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# Management of fractures of proximal tibia by various treatment modalities: A study of 56 patients

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**Abstract**
**Objectives:** To compare the end results obtained after treating patients of proximal tibial fractures with various modalities
**Materials and Methods:** This prospective study was carried out for patients treated by various modalities for fractures of proximal tibia from May 2014 to April 2016 at Tertiary care Hospital.
**Results:** Clinically, Excellent results were seen in 51.7% of patients, Good results were seen in 32.1% of patients while 10.7% of patients had fair results. Radiologically, 61.5% had excellent results, 34.6% had good result and 3.8% had fair result. We did not encounter any patient with poor result.
**Conclusions:** The surgeon must have sound knowledge of the nature of the proximal tibia injury and must be familiar with variety of techniques available at present for treating these fractures to achieve consistent excellent and good results.

**Keywords:** Proximal tibia, Rasmussen's score, Hockey plate, T-Buttress plate

**Abbreviations:** CC-Cannulated Cancellous screw; MIPPO-Minimally invasive percutaneous plate osteosynthesis; ORIF-Open reduction and internal fixation

## 1. Introduction
The tibia is the second longest bone of the body, located at medial side of the leg. Among all the fractures in the body, tibia is the single largest bone that is commonly involved in injuries. Owing to the increase in vehicular accidents and industrial mishaps, high velocity trauma produces tibial fractures in increasing numbers. By its location and by being subcutaneous in most of its length tibia fractures tend to be open very commonly. Due to its precarious blood supply and scanty soft tissue coverage orthopedic surgeons around the world have been fighting infections and union problems.
Fractures of the proximal tibia can be quite challenging to manage. They are notoriously difficult to reduce, align and stabilize, and are prone to develop wound complications and infections. As these fractures involve a major weight bearing joint, they result in functional impairment. To preserve normal knee function, it is must to maintain joint congruity, preserve the normal mechanical axis, ensure joint stability and restore full range of motion especially in Indian culture where squatting and sitting cross legged is must as routine. This is a formidable task to accomplish, especially in the phase of compromised soft tissues especially in open fractures, variable bone quality and associated medical conditions of the patients.
There is a considerable debate regarding the best method for treating proximal tibial fractures. Due to advancement especially in orthopedic trauma, a better understanding of biomechanics, quality of implants, principles of internal fixation, soft tissue care, antibiotics and asepsis have all contributed advancement from the conservative approach to internal fixation in fractures as an acceptable mode of treatment. Nevertheless, proximal tibia fractures challenging remain because of their number, variety and complexity. With advancements the treatment of each fracture type is still not defined hence we have taken up this study to analyze various fracture patterns and its outcome.
Indirect reduction was introduced in the 1988 by Mast *et al*. and others. It was an attempt to decrease surgical dissection by relying on ligamentotaxis, blind repositioning of fragments, reduction aids such as the distracter and other methods to maintain soft tissue integrity and

preserve bony perfusion. Additionally, plates were redesigned to limit contact with the underlying bone and further preserve bony vascularity. In the 1990s, Krettek *et al*. popularized Minimally Invasive Percutaneous Plate Osteosynthesis Techniques using conventional implants placed through small incisions and submuscular (subcutaneous) tunnels. Cadaveric studies demonstrated better preservation of periosteal vasculature with these minimally invasive methods than with standard open exposures for internal fixation. As part of the continued development of Biologically Friendly Plating, and to facilitate Minimally Invasive Plating Techniques, the use of plates that allow screws to lock into the plate to create a fixed angle construct is gaining popularity nowadays.

Several different surgical approaches have been described for Proximal Tibial fractures (medial, lateral and combined) depending on the location of the fracture. Combined extensive approaches, in particular, are associated with high complication rates, possibly due to compromised soft tissue perfusion and/or extensive soft tissue stripping from bone fragments. A review of the recent literature demonstrates a trend toward increasingly limited open reduction and internal fixation, often in association with some form of external stabilization. Minimally invasive techniques have also been described for intra-articular fractures (metaphyseal and diaphyseo-metaphyseal) of the proximal tibia. These techniques avoid the long incisions and extensive soft tissue stripping associated with conventional techniques and are best used with shorter, lower profile plates.

## 2. Aims and Objectives

- To compare the end results obtained after treating patients of proximal tibial fractures with various modalities
- To find out which treatment should be preferred in different presentations of proximal tibial fractures

## 3. Materials and Methods

This prospective study was carried out for patients treated by various modalities for fractures of proximal tibia from May 2014 to April 2016 at Tertiary care Hospital.

## 4. Criteria for Patient Inclusion

1. The fractures of the proximal tibial metaphyseal, metaphyseo-diaphyseal with or without intra-articular extension (including upper third fractures of tibia)
2. Closed fractures, fractures with Open grade-I (Gustillo Anderson Classification) wounds were also included

## 5. Criteria for Patient Exclusion

1. Pathological Fractures
2. Open fractures having grade II and III injury (Gustillo Anderson)
3. Pediatric patients
4. Pregnant females
5. Old neglected fractures
6. Fracture Non-unions

## 6. Method of Treatment

The patients were first seen in the casualty. The history was taken followed by general and local examination of the patient. Concerned specialists undertook appropriate management of the associated injuries. Intensive care was given to those patients who presented with shock and immediate resuscitative measures were taken. Once the patient's general condition was fit, relevant X-rays were taken. Investigation such as CT scan was done for tibial plateau fractures whenever necessary.

The treatment method was based on the type of fracture, the amount of displacement, the amount of depression and surrounding local skin & soft tissue condition. Based on fracture pattern surgical or conservative treatment was done for all type of fracture. The patients were taken for surgery at the earliest possible time depending on their medical condition, skin condition and the amount of swelling. All surgeries were done under C-arm image intensifier control. Fractures were fixed either with percutaneous technique or by open reduction and internal fixation. The fixation devices consisted of T-Buttress plate, Hockey plate, 6.5 mm cannulated cancellous screws and external fixator as required. Bone grafts were used in depressed and comminuted fractures. The source of bone graft was ipsilateral iliac crest.

Postoperatively patients were immobilized with an above knee posterior slab or a compression bandage for 3 weeks. The sutures were removed on the 12th postoperative day. Antibiotics were given till suture removal by 5 days of intravenous and 7 days of oral. The patients were advised static quadriceps exercises for initial 3 weeks followed by passive range of motion with protected knee brace and non-weight bearing crutch walking up to 6 weeks after 11 weeks knee mobilization and weight bearing crutch walking. An immediate postoperative X-ray was also done later on repeated at 6 weeks, 3 months and 6 months.

## 7. Follow Up

Follow up was conducted regularly at the interval of 4-6 weeks. The patients were followed up in the outpatient department. At the time of follow up a thorough clinical evaluation was done for progress of union, healing of trauma wound and acquired amount of joint stiffness. Once the fracture had shown union partial weight bearing was started on the injured limb. On follow up the patient was evaluated clinically and radiologically according to the predefined Performa.

## 8. Results

This study was carried out at Tertiary Care Hospital from May 2014 to April 2016, inclusive of both. During this period, 70 patients with proximal tibia fractures were identified of which 65 patients were enrolled in the study based on the inclusion and exclusion criteria. With 9 patients being lost to follow-up during the course of study before completing at least 6 months of follow-up, we had 56 patients remaining to study.

The youngest patient in our study was 19 years old and oldest was 72 years of age with 50% of the patients belonged to age group of 31-50 years showing that majority of the patients were in the age group of active earning people. In this study 75.0% (42 patients) were males and 25.0% (14 patients) were females with significant male preponderance. In this study 26 (46.4%) patients sustained injury on the right side and 30 (53.6%) on the left side. The commonest mode of injury was vehicular accident (65.2%) out of which motorcycle accidents were 35.7%. The other common mode of injury is fall from height (18 patients, 32.1%). We had associated injuries of 1 calcaneus fractures, 1 distal radius fractures, 2 forearm fractures, 2 clavicle fractures and 3 rib fractures.

Majority (52) of the patients had closed injury (92.9%) while 4 patients (7.1%) had Open grade-I (Gustillo Anderson) fracture. All fractures were classified according to AO classification system. In this study ~45% of the patients had AO-A type (Extra-articular) fractures, ~10% of the patients had AO-B type (Partially-articular) fractures while ~45% of the patients had AO-C type (Intra-articular) fractures.

We treated 8 patients with CC screws, 16 patients with T-Buttress plate, 22 patients with hockey plate, 6 patients with Plate + External Fixator and 4 patients with dual buttress plates. Out of plating group, 10 patients were treated with MIPPO plating while others were treated by ORIF. Anatomical reduction was achieved in 53.6% of the patients, reduction was acceptable in 39.3% of the patients and reduction was not acceptable in 7.1% of the patients (comminuted fractures).

16 patients were followed up for a period of 6 months, 22 patients were followed up for a period of 7-12 months, 16 patients were followed up for a period of 13-24 months and 2 patients were followed up for more than 24 months (28 months). Our average follow up period was 11.43 months; minimum being 6 months and maximum being 28 months.

On follow up 30 (53.6%) patients did not have pain, 18 (32.1%) had complain of occasional pain and 8 (14.3%) had complain of pain on routine activity. On follow up, 42.9% of patients could walk for >60 minutes, 53.6% of patients could walk up to 60 minutes and 2 patients could walk up to 40 minutes. Normal (>$120^0$) knee range of motion was seen in 78.6% of patients while of extensor lag (less than $10^0$) was seen in 21.4% of patients. On follow up, 84.3% of patients had no instability while 15.7% patients had abnormal instability in 20 degrees flexion. In 53.6% of the patients union achieved between 10-14 weeks, in 42.9% of the patients union achieved between 15-18 weeks and 2 patients (3.2%) had union at 20 weeks.

Amongst fractures involving tibial plateau, on follow up X ray no articular depression was seen in 39.3% of patients, <5 mm of articular depression was seen in 57.1% of patients and 6-10 mm in 3.6% of patients. On final follow up, 95.7% of patients did not have condylar widening while 4.3% patients had < 5 mm of condylar widening. On final follow up x-ray, 80.36% of the patients had no varus or valgus deformity, 16.04% of the patients had less than $10^0$ of deformity and 3.6% of the patients had $10^0$-$20^0$ of varus or valgus deformity. Amongst intra-articular fractures, 69.3% of patients had no progression to osteo-arthritis while 30.7% of patients had progression by one grade.

Superficial skin necrosis was seen in one patient. Superficial skin infection was seen in three patients, which was managed with debridement and antibiotics. Varus mal-union was seen in five patients (although without functional deficit) while valgus malunion was seen in six patients.

Excellent results were seen clinically in 51.7% of patients, Good results were seen in 32.1% of patients while 10.7% of patients had fair results. Radiologically, 61.5% had excellent results, 34.6% had good result and 3.8% had fair result. We did not encounter any patient with poor result.

## 9. Discussion

The management of proximal tibia fracture has always been a subject of debate because of their variety and complexity. When reviewing previous studies, it is apparent that results are reported collectively without regard to the severity of the fracture type. A comparison of contemporary retrospective studies is difficult. However it is possible to separate out these injuries that are described as “severe or complex”. The results of the non-operative management of these injuries have historically been unsatisfactory [1-3]

These fractures are the result of a combination of forces, axial loading and valgus stress. The forces have been measured are approximately 1,600 to 8,000 pound/inch [2] resulting in multiple fracture lines or “explosive” fracture patterns. If we take age into consideration, in our study the youngest patient was 19 years and oldest was 72 years of age with 50% in the age group of 31-50 yrs showing that majority of the patients fall in the age group of active earning people with average age being 42.3 years. To add to it being the most active group they are usually under time constraint making their driving to be rasher increasing the chances of road traffic accidents and subsequent proximal tibial fractures. Similar results have also been found by Porter [4] in 1970 reported an average age of 47 years in his study of 68 cases. Bowes and Hohl [5] in 1982 and Duvelius and Conolly [6] in 1988 reported average age group of 48 years.

This study had male preponderance. The reason could be males being the earning member of the family causing the need to travel more, thereby increasing the chances of accidents. Females usually are at home and travel only for social purposes thereby decreasing the incidence of accidents among them. All the studies by Bowes and Hohl [5], Marwah *et al* [7] and Duvelius and Conolly [8] showed a male preponderance. In our study, 26 patients sustained injury to the right and 30 patients to the left. The difference between them being negligible there is no specificity to a particular side towards injury. Rasmussen D.S. [9] reported the fractures were equally distributed in the right and left knee that was 131 on right and 129 on left.

Road traffic accident was the commonest mode of injury (65.2%) followed by fall from height (32.1%). The highest amongst the road traffic accidents were involving two wheelers which was 20 out of 36 road traffic accidents reported, this could be because 2 wheeler is maximally used for travelling, being most economical and convenient for the middle class patients, to add to it 2 wheelers are unstable as compared to four wheeler thereby increasing the chances of accidents amongst them. While riding two wheelers the rider keeps knees and hip in 90 degrees flexion thereby increasing the chances of direct impact on proximal part of tibia during collision, thereby increasing chances of fractures. Fall from height has contributed towards 32.1% of total injuries where in direct impact of the lower end of femur over tibial plateau results in fracture of upper tibia. Chaix *et al* [10] in1982 reported 71.6% of their cases were due to road traffic accidents 16% due to fall from height, and 1% due to sports injuries. Blokker *et al* [11] in 1984 reported the most common mechanism of injury were motor vehicle accidents 43.7%. Rasmussen [9] reported most common cause was by road traffic accidents that is 45% of the cases. Lansinger [12] reported 31% of the patients injured due to direct trauma, 33% due to fall from height and 45% were injured in road traffic accidents.

Associated injuries were found in the study but, it had not more to do with the mechanism of trauma hence neither any correlation of upper end tibia fractures with other injuries, nor is it reported anywhere in available literature. Majority of the patients came with closed injury. Closed being 92.9% and Open being 7.1%. Patients with open injury had Gustillo Anderson Type 1 fractures. However certain fractures were such, though being closed the skin condition above was complicated by abrasions or blisters, thereby delayed surgery.

None of the patients were operated within 24 hr as none of the patients had compartment syndrome or vascular injury requiring immediate surgery. Based on our study, surgical methods gave excellent to good results. Similar reports have been published by Chaix *et al* [10] reported 86% good to excellent results by surgical means of treatment. Tscherne [13] reported 190 (77%) of the 244 cases of proximal tibia fractures treated by surgical methods showed good results. Keogh [14]

treated displaced tibial plateau fractures treated with percutaneous screw fixation showed 11 had satisfactory results, one had fair and one had poor results out of 13 patients. Stokel [15] reported 65% had good to excellent results after being treated by surgical means. With operative treatment, Roberts [16] in 1968 got 76% good to excellent results but they were mainly split compression fractures. Burri *et al* [17] reported 89% acceptable results of fractures treated by experienced surgeons with accurate reconstruction of articular surface, rigid external fixation and early mobilization.

Anatomical reduction was achieved in 53.6% of the patients; reduction was acceptable in 39.3% of the patients. Acceptable reduction was considered when Inspite of all efforts (due to comminution), perfect anatomical reduction could not be achieved and hence a step of less than 2 mm was accepted. We achieved reduction in all patients by indirect open reduction without bone grafting, arthrotomy or arthroscpopic assisted reduction. We did not use any of these methods and our results are comparable to those results where they have used those methods, we had 53.8% excellent results, 34.6% good results and 11.5% fair results. In a study done by Yi-Sheng Chan *et al* [18], where they used arthroscopic reduction for 18 patients and 4 (22%) patients were rated as excellent, 12 (67%) good, and 2 (11%) fair. Hence it is not always necessary that we use arthroscopic assisted reduction to achieve excellent results.

In certain studies, Authors advocate the use of bone graft to maintain reduction of Schatzker type II and III fractures (to elevate the depressed fragment). We had achieved excellent to good results both clinically and radiologically except in one patient in whom fair results was achieved (where T-Buttress plate was used). This is comparable to a study done by Ivar Palmar *et al*. [19] where he studied compression fractures of the lateral tibial condyle where he used bone graft for attaining and maintaining reduction and he stated that 8 of the 14 patients operated upon were followed for more than a year and show undisturbed reposition and a stable joint with normal or almost normal mobility. Hence by using appropriate implant with adequate fixation and reduction technique we can achieve excellent results.

All fractures in this study treated surgically were treated with various modalities, where Hockey and T- buttress plate was maximally used. On reviewing numerous series where Authors have studied various methods of treatment of different fracture types, but it is not mentioned anywhere, where they advocate one particular type of implant or method for a particular fracture type. In our study implant selection was based on the type of fracture, the skin condition and the financial considerations of the patient and according to the surgeon's preference. On reviewing our study where we have used percutaneous CC screw s for Schatzker type I, II, III, IV fractures and in eight patients we had achieved good to excellent results in all with no loss of reduction.

Anatomical plate should be preferred over T-buttress plate for all fracture types where there is comminution. Plate with external fixator is a good implant in selected hands as chances of pin track infections are high thereby delaying union and causing other complications like delayed union. Barakat El Alfi *et al* [20] has reported indirect reduction and hybrid external fixation is a good method for the management of complex high-energy tibial plateau fractures it minimizes the risk of soft tissue damage and reduces the incidence of serious complications. In an article that has been published by Shrestha BK *et al* [21] in the Kathmandu University Medical Journal where they had reviewed 81 patients in whom Schatzker Type 1,2,3 were treated with CC screws whereas type 5 and 6 were treated with dual buttress plate or external fixator. In a study of 33 patients by Hisam Muhamad Ariffin *et al*. [22], he used Modified hybrid fixator for high-energy Schatzker V and VI tibial plateau fractures and he achieved (48%) excellent Rasmussen knee functional scores.

Most of the patients were operated by indirect open reduction, followed by percutaneous MIPPO plating. Being intra articular fractures of major weight bearing joint articular restoration is an essential feature of management and hence to achieve this open reduction was done in majority of the cases of intra-articular fractures. According to Rasmussen's clinical score, 53.8% of patients had excellent results, 34.6% had good results and 11.5% had fair results. Similar results were reported by Roerdink *et al* [23] [excellent (62.3%) and good (24.2%)].

Most of the patients had union between 10-18 weeks while 1 patient had union at 19 -22 weeks. On an average of all the fractures for union was 14.61 weeks. The average time taken for union following fracture is independent of the type of injury but is more relevant with complications like pin track infections, etc. In a similar study done by A Biyani *et al* [24] where they studied 32 patients with proximal tibial fractures they found the average time to fracture union was 12 weeks (range 10 to 20 weeks).

Plating has higher chances of skin infection and superficial necrosis which could be due to extensive dissection needed in plating and then type of fracture wherein plating is used being high velocity injury. CC screw on the other hand had lesser soft tissue complications but being inadequate support can result into varus or valgus deformity, similarly even T-Buttress plates could not withstand against higher muscular forces of the leg and hence resulted into malunion in spite of adequate anatomical reduction immediate post-operatively, thereby proving it to be a weaker implant compared to anatomical (Hockey) plate.

## 10. Conclusion

The correct method of management of proximal tibia fractures depends on good clinical judgment. If rational treatment is to be instituted the surgeon must have sound knowledge of the personality of the injury and a clear understanding of the knee examination, imaging studies and must be familiar with variety of techniques available at present for treating these fractures.

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