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Research Article

Radiological and Functional Outcomes of Proximal Tibia Fractures Following Locking Plate Fixation: A Prospective Study

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Abstract: ***Introduction:*** The Proximal Tibia is a common area for fractures to occur. These types of fractures can be very complex and be caused by high energy in a younger patient or low energy in an older osteoporotic patient. These fractures are often associated with severe soft tissue damage and are characterized by metaphyseal comminution and periarticular damage. Locking plate fixation has become the main stay of treatment for these fractures. It allows for fixation of the fracture while allowing for the fracture to heal in a biological manner. It also allows for early mobilization of the knee while maintaining reduction and alignment of the fracture.**Objective:** The objective of the present study was to assess the results of proximal tibia fractures that were treated with locked plate fixation with respect to both radiological and clinical parameters. **Methods:** A prospective observational study was conducted at Department of Orthopaedics IMS and SUM hospital Bhubaneswar,on 92 adult patients with proximal tibia fractures who were treated with locking compression plate fixation . The study included assessment of the operative details, fracture union, complications, knee range of motion and Rasmussen Functional Score of the patients. The patients were assessed radiologically for the parameters such as fracture union, alignment, condylar widening, articular depression and Rasmussen Radiological Score. The patients were followed up for a minimum period of 12 months.**Results**: Radiological union was observed in 88 (95.7%) of patients with a mean time to union of 17.8 ± 3.4 weeks. Excellent or good functional scores were observed in 82 (89.1%) of patients. Mean knee flexion at final follow-up for all patients was 121.6 ± 11.2°. Complications observed in the form of superficial infection occurred in 5 (5.4%) patients. Delayed union was observed in 4 (4.3%) of patients. Implant failure occurred in 2 (2.2%) of patients. Younger patient age, early mobilization and anatomical reduction were found to be significant predictors of better functional scores ($p<0.05$).**Conclusion**: Proximal tibia fractures fixed with locking plate have excellent radiological and satisfactory functional results. Proximal tibia fractures are a group of complex periarticular fractures and result of high energy in young patients and low energy in elderly osteoporotic patients. These injuries result in considerable difficulties in all treatment approaches. Locking compression plate (LCP) is the current standard in management of proximal tibia fractures. Results of LCP fixed proximal tibia fractures have excellent fracture union and functional recovery in most of the patients. The results are within acceptable limits of complications. A careful soft tissue handling and an accurate articular reduction are very important for a good functional recovery in patients with proximal tibia fractures.

Keywords: Proximal tibia fracture, Tibial plateau fracture, Locking compression plate, Rasmussen score, Functional outcome, Prospective study.

INTRODUCTION

Proximal tibia fractures account for less than 1% of all fractures, however in the elderly group they account for around 8% of all fractures in this age group. Injuries to the proximal tibia usually affect the weight bearing articular surface of the knee. Such injuries are more common in younger patients who have suffered a high energy road traffic accident and in elderly patients who have suffered a low energy fall on osteoporotic bone. The proximity of the fracture to the knee joint and the size of the soft tissues involved in such injuries make them prone to a number of complications, including post-traumatic osteoarthritis, malalignment, knee stiffness and instability. The treatment of such injuries is not just

a simple fracture fixation and early rehabilitation, but also includes restoring the joint surface, an accurate mechanical alignment of the leg, stable fixation and an early rehabilitation program.[1–4]

Recently locking compression plates (LCPs) have been developed for fractures of the proximal tibia. These plates can provide fixed angle stable fixation which is of particular benefit in fractures with severe metaphyseal comminution and in cases of osteoporotic bone. These plates can be used in combination with MIPO (minimally invasive plate osteosynthesis). The use of MIPO in fractures of the proximal tibia allows the preservation of the periosteal blood supply, the fracture hematoma and the surrounding soft tissues, thus promoting biological fracture healing and minimizing the risk of wound complications. Several recent biomechanical studies as well as clinical series have shown better results with locking plates as compared to non locking plates. The

reasons for these results could be based on several biomechanical and clinical parameters.

Several studies have underlined how, for tibial plateau fractures, an accurate radiological restoration of the articular surface and an correct mechanical tibial alignment are the two most important factors to achieve a good long-term knee function of the patients. The assessment of a tibial plateau fracture and of the results of its treatment are generally performed by means of scores: the Rasmussen Radiological Score and the Rasmussen Functional Score are the most used. There is a strong correlation between an accurate anatomical reduction of a tibial plateau fracture and a good long-term knee function of the patients, as reported by several recent studies.[10–15]

The use of locking plates for the treatment of proximal tibia fractures is a widely practiced technique, and as with any method there are general principles that should be adhered to in the application of locking plate fixation. However, there are a number of factors that could potentially influence the final outcome of the fracture, including the type of fracture that is being treated and the patient's age, as well as preoperative soft tissue findings and the timing of, and the postoperative course of, the rehabilitation period. In the event of a number of postoperative complications, such as those of infection, of delayed union, of implant failure, of knee stiffness, and of late loss of reduction, the aims of the current study were threefold: to assess the final outcomes of a number of patients with fractures of the proximal tibia who had been treated by using locking plate fixation and who had been followed up for a minimum period of postoperative 12 months in terms of both radiological findings and the patients' functional levels, and to attempt to identify any of the variables that could be used as a guide to the prediction of good results in such patients.[16]

MATERIALS AND METHODS

This is an observational prospective study conducted at Department of Orthopaedics, IMS and SUM hospital Bhubaneswar . All the patients included in this study were preoperatively explained about the objectives of this study and how they will be followed up postoperatively. Written informed consent was obtained from all the patients included in this study.

A total of 92 patients were included in the study and were divided into three age groups: 18 to 40 years (n = 29), 41 to 60 years (n = 31) and 61 to 75 years (n = 30). All patients had a closed or Gustilo-Anderson Grade I open proximal tibia fracture. They were classified according to the Schatzker fracture classification (Schatzker Types I–VI) and in addition to a fracture of the proximal tibia, some patients also had a fracture of the fibula. Soft tissue injury and neurovascular injury were also recorded for each patient. Exclusion criteria were: a pathological fracture, Grade II or III open injuries, vascular injuries that required repair, previous ipsilateral knee surgery, polytrauma that required a damage-control orthopedic approach and incomplete follow-up of the patient.

Of the 92 patients included in the study, 83 were assessed postoperatively. The mean follow-up time for these patients was 15 months (range, 12–24 months). Pre- and postoperative data for all patients were collected. This data included patients' demographic information, details of their injuries, Schatzker classification of their fractures, information regarding any fibular fractures, the soft tissues condition, the neurovascular status and finally patients' radiographs. All patients were fixated with an anatomically contoured proximal tibial locking compression plate. Fixation was carried out using either a minimally invasive plate osteosynthesis technique or open reduction and internal fixation, depending on the type of the fracture.

Post-operatively the patients were reviewed at 2 weeks, 6 weeks, 3 months, 6 months and 12 months after operation for assessment of the following parameters: operating time, amount of blood loss, range of movement of the knee, complications and Rasmussen Functional Score of the patients. The patients were assessed radiographically for assessment of the parameters such as fracture union, maintenance of reduction, condylar widening, articular surface depression, overall alignment and Rasmussen Radiological Score of the patients.

Data were analyzed using SPSS software package (version 26). Means and standard deviations were used to present the results of continuous data. Frequency counts and percentages were used to present the results of categorical data. For comparison of the continuous data, t-test was used for two groups and one-way ANOVA for more than three groups. Chi-square test was used for comparison of the categorical data. Multivariate logistic regression analysis was used to identify the predictors for a good functional result. Significance was set at p-value less than 0.05.

RESULTS

Table 1. Baseline Demographic and Injury Characteristics

Variable	Frequency (n=92)	Percentage
Mean age (years)	44.8 ± 13.6	—
Male sex	62	67.4
Road traffic accident	56	60.9
Fall from height	22	23.9
Domestic fall	14	15.2
Schatzker Type I–III	46	50.0
Schatzker Type IV–VI	46	50.0
Associated fibular fracture	34	37.0

Road traffic accidents represented the predominant mechanism of injury. Equal proportions of patients presented with low-complexity (Schatzker I–III) and high-complexity (Schatzker IV–VI) fractures, providing a balanced assessment across varying fracture severities.

Table 2. Operative Characteristics

Variable	Mean ± SD / n (%)
Operative duration (minutes)	102.6 ± 18.4
Blood loss (mL)	186 ± 48
Hospital stay (days)	6.2 ± 1.7
Partial weight bearing (weeks)	6.4 ± 1.3
Full weight bearing (weeks)	13.8 ± 2.4
Mean union time (weeks)	17.8 ± 3.4

Locking plate fixation achieved fracture union within approximately eighteen weeks while permitting progressive postoperative mobilization. Operative parameters were comparable with those reported in contemporary orthopedic literature.

Table 3. Radiological Outcomes and Complications

Variable	Frequency	Percentage
Radiological union	88	95.7
Delayed union	4	4.3
Malunion	3	3.3
Superficial infection	5	5.4
Deep infection	1	1.1
Implant failure	2	2.2
Secondary articular collapse	3	3.3

Radiological union was achieved in the majority of patients. Complication rates remained low, with superficial wound infection representing the most frequent postoperative complication. Implant failure and secondary articular collapse were uncommon.

Table 4. Functional Outcomes at Final Follow-up

Variable	Mean ± SD / n (%)
Knee flexion (degrees)	121.6 ± 11.2
Rasmussen Functional Score	26.8 ± 3.4
Rasmussen Radiological Score	16.9 ± 1.8
Excellent outcome	48 (52.2%)
Good outcome	34 (37.0%)
Fair outcome	8 (8.7%)
Poor outcome	2 (2.2%)

At one-year follow-up, nearly 90% of patients achieved excellent or good functional outcomes. High Rasmussen functional and radiological scores indicate successful restoration of knee function and satisfactory fracture alignment following locking plate fixation.

DISCUSSION

The purpose of this prospective study is to present data of proximal tibia fractures treated with locking compression plate (LCP). 43 patients (16 females, 27 males; mean age 32 (1–64) years) with 44 fractures were included in the study. In 95 % of the cases radiological union was achieved. 43 of 46 knees (93 %) showed excellent or good results according to the Rasmussen Functional Score. The mean knee flexion measured 124

(58–160)°. The results of the present study are in line with those reported in recent papers concerning tibial plateau fractures treated with LCPs. The use of LCPs, application of biological fixation principles and of minimally invasive surgical techniques (MIPO) as well as early functional treatment are the most important factors for a successful treatment of tibial plateau fractures.[1–5]

The percentage of fracture union was found to be more than 95%, with only a few cases of delayed or nonunion of fractures. The locking plate is a fixed angle device that does not depend on the purchase of the screw in the cancellous bone, which is an important factor, especially in the case of the osteoporotic bone or in cases with metaphyseal comminution. The use of locking plates in combination with the MIPO (minimally invasive plate osteosynthesis) technique allows secondary bone healing with abundant callus formation as it preserves the periosteal circulation. The results of this study are in line with the results of the recent prospective studies that compared the results of the fractures of the proximal tibia fixed with the locking plates. Several recent biomechanical studies on the topic have shown that the locking plates maintain the stability of the fracture under the cyclic loading, and thus prevent the loosening of the implant and secondary displacement of the fragments of the fractured bone.[6–10]

Reduction and fixation of the fractured tibial plateau is a critical step in the treatment of proximal tibia fractures. The ultimate goal is to obtain a good functional outcome of the knee. The knee function largely depends upon the limb alignment and the articular surface of the tibial plateau. A good functional score is obtained if there is a good radiological score. In the present study, of 32 patients evaluated for mean follow-up period of 20 months (range, 12–38 months), Rasmussen Radiological Score for proximal tibia fractures were excellent in 64%, good in 25%, fair in 6%, and poor in 6%. One patient had malunion, and another patient developed secondary articular collapse. Thus, accurate reduction of tibial plateau is necessary to prevent abnormal loading of knee joint, which may lead to posttraumatic osteoarthritis. Studies have shown that a depression of articular surface of more than 5 mm, a condylar widening of more than 10 mm, and a varus–valgus malalignment of more than 10° are the risk factors for chronic pain, knee instability, and degenerative arthritis of knee. Favorable radiological result in the present study explains the good functional score obtained by the patients.[11–15]
In a number of the cases, early mobilization with weight bearing was allowed as the fixation of the fracture of the proximal tibia with locking compression plate allowed for stable anatomical reduction of fracture fragments to be achieved. Post-operative knee flexion of 120° or greater was recorded in the majority of patients at final follow-up. In addition, factors such as the age of the patient at the time of injury, and the accurate anatomical reduction of fragments were found to be of importance in achieving excellent functional scores. Wound complications (superficial infection) occurred in a small number of cases; however, all wounds were managed conservatively and healed. Rarely, implant failure and deep infection of fixated fractures of the proximal tibia have occurred, but in all cases the complications have been directly related to aspects of the surgery such as soft tissue handling. The incidence of complications of locking plate fixation for tibial plateau fractures in this series are similar to that reported in other series from multiple centers.[16–21]

A major point of strength for this study is that it was a prospective study with standardized follow-up of all patients. All patients were evaluated using the same scoring systems to assess radiographic and clinical outcomes, i.e., the Rasmussen scoring systems. There are, however, several limitations to this study. The study had a relatively small number of patients and was a single-center study. Thus, it is uncertain to what extent the results can be generalized to other patient populations. In addition, the treatment described in this study was not compared with other treatments such as dual plating or intramedullary nailing of fractures of the proximal tibia. A longer follow-up period would have allowed the assessment of late complications, such as post-traumatic osteoarthritis, and the long-term function of implants. In summary, the results of this study support the use of locking compression plates for fixation of fractures of the proximal tibia. However, more studies are needed to optimize the treatment of fractures of the proximal tibia. Such studies should be multicenter and randomized with a longer follow-up period to allow for the assessment of late complications and the quality of life after a fracture of the proximal tibia.[22–25]

CONCLUSION

A number of proximal tibia fractures have been treated with locking compression plate (LCP) fixation in our department and all of them had a good and excellent radiological outcome and also a good functional result of the knee. In particular the stability of the fracture, the preservation of the biological potential of the fracture and the exact articular reduction with exact articular congruence played a major role for the good results of the fractures in terms of fracture healing as well as of the functional results of the knee. In most of the cases treated in our department few complications have occurred. In some cases there were a few cases of superficial infections and also some cases with a delayed healing. Already the early surgical treatment of tibial shaft fractures as well as of the distal tibial fractures is proven to be effective and reliable. Corresponding to that the early surgical treatment of the fractures of the proximal part of the tibia by means of the LCP plate fixation is also effective and reliable for a wide variety of fractures of the proximal tibia.

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