

TWO STAGE RECONSTRUCTION PROTOCOL IN MANAGEMENT OF HIGH-ENERGY PROXIMAL TIBIA FRACTURES (SCHATZKER, TYPE IV-VI)

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ABSTRACT: BACKGROUND: Proximal tibial fractures with high energy trauma are extremely complex injuries with significant associated soft-tissue damage. This Retrospective study was used to evaluate advantage of two stage reconstructions as a protocol in management of high-energy proximal tibia fractures regards of soft-tissue management, development of complications, and functional outcomes. **MATERIALS AND METHODS:** This retrospective study includes 40 patients who had sustained high energy Proximal tibial fractures were managed at our institute. In all patients, we placed immediate temporary distraction external fixation with management of soft-tissue injuries with delayed definitive fixation. The mean clinical and radiographic follow-up was 1year (range 12-18 months), and functional outcome was assessed by knee society score. **RESULTS:** The mean follow-up is minimum 1 year (range 12-18 months) with KSS was good in 26 cases (65%), fair in 10 cases (25.0%) and poor in 4(10.0%) at latest follow-up. The complications includes 6 patients (15%) suffered superficial infection, deep infection was observed in 4 patients (10%), 2 patients had developed compartment syndrome. 2 patients had deep venous thrombosis. Malalignment included 4 (10%) cases of residual varus and 3 (7.5%) cases of residual valgus deformity. **CONCLUSION:** The use of this protocol, with the initial application of a temporary distraction external fixator followed by delayed internal fixation, is suggested for treatment of high energy tibial plateau fractures. The benefit of this protocol includes access to soft tissues, and prevention of further articular damage and relatively low rates of complications in patients who sustain high-energy proximal tibia fractures. In addition, this protocol allows use of MIPO technique which is based on combination of the principles of stability, restoration of anatomy and early motion, while eliminating the need for excessive soft tissue dissection.

KEYWORDS: Proximal tibial fractures, two stage reconstruction, Knee society score

INTRODUCTION: Intra articular Fractures of the proximal tibia encompass a wide range of severity, from stable undisplaced fractures with minimal soft tissue injury to highly comminuted unstable fractures, and severe soft tissue involvement.^{1,2,3} Careful and thorough assessment of injury is critical in achieving optimal outcomes and avoiding complications.⁴ Various treatment modalities have been used over the years, with mixed results. These includes circular frames⁵, percutaneous screw fixation, open reduction/internal fixation (ORIF)^{2,4} have also been advocated.

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Staged management of tibial plateau fractures refers to the use of temporizing methods of care in the form of spanning external fixator and delaying definitive fracture surgery till the skin and soft tissue status is satisfactory and initial soft tissue inflammation and edema subsides. Staged management also refers to employing fracture stabilization techniques that are more “friendly” to injured soft tissues.⁵

This Retrospective study evaluated the use of a two stage management protocol involving temporary distraction external fixation and delayed definitive fixation in the management of high-energy intraarticular proximal tibia fractures in terms of soft-tissue management, development of complications, and functional outcomes.

MATERIALS AND METHODS: The present retrospective study conducted between August 2008 and September 2011, 52 patients who had sustained high-energy intraarticular proximal tibial fractures (high-energy fractures, Schatzker , type IV-VI; OTA types 41A, B, C) were treated at P.D.U. Medical College, Rajkot. According to protocol made, we used to place immediate temporary distraction external fixator and take care of soft tissue for all high-energy intraarticular proximal tibia fractures. 12 patients were lost to follow-up were excluded from the final analysis. Thus, 40 patients (27 males, 13 females, mean age 52 [range 18–94 years]) form the basis of this report.

All these patients were subjected to detailed history to ascertain age, sex, mechanism of injury, related injuries and pre-existing local and systemic diseases that may affect recovery. Laboratory investigations were done as per requirement.

Initial Evaluation

The high-energy trauma patient is usually hypotensive, coagulopathic, and may have multi-system injuries. They were initially managed using accepted ATLS protocols for trauma victims. Intravenous antibiotics are administered and tetanus prophylaxis is given.

RADIOGRAPHY: Every patient with tibial plateau fractures was subjected anteroposterior (AP) and lateral plain radiographs of the knee. In situations where the fracture line propagates to the tibial shaft, full-length AP and lateral radiographs of the tibia should also be obtained. Because of the prevalence, ease, and superior-quality images obtained from computed tomography (CT), this modality has replaced additional plain radiographs during the initial work up.

CLASSIFICATION: Tibial plateau fractures are commonly classified using the Schatzker classification, which subdivides these injuries into six types; study includes high-energy fractures, Schatzker⁶, type IV-VI. The OTA/AO classification can be used to classify these injuries, both intra- and extra-articular ones. The Gustillo-Anderson⁷ classification was used for open injuries.

The use of this protocol is unnecessary in low-energy tibial plateau injuries such as Schatzker type I-III fractures, which are amenable to early definitive fixation or stabilization using an external splint.

TECHNIQUE: The patient after initial resuscitation may be taken to the operating room for further care. Open injuries need to be treated with appropriate debridement. Compartments syndromes are identified with clinical examination and pressure monitoring, and a four-compartment fasciotomy performed if needed. An attempt is made to apply the external fixator

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within 6 hours of the injury for open fractures and within 24 hours for closed injuries with no compartment syndrome.

Using standard precautions, the patient is preferably positioned supine on a radiolucent table. This allows approach to the head, chest, abdomen, or the pelvis. Further radiographs or fluoroscopy may be obtained as needed.

The position of the half pins in the tibia should be considered carefully so as to avoid all future definitive fixation hardware. Haphazard pin placement may result in compromising future incisions and also increase the risk of pin tract infections. The pins are generally placed percutaneously using soft tissue protectors. The bone should be pre-drilled and the pins not placed too close to each other for fear of creating a stress riser after pin removal. One should try and avoid injured soft tissue including areas of blistering, avulsion, or open wounds. The two femoral pins are inserted anteriorly, or anterolaterally, approximately 10 centimeters proximal to the superior pole of the patella. The two tibial pins are inserted on the anteromedial border. The pins are connected using bars and clamps at the level of the knee joint after traction is applied to regain length and alignment. The reduction relies on ligamentotaxis and care must be taken to avoid over-distraction. The knee is kept in 20° of flexion for comfort. The frame is either anterior or anterolateral depending on soft tissue status and the need for further debridements or other wound care and surgeon preference. A posterior splint may be added for comfort.

POSTOPERATIVE CARE AND FURTHER PLAN: Once the fixator has been applied additional enhanced imaging can be obtained in order to identify the fracture lines in both coronal and sagittal planes and delineate the size of various fracture fragments. It also prepares the surgeon for the degree of comminution and any joint depression that exists but may be unclear on plain radiographs. Chan⁸ showed the importance of a CT scan as it changed the classification and operative plans in a significant number of patients with tibial plateau fractures.

The pins and the clamps are usually cleaned and used in the final procedure as a reduction tool allowing traction for distraction and joint visualization. The fixator can be used as supplemental fixation, if minimal internal fixation is used for the articular fracture fixation, or converted to a non-joint spanning frame for fracture stabilization. Postoperatively, it may be retained as a splint for comfort and wound care. By the time of definitive fixation, all open wounds and/or fracture blisters will be clean, closed, or covered.

TIMING OF DEFINITIVE SURGERY: While definitive fixation can frequently be carried out within a week of injury, it is not uncommon to wait as long as 3 weeks, when the soft tissues are deemed “settled” – classical signs being healing and re-epithelialization of blisters and absence of pitting edema and the “wrinkle sign.” As long as limb length and general limb alignment have been maintained in the external fixator, waiting 3 weeks to perform definitive surgery is acceptable.⁹

GOALS OF DEFINITIVE TREATMENT: It has long been taught that anatomic reduction of the articular surface was the most important factor affecting outcome following tibial plateau fractures. Careful review of the literature, however, seems to indicate that the health of the articular cartilage, mediolateral stability of the knee, presence of the menisci, and overall alignment of the tibia are of equal or greater importance.^{10,11,12} On the basis of these principles, the choice of definitive fixation may include plates may be dual plating¹³, LISS (Less invasive

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stabilizing system)¹⁴ or single lateral plating with or without non-bridging external fixation with minimal invasive lateral plating.¹⁵

As such, perioperative antibiotic usage for delayed fracture surgery should be the same as for clean, elective orthopedic procedures. A first-generation cephalosporin begun within an hour prior to surgical incision and continuing for 24 hours is the regimen routinely employed. Sutures are removed after approximately 2 weeks.

FOLLOW-UP ASSESSMENT: Union was defined as evidence of bone healing by direct or indirect means in at least two radiographic planes and a full painless weight bearing joint. Functional assessment was performed using the Orthopedic assessment done at latest follow-up included a clinical and radiographic examination and functional outcome measurement with the Knee Society score (KSS).¹⁶

RESULTS: There were 10 type IV, 22 type V and 8 type VI fractures. 93% of the fractures was closed type and 7% were open. 6 patients were treated with closed reduction and percutaneous cannulated screw fixation, 2 patients with medial MIPO plating, 10 patients with single lateral plating (MIPO), 8 with lateral plating (MIPO) with medial fixators, 4 patients with dual plating (MIPO), 8 patients with open reduction and internal fixation and 2 patients with Illizarov's circular frame. The average time to union was 13 weeks (range 8–36). Out of all the included cases, excellent joint reduction and alignment were achieved initially in 34 cases (85%), but was reduced to 30 (75%) at final follow-up. Malalignment included 4 (10%) cases of residual varus and 3 (7.5%) cases of residual valgus deformity (up to 10 degrees). Five patients developed leg-length discrepancy (two with 2.0 cm, two with 1.5 cm and one with 1.0 cm).

Type of fractures	Modality of fixation	No. of patients
Type IV (n=10)	CR + Percutaneous Cannulated Screw Fixation	6
	CR+ MIPO	2
	OR+ IF	2
Type V (n=22)	CR+MIPO(single lateral plating)	10
	CR+MIPO(lateral plating with medial fixator)	8
	OR+IF (Dual plating)	4
Type VI (n=8)	CR+MIPO (Dual plating)	4
	OR+IF (Dual plating)	2
	Illizarov's circular frame	2

The complications includes 6 patients (15%) suffered superficial infection; All were successfully treated with local wound care and antibiotics. Deep infection was observed in 4 patients (10%). One of them had been treated with external fixation and developed deep sepsis within two weeks of the operation and was managed with surgical debridement. Two patients were diagnosed with deep sepsis at six months following surgery and required metalwork removal. One patient developed deep infection one year after surgery and required sinus excision and metalwork removal.

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Two patients had developed compartment syndrome. This was treated by fasciotomies and subsequent split skin grafting. Two patients had deep venous thrombosis (DVT) required anticoagulation therapy. Postoperatively, one patient developed a foot drop but fully recovered 12 months later without permanent damage.

The Knee society score (KSS) was good in 26 cases (65%), fair in 10 cases (25.0%) and poor in 4 cases (10.0%) at latest follow-up. One case with poor results was seen in patient who developed deep infections. The other 3 had multiple injuries that significantly affected outcome.

Type of fractures	Results (Knee Society Score)	No. of patients
Type IV (n=10)	Good	8
	Poor	2
	Fair	0
Type V (n=22)	Good	14
	Poor	6
	Fair	2
Type VI (n=8)	Good	4
	Poor	2
	Fair	2

DISCUSSION: The management of high energy proximal tibia fractures is a challenging task for the surgeon, as they are often associated with a number of complications.^{2,4,6,17} Problems of classification have previously been addressed in the literature⁶; however, evaluation criteria and optimal management remain controversial.

The most devastating complication associated with the management of high energy proximal tibia fractures is infection. Its incidence can be decreased by careful surgical timing and soft tissue handling. Indirect reduction techniques and minimally invasive surgery also decrease the likelihood of further devascularisation. In our series the incidence of superficial and deep infection was 15.2% and 9.6%, respectively. Four patients (3.9%) with bicondylar fractures, developed septic arthritis and were treated by metalwork removal and wash out. Infection rates range between 0 and 87.5% in the literature.^{12,13,19}

There was 10% incidence of residual varus deformity. Gaudinez et al¹⁸ reported 19% of varus deformity in his series of 18 complex (types V and VI) fractures. We had 4 patients with 10 degrees or less of varus, which did not require any further intervention; 3 of our patients developed <10° of valgus and did not require further surgery.

Complex tibial plateau fractures are associated with nonunion and malunion, as a result of comminution, unstable fixation, failure to bone graft, infection or combination of these factors. The rate of nonunion in this series was 1.6% which is comparable to other studies¹⁸. We achieved excellent joint reduction in 34 cases at the time of initial surgery but this number was reduced to 30 at the final visit. Loss of reduction was directly proportional to Schatzker type, which was worse in the bicondylar group (Schatzker type V & VI).

Compartment syndrome is often associated with high energy trauma. Two (5%) patients developed this complication. A recent series of 41 bicondylar fractures reported 9.76% incidence of compartment syndrome.^{12,13}

Patients with tibial plateau fractures are at high risk of thromboembolic complications. Despite anticoagulation measures and early mobilisation, 2 (5%) patients developed DVT and one (2.5%) PE; however, all recovered satisfactorily. Other studies have reported rates ranging between 1.7% and 20%.^{12,13}

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Different scoring systems have been used to evaluate functional outcome of tibial plateau fractures. We used the KSS¹⁶ which is graded between 0 and 100. A score of <60 was graded as poor, 60–70 as fair, 70–85 as good and 85–100 as excellent. The outcome was good in 28 cases (70%), fair in 10 (25%) and poor in 2 (5%). Others have reported good/excellent scores in 65–89% of subjects²⁰. Poorer outcomes can be expected following complex fractures; however, Ali reported 80% of satisfactory functional and radiological outcomes using fine wire fixators for these injuries. Thus, Our results are comparable with other published studies.^{12,13,18,19}

The introduction of minimally invasive techniques and limited dissection where appropriate, can provide stable fracture configurations and promote reliable bone healing, while preserving the soft tissue envelope.¹⁴ 30 patients in our study treated with MIPO technique either single medial plating, single lateral plating or dual plating. All of those patients are associated with either good results (20) or fair results (10).

This study illustrates that proximal fractures continue to remain an important cause of morbidity. Treatment goals should include a congruent articular reduction, adequate knee stability, anatomical limb alignment and avoidance of complications. Functional outcome is directly dependent on achieving these targets.

Finally, we are aware that this study has a number of limitations including a follow-up period of less than ten years, use of different methods of fracture fixation, it is not a single surgeon's series and it is of retrospective nature. Despite these limitations, we believe that it provides useful information with regard to the intermediate functional outcome following these injuries. Although pain severity was associated with the degree of OA, this association was not linear. This can be valuable in informing patients about the outcome that can be expected.

CONCLUSION: The use of this protocol, with the initial application of a temporary distraction external fixator followed by delayed internal fixation, is suggested for treatment of high energy tibial plateau fractures. The use of staged protocol for pilon fractures has been successful in reducing the historically high rates of wound complications associated with these high-energy injuries. The benefits of this protocol includes, access to soft tissues, and prevention of further articular damage and relatively low rates of complications in patients who sustain high-energy proximal tibia fractures as well as, access this technique affords in open fractures and those with compartment syndrome. This study supports the practice of delayed internal fixation until the soft-tissue envelope allows for definitive fixation; as well this protocol allows use of MIPO technique which is based on combination of the principles of stability, restoration of anatomy and early motion, while eliminating the need for excessive soft tissue dissection.

REFERENCE:

1. Shepherd L, Abdollahi K, Lee J, Vangsness CT Jr: The prevalence of soft tissue injuries in nonoperative tibial plateau fractures as determined by magnetic resonance imaging. *J Orthop Trauma* 16(9): 628-631, 2002.
2. Lansinger O, Bergman B, Korner L, Andersson GB. Tibial condylar fractures. A twenty-year follow-up. *J Bone Joint Surg Am.* 1986;68:13-19.
3. Pape HC, Giannoudis P, Krettek C: The timing of fracture treatment in polytrauma patients: Relevance of damage control orthopedic surgery. *Am J Surg* 183(6): 622-629, 2002.
4. Young MJ, Barrack RL. Complications of internal fixation of tibial plateau fractures. *Orthop Rev* 1994;23:149-54.

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5. Mikulak SA, Gold SM, Zinar DM. Small wire external fixation of high energy tibial plateau fractures. *Clin Orthop Relat Res* 1998;356:230-8
6. Schatzker J, McBroom R, Bruce D: The tibial plateau fracture: The Toronto experience 1968-1975. *Clin Orthop* (138):94- 104, 1979.
7. Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: Retrospective and prospective analyses. *J Bone Joint Surg Am.* 1976;58:453-8.
8. Chan PS, Klimkiewicz JJ, Luchetti WT, et al: Impact of CT scan on treatment plan and fracture classification of tibial plateau fractures. *J Orthop Trauma* 11(7): 484-489, 1997.
9. Egol KA, Tejwani NC, Capla EL, Wolinsky PL, Koval KJ. Staged management of high-energy proximal tibia fractures (OTA types 41). The results of a prospective, standardized protocol. *J Orthop Trauma.* 2005;19:448-456.
10. Lachiewicz PF, Funcik T. Factors influencing the results of open reduction and internal fixation of tibial plateau fractures. *Clin Orthop Relat Res.* 1990;(259):210-215.
11. Delamarter RB, Hohl M, Hopp E Jr. Ligament injuries associated with tibial plateau fractures. *Clin Orthop Relat Res.* 1990;(250):226-233
12. Barei DP, Nork SE, Mills WJ, Coles CP, Henley MB, Benirschke SK. Functional outcomes of severe bicondylar tibial plateau fractures treated with dual incisions and medial and lateral plates. *J Bone Joint Surg Am.* 2006;88:1713-1721.
13. Barei DP, Nork SE, Mills WJ, Henley MB, Benirschke SK. Complications associated with internal fixation of high-energy bicondylar tibial plateau fractures utilizing a two-incision technique. *J Orthop Trauma.* 2004;18:649-657.
14. Ricci WM, Rudzki JR, Borrelli J, Jr. Treatment of complex proximal tibia fractures with the less invasive skeletal stabilization system. *J Orthop Trauma.* 2004;18:521-527.
15. Gosling T, Schandelmaier P, Muller M, Hankemeier S, Wagner M, Krettek C. Single lateral locked screw plating of bicondylar tibial plateau fractures. *Clin Orthop Relat Res.* 2005;439:207-214.
16. Insall JN, Dorr LD, Scott RD et al (1989) Rationale of the Knee Society clinical rating system. *Clin Orthop Relat Res* 13-14.
17. Papagelopoulos PJ, Partsinevelos AA, Themistocleous GS, et al. Complications after tibia plateau fracture surgery. *Injury.* 2006;37:475-484. doi: 10.1016/j.injury.2005.06.035.
18. Gaudinez RF, Mallik AR, Szporn M (1996) Hybrid external fixation of comminuted tibial plateau fractures. *Clin Orthop Relat Res* 203-210.
19. The Canadian Orthopaedic Trauma Society Open reduction and internal fixation compared with circular fixator application for bicondylar tibial plateau fractures. Results of a multicenter, prospective, randomized clinical trial. *J Bone Joint Surg Am.* 2006;88:2613-2623. doi: 10.2106/JBJS.E.01416.
20. Koval KJ, Sanders R, Borrelli J, et al. Indirect reduction and percutaneous screw fixation of displaced tibial plateau fractures. *J Orthop Trauma.* 1992;6:340-346. doi: 10.1097/00005131-199209000-00012.