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Complications In The Management Of High-Energy Closed Fractures Of Proximal Tibial Plateau. A Retrospective Study

Rahman Rasool Akhtar[1], Waqas Ali[2], Riaz Ahmed[3], Muhammad Nadeem Kashmiri[4], Hira Waris[5], Muhammad Haider[6]

Abstract

Objective: To analyze the management of high-energy Schatzker type V and VI tibial plateau fractures which are associated with infectious and noninfectious complications.

Methods: This study was carried out in the Department of Orthopedic Surgery, Rawalpindi Medical University from July 1, 2018, to June 30, 2021. This is a retrospective study which is done in three years. Patients had to be between the ages of 18 and 60, have no history of arthritis, have a closed fracture of the proximal tibia (Schatzker type V and VI), or have AO type 41-C1, C2 or C3 involvement of the lower limb. Each patient received treatment using techniques such as internal fixation with locking plates and open reduction which are minimally invasive.

Results: This study involved a total of 132 patients.Mean age was 35.15±10.59.115(87%) were men and 17(13%) were women out of 132. A total of 39 out of 132 patients experienced complications (29.54%). Infectious complications (18.93%) were found in (25/132) patients 16 out of 25 patients had superficial infections. Routine dressing changes and antibiotic treatment were carried out in patients who had superficial infections.9 out of 25 patients who had faced a deep-seated infection underwent repeated implant removal, debridements, amputation, and flap covering depending on the reaction of the host. Noninfectious complications had been reported in 14 patients(10.6%). Six patients had hardware-related issues and four of them required a secondary treatment.08 individuals had malalignment, with five of them having it in their immediate postoperative radiographs and three others having it in their late postoperative radiographs.

Conclusion: In closed wounds, substantial soft tissue destruction is linked to the fractures of the proximal tibial plateau, particularly Shatzker type V and VI. By selecting the right patients and minimising soft tissue dissection, the problems related to the management of these fractures can be reduced.

Keywords: Proximal tibial plateau, Malalignment, Infectious complications, Debridement, Schatzker type V and VI.

[1] Assistant Professor, Orthopedic Surgery, Holy Family Hospital, Rawalpindi Medical University, Rawalpindi; [2] Associate Professor Orthopedic Surgery, CMH Kharian Medical College, Kharian; [3] Former Dean Ortho, N/S & Trauma, Professor of Orthopedic Surgery, Rawalpindi Medical University, Rawalpindi; [4] Associate Professor, Orthopaedics, NUST School of Health Sciences, Islamabad; [5] Post Graduate Resident, General Surgery, Surgical Unit-II, Holy Family Hospital, Rawalpindi Medical University, Rawalpindi; [6] Consultant Orthopedic Surgeon, Holy Family Hospital, Rawalpindi Medical University, Rawalpindi.

Correspondence: Dr. Rahman Rasool Akhtar, Assistant Professor Orthopedic Surgery, Holy Family Hospital, Rawalpindi Medical University, Rawalpindi. **Email:** virgo_r24@hotmail.com

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1. Introduction

The tibial plateau is defined as the region on the articular surface of the superior tibial that extends at the tubercle's base of the inferior tibial surface.[1,2,3,4] There were many traditional classification systems like the OTA/AO 2007 system, Hohl and Moore and the most famous were the Schatzker classification system which was used for direct surgical therapy that involved the plain X-rays. This classification had a significant impact. Advanced computed tomography was mostly used for the detailed study of TPF and this advancement made the classification easier and simpler. A concept called the column concept was elaborated by Luo and his colleagues this concept was further divided into 04 quadrants and 02 condyles and this concept was mentioned by Chang et al. in 2014. Khan et al. in 2017 divided the TPF into 07 types subcondylar, lateral, rim, medial, posterior, bicondylar, and anterior. The Duparc classification was divided by Gicquel et al. (2013) into four types which were posteromedial fractures, bicondylar, unicondylar, and spinocondylar.[4]

Tibial plateau fractures are a large but infrequent injury spectrum and makeup about 1.2% of all fractures.[5] External fixation and computed tomography scans are used as a multi-stage control strategy, which is used for bicondylar injuries.[6] However, it has been found that between the ages of 40 and 60, both sexes are more likely to suffer it.[7]

Fractures of the tibial plateau were usually categorized into six kinds by using the classification system of Schatzker (Table 1.)

Patients may experience a significant osseous which is localised, spinal and visceral injuries, soft tissue, and neurovascular injury as these injuries are shown frequently in patients who are involved in extreme sports, car accidents and falls from heights.[8] Up to 90% of cases can have soft tissue damage, and 1%–3% of soft tissue envelope injuries might result in open fractures. The older patient has a certain kind of beast with less energy and an intricate fracture pattern.[9] Tibial plateau fractures are typically initially evaluated in emergency rooms. The mechanism of injury is of the highest importance since it affects the variety of injuries connected to high-energy trauma as well as the vast majority of patients who present after it. In patients who fall from a height face spine or pelvic injuries when fall onto their lower limbs. Injuries to the head, chest, abdomen, and spine are common among patients who have been in auto accidents, in addition to several skeletal injuries.[10] Open fractures and vascular injuries may be orthopaedic concerns, but they should never override the need to manage more serious injuries. Generally, the Advanced Trauma Life Support which is abbreviated as ATLS protocol's principles ought to be quickly adopted. The evaluation of orthopaedic for a local injury consists of an evaluation of compartment syndrome and an assessment of the envelope of soft tissue and neurovascular.[11] To produce the best results and avoid complications in the severity of high-energy injury evaluation should be done carefully.[12] Compartment syndrome consists of 18% of injuries and these injuries are type VI of the Schatzker classification system while 53% of fractures are medial plateau dislocations and these injuries are observed in a study by Stark and Tornetta in 2009.[13] There should be a greater chance that injury to the neurovascular systems behind the knee will also occur at the same time as a relocation of a knee dislocation.[14] As a result, these patients must get a pedal pulse reading, a low threshold for vascular imaging, and verification of the ABPI. The peroneal nerve suffers injuries most frequently accounting for 1% of all nerve injuries. Traditional midline incisions have wound complications which show a high rate of up to 80%,[15] and are used to precisely eliminate these fractures which are complex in pattern.

To reduce the risk of complications, Barei et al.[16] advised employing a knee-spanning external fixator and the fracture is subsequently surgically repaired by performing an open reduction. Phased therapy has considerably reduced the occurrence of issues in these high-energy fractures, but complications are still thought to occur at a rate of about 10%.[17,18,19]

Treatment goals include proper intra-articular reduction, limb axis restoration, and prevention of further soft tissue damage. However, serious effects can be avoided by using excellent skills in the manipulation of soft tissues.[20,21] Fixation like using formal open reduction procedures, non-locking and locking plates and hybrid fixators, are some of the available treatment methods.[22,23] The treatment of fractures of the proximal tibial containing high energy treated with locking plates,[24,25] problems that have been previously reported in the literature is assessed in this study.

2. Materials & Methods

The Department of Orthopedic Surgery, Rawalpindi Medical University conducted this three-year retrospective analysis from July 1, 2018, to June 30, 2021. Procedures like Open reduction and internal fixation were employed with locking plates to treat each patient through the use of minimally invasive techniques.We have compiled all the clinical data of before and after operative trials by reviewing the sheets of data which we have obtained from the record section of the medical institution. All the factors like the reason behind the injury, the cause of delay in surgery time, and operational notes were all included in the datasheet of the hospital. We contacted the patients through phone calls, regular mail, or sometimes both. Every patient was informed about the study and allowed to consent. 132 patients in total participated in this study. The mean patient age was (35.15±10.59) years, with 115 of the 132 patients being male and 17 being female. In 105 cases, motorbike accidents were to blame for the injuries; in 9 cases, falls from height; in 3 cases, assaults; and in 15 cases, pedestrians were struck by cars. Up until the soft tissue swelling subsided and the wrinkle indicator became obvious, the patients underwent phased therapy. Four compartment fasciotomies, external fixation with delayed primary closure, split-thickness grafting and delayed fixation were used as treatments for compartment syndrome. Preoperative antibiotics (one gram of cefuroxime which were injected intravenously) were given to all patients after sensitivity testing by the institution's practice. A typical operating room was used for the surgical operation.

The fracture was accessed from either the anterolateral or posteromedial side depending on how it was set up. Fluoroscopy verified the tentative fracture reduction. Single or dual plating on patients was applied depending on the type of fracture. The operating surgeon was in charge of deciding whether to employ a bone graft which is autologous or substitute. After surgery, patients were allowed to gradually add some weight, and complete bearing of weight was allowed after twelve weeks. The union of bone was described as directly healing by two radiological planes. Radiographs in series were used for the evaluation of fracture union on follow. Prescribed radiography also comprised lateral and anterior views of the knee joint. After the procedure, 06 weeks, 03 months, 01 years, and 02 years later were all used as time points. The radiographs were carefully examined for indications of implant failure, loss of alignment, prolonged intra-articular step-off, and bone consolidation. Deep and superficial infections were distinguished from one another based on the depth of the infection below or above the fascia, removal of hardware, and whether there are any additional therapies for malunion, alignment, and nonunion, that the patients previously had. Patients included in this study were aged from eighteen to sixty, had no history of arthritis, closed fracture of the proximal tibia (Schatzker type V and VI) or had AO type 41-C1, C2, or C3 involvement of the lower limb. History of arthritis, open fracture of proximal tibia, history of ipsilateral lower limb surgery, polytrauma patients or involvement of the contralateral lower leg by AO type 41-C1, C2, or C3, were excluded from the study. A significant response is shown in P-values which is less than 0.05, whereas values greater than 0.05 denote non-significance in the statistical analysis performed with SPSS 8.1. The data, which were presented as means and standard deviation, were examined using Fisher's exact (two-tailed test).

3. Results

Of the 132 individuals who matched our inclusion criteria for the current retrospective cohort analysis 60 patients were facing the fractures of Schatzker type V and 72 patients were facing type VI fractures. Between 24 and 50 months, there was an average of (36.96±11.59) follow-up visits. They included 94 patients who received follow-up for between 24 and 36 months and 38 patients who had follow-up for more than 36 months. Twelve patients were required to undergo fasciotomies for compartment syndrome; four patients were facing the primary wound closure, while eight were in great need of thickness grafting. Six patients were affected with peroneal nerve palsy, and each one of them made a full recovery. Ten people sustained injuries to their upper and lower limbs on the opposing sides. Meniscal and ligamentous injuries appeared after the fracture was treated. The second surgical procedure was not performed on these patients because they refused to have ligament restoration. Anesthesia-induced manipulation was used on 12 patients who were facing serious stiffness in fracture after surgery. A total of 39 out of 132 patients experienced complications (29.54%). Infectious complications (18.93%) were found in (25/132) patients. The table below provides a summary of the complications that arose after treating fractures of the high-energy tibial plateau.

Table 1: Demonstrates Schatzker's categorization for fractures of the tibial plateau.

Type I	**Splitting the lateral plateau**
Type II	Type I as well as the depression in the lateral plateau residue
Type III	Fracture of the depressed lateral plateau
Type IV	Fracture of the medial tibial plateau
Type V	Broken bicondylar plateau
Type VI	Metaphyseal separation in conjunction with a bicondylar fracture

Infection is one of the most dreadful issues that can arise when treating these types of fractures. Infectious issues arose in 25 patients (18.93%). The vast majority of the patients (16/25) had minor infections, which were managed with regular dressing changes and antibiotic therapy. Within a month, the infections in all of these cases were completely under control. Depending on how the host responded, the (09/25) patients had to have their flaps covered, their implants taken out, and their limbs repeatedly debrided, or amputated.

Every instance of dual plating was completed with an average delay of 14.5 days before applying the plates. Once the patients were discharged, their wounds started to degenerate. After a six-week intravenous antibiotic course, they received oral antibiotics at the end of this period for another six weeks. The patients had restricted motion at their knee joints. The infection in 01 patient persisted long after the implant was taken out, leading to an amputation above the knee level. Pseudomonas aeruginosa was found in the cultures of that patient.

Table 2: Complications of various kinds

Complications	Number of cases (n=132)
Total complications	39 (29.54%).
Infectious complications	25 (18.93%)
Superficial infection	16
Deep-seated infection	09
Non-infectious complications	14 (10.6 %).

Non-infectious complications emerged in 14 patients. Six of the incidents included hardware issues. Two patients who were having pain from the lateral locking plate had one proximal row screw removed. The removal of their implants was chosen by two of the patients, the other two patients underwent conservative treatment. Malalignment was discovered in eight patients; this involved five postoperative radiographs and three follow-up radiographs. six patients exhibited varus abnormalities, whereas two patients had a valgus deformity in the coronal plane. Three of them experienced malunion because an accompanying deep-seated infection forced early implant removal. A hypertension deformity was visible in the sagittal plane. The patient had to deal with secondary osteoarthritis as a result of having their entire knee replaced when they were last checked (36 months later). The 3 h vs. 2.3 h was observed in infected complications which was a longer operational time as compared to non-infected cases. Multivariate logistic regression analysis was used for the parameters of operation time, injury severity score, and fasciotomy because univariate analysis revealed that they were statistically significant. This analysis discovered that, whereas fasciotomy did not affect the rate of infection, the time of surgery and the injury severity score did. Individuals with injury severity scores greater than 9 in noninfected tibial fractures indicated a higher prevalence of infection. Variables including age (44.15 years and 42.16 years, $p \geq 0.05$), diabetes mellitus (20% and 8.8%, $p \geq 0.05$), and sex (78.4% males and 68% females, $p \geq 0.05$), were patient-dependent characteristics that did not substantially differ about infection rate.

Table 3: Patients with deep-seated infection

Case no.	Type of fracture	Clinical properties	Treatments
5	$41C_2$	Purulent discharge, Wound dehiscence	Debridement
11	$41C_3$	Wound dehiscence	Debridement
37	$41C_2$	Serous discharge	Flap coverage
45	$41C_2$	Serous discharge	flap coverage
78	$41C_2$	Wound dehiscence	Debridement, flap coverage, external fixator,
106	$41C_3$	Serous discharge, Wound dehiscence	Debridement, flap coverage
115	$41C_2$	Wound dehiscence	Debridement, flap coverage
121	$41C_3$	Purulent discharge, Wound dehiscence	Debridement, implant removal Later on, Above knee amputation
129	$41C_3$	Wound dehiscence	Debridement, implant removal

4. Discussion

Treatment for fractures of the tibial plateau with high energy is challenging. Because high-intensity trauma frequently results in these injuries, major concurrent injuries are likely present. Furthermore, a sizable proportion of patients might have critical issues. Anatomical restoration of the joint surface and stable fixation to promote early mobilisation result in favourable clinical outcomes. Excellent preoperative planning can reduce complications by choosing the best location for fracture access and soft tissue protection.[26] Conservative therapy is only available for non-displaced fractures. The joint surface's axial alignment and healing are the main goals. Stable fixation safeguards reduction and permits early mobilisation to prevent stiffness. Fixation often involves the use of conventional or angle-stable anatomical plates. Minimally invasive techniques can be employed in some cases. Soft tissues can suffer significant damage as a result of the high energy that produces these types of accidents.[27] Tibial plateau fractures make up about 30% of all tibia fractures. Open reduction and internal fixation are some of the most used methods for treating high-energy tibial plateau fractures. Although the invention of a minimally invasive process and locking plates has significantly decreased the possibility of problems, there is still disagreement over the ideal course of action for treating these fractures. With open reduction, the tibial plateau fracture is easily seen and can be treated. Accurate intra-articular reduction aids in the functional outcome.[28] The characteristics of the patient and the specific fracture should determine the appropriate course of treatment because it contains a vast range in complexity of fracture, severity of fracture, and involvement of soft tissues.[29] Benirschke et al. observed the debridement, repair of fracture, fracture cleaning and postponed wound closure.[30] Barei et al. discovered a much-decreased complication rate when treated with 41-C3 fractures with many incisions after the soft tissue swelling had subsided. Khatri et al. observed a retrospective study cohort in 5 out of 62 patients.[31] The prevalence of surface infection 8/62 was greater than that of deep-seated sickness.[32] In this study, 18.93% of cases (25/132) in the current retrospective cohort had infectious complications.

Table 3 reveals the patients who had faced deep-seated infection which was comparable with the deep infection reported by Barei et al. in 9/25 patients. Surface infections were treated with conventional bandages and oral medications despite being more frequent (16 out of 25). Evangelopoulos et al. performed an analysis which is a retrospective study after severe Schatzker classification types IV, V, and VI intra-articular tibial fractures. No fracture underwent nonunion treatment, and no postoperative infections developed. Arthritis was absent in just 6.3% of individuals, according to research. In 45.5%, 27.3%, and 36.3% of cases, mobility, self-care, and routine activities all hurt patients' postoperative quality of life. Anxiety pain or discomfort were indicated in 40.9% of instances. The bulk of the study had fairly favourable findings during their medium-term clinical evaluations.[33] Malalignment was discovered both immediately postoperatively (3.78% cases) and during the follow-up phase (2.27% cases). The literature contains records of 0% to 59% of this problem. The wide variation in reporting may be caused by different evaluation criteria, the dependability of measurement techniques, and the quality of the radiographs used for evaluation. Insufficient intraoperative reduction was revealed to be the cause of postoperative malalignment in some cases.

To avoid malalignment, different techniques like indirect reduction are mostly utilized. The fracture needs to be accurately minimised before plating. A higher rate of malalignment was also seen in people with AO type 41C3.[32] This may be due to the difficulty in decreasing severely comminuted fractures. Alignment was lost in the two cases that were watched. Alignment loss is more obvious in comminuted fractures because the subchondral purchase is frequently prevented in these circumstances by a predetermined angle for screw insertion, still, additional study is required to evaluate their long-term benefits.[34,35,36]

Khatri et al. observed 37 cases of type VI fracture of the tibial plateau according to the classification of Schatzker which is comparable to 64 of the 72 cases of type VI fracture of the tibial plateau of Schatzker in our current study which were treated with a posteromedial buttress plate. At the most recent follow-up, one patient received a total knee replacement while the other patient declined to have any more surgery.

5. Conclusion

There are considerable soft tissue damages linked with the fractures of high-energy Schatzker type V and VI. The most common treatments for these fractures are internal fixation and open reduction. There are numerous problems with addressing these fractures, even when employing progressive techniques. By carefully choosing patients and restricting soft tissue dissection, the quantity and severity of issues can be reduced. High energy fractures (proximal tibial plateau) affect patients' quality of life, even though the majority of patients can resume their previous employment and lead normal lives.

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R.R.A, M.N.K, H.W, M.H - Manuscript Writing
R.A, M.N.K - Critical Review

W.A, R.A, H.W, M.H - Facilitation and Material analysis

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