injury in rest 4 cases is fall from height. Lee JA *et al* in a similar study reported an incidence of 80% due to RTA, 11.4% due to fall from height, 5.8% due to blow and 2.8% due to shotgun injuries. ^[6] This suggests that periarticular fracture around knee joint are caused by high energy trauma most commonly due to road traffic accidents. Out of our 25 cases of tibial plateau fractures, there was 10 cases of Schatzker type III (40%) case of type IV were 5 (20%) fracture, 4 (16%) case of type V, 6 (24%) cases of type VI fractures as we have excluded type 1 and type 2 fracture from this study, From the observation tables, it is clear that type III. Depression type of fractures is more common followed by type VI and IV. In Hohl M. and Luck J.V. (1956) series depressed types of fractures were 63.3%. ^[10] In our study, it was 40%, Type IV fracture is usually found in pure compression type of injuries. In our presented study, associated injuries were present in 10 cases (40%). Among them, there were 2 cases of head injury, 4 case of chest injury (multiple ribs fracture), 2 cases of ipsilateral fracture of humerus and 1 case of contralateral fracture shaft of femur, 1 case of cervical spine injury with no neurological loss. Ryan JK *et al* reported that of 58 tibial plateau fracture patients, thirty nine (67%) suffered from polytrauma. ^[8] The series of Lee JA *et al* two patients had pneumothorax and rib fractures, two had upper extremity injuries (shoulder dislocation, humerus fracture) making a 16% incidence of other coexisting injuries ^[6]. This suggests that high-energy trauma, which cause periarticular fractures around the knee, are often associated with multiple other injuries. In our presented series, the average time to union was 13.05 weeks (range from 8 to 18 weeks). Lee JA *et al* in their similar study found average time to healing of the 25 fracture as 4.2 months (range 3 to 7 months). ^[6] Ryan JK *et al* in their study found that average time to union with locking plate was 6 months (range 3 to 14 months). ^[8] This suggests that proximal tibial fracture with metaphyseal extension takes longer time due to severity of injury and fracture pattern. In our study lack of extension were not reported in any of the cases, similar results were found by Unnikrishnan J in his study ^[11]. In our study the overall range of motion at knee joint averaged 124.4 degree (range 90-135 degree). Stannard JP *et al* in their similar study measured average range of motion of 127 degree (range 90-145 degree) ^[12]. Lee JA *et al* in their similar study found overall range of motion average 105 degree (range 0-135 degree) ^[6]. Proximal tibial fractures usually result in increased fibrosis and thus decreased

subsequent range of motion, but stable fixation with locking plate enables early mobilization of joints and provides with higher range of motion as evidenced in all these studies. In our study there was no cases reported for > 5 degree varus/valgus instability, in study of 25 cases by Unnikrishnan J only 4% had >5 degree of instability. ^[11] Combined functional and radiological grading in our study of 25 cases showed, 18 (72%) cases showed excellent results, 5(20%) Showed good results, 2 (8%) fair, comparable results were found in study of Unnikrishnan J 68% performed excellently and 16% showed good performance and performance is fair only in 12% and 4% performed poor ^[11].

Conclusion

We conclude by stating that locked plate fixation technique is very effective in achieving high rates of union, preventing loss of reduction and mechanical failure. In a well reduced proximal tibia fracture, this fixation technique likely to provide a good outcome.

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