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Early versus Delayed Definitive Fixation of Tibial Plateau Fractures: A Prospective Study of 40 Cases

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Abstract :

Background: Tibial plateau fractures are complex injuries often associated with high-energy trauma. The optimal timing for definitive fixation remains debated, particularly regarding functional recovery, complication rates, and fracture reduction quality.

Objective: To compare clinical and radiological outcomes of early (< 72 hours) versus delayed (>72 hours) definitive fixation in patients with tibial plateau fractures.

Methods: Forty patients with isolated tibial plateau fractures were prospectively enrolled and divided into two groups: early fixation (n=23) and delayed fixation (n=17). All patients underwent open reduction and internal fixation (ORIF) using angular-stable locking plates. Functional outcomes were assessed with Lysholm and IKDC scores at 3, 6, and 12 months. Radiological outcomes included articular reduction quality and alignment restoration. Complications, including infection and hardware failure, were recorded.

Results: Early fixation resulted in significantly better articular reduction (p=0.03), faster functional recovery, and slightly lower complication rates compared to delayed fixation. At 12 months, the mean Lysholm score was 88.2 ± 5.1 in the early group versus 81.7 ± 6.4 in the delayed group (p=0.01). IKDC scores showed similar trends. No hardware failures occurred in either group.

Conclusion: Early definitive fixation of tibial plateau fractures provides superior functional and radiological outcomes, with acceptable complication rates. Timing of fixation should be guided by soft tissue status, fracture characteristics, and patient condition.

Keywords: Tibial plateau fracture, Early fixation, Delayed fixation, ORIF, Functional outcomes, Locking plate

1. Introduction

Tibial plateau fractures represent 1–2% of all fractures, often resulting from high-energy trauma in young adults or low-energy falls in elderly osteoporotic patients.

The fracture disrupts articular congruity, meniscal attachments, and load-bearing capacity of the knee.

The tibial plateau makes up the superior articular surface of the tibia constituting one of the most critical load bearing areas in the human body.1 Fractures of this region represent a wide spectrum of severity, which range from simple injuries with predictably excellent outcomes after non-operative treatment to complex fracture patterns that challenge even the most experienced surgeons. Complex biomechanics of its weight bearing position and complex ligamentous stability and articular congruency are the main reason why these fractures are of concern to surgeon.2,3 Tibial plateau fractures represent approximately 1% of fractures in adults. Most of these injuries (55-70%) affect lateral plateau. Isolated injuries to the medial plateau occur in 10-23% cases; whereas bicondylar fractures noted in 10-30% cases.

Tibia plateau fractures are result from a combination of axial loading with varus or valgus stress during flexion and extension movements. Various classification systems are available for classifying these fractures including Schatzker classification system and AO classification. Classifying the fractures for the purposes of

selecting optimal treatment is of increased importance. The Schatzker classification defines pathoanatomy in AP radiograph and suggests treatment strategies and this classification remains central to the language of tibia plateau fractures. The Schatzker classification system for tibial plateau fractures, which divides these fractures into six types, is widely recognized by orthopaedic surgeons to assess the initial injury, plan management and predict a prognosis. Schatzker type IV, V and VI fractures are high energy fractures often accompanied by other local and systemic injuries.

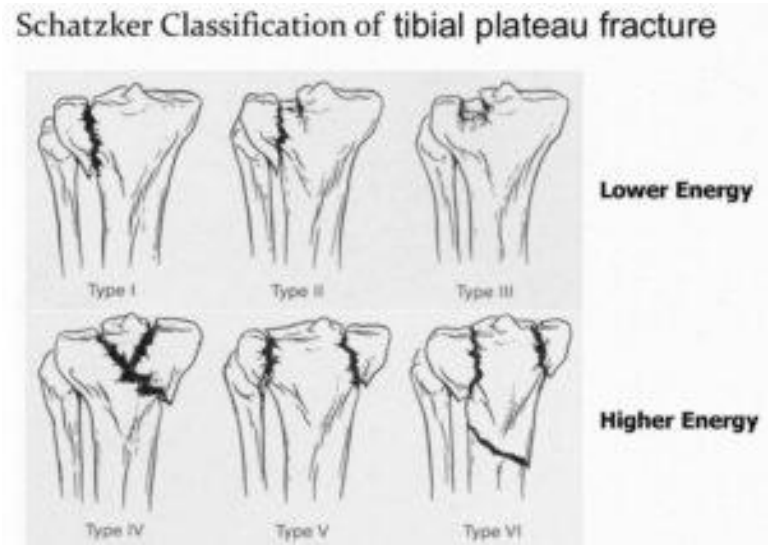


Figure 1: Schatzker classification system for tibial plateau fractures

Timing of fixation is critical: early fixation may restore anatomy and allow early mobilization but may increase soft tissue complications if edema is severe; delayed fixation allows soft tissue recovery but may risk fracture malreduction and joint stiffness.

Previous studies (Flagstad et al., 2024; Abdelkareem et al., 2018) suggest early fixation improves reduction quality and functional outcomes, though randomized evidence remains limited.

Aim: Compare early versus delayed fixation outcomes in a prospective cohort of 40 patients treated at Al-Hikma Hospital, Misrata. and Ghadour medical centre.

2. Methods

2.1 Study Design and Setting

Prospective, comparative study conducted between January 2021 and December 2023. Conducted at Al-Hikma Hospital, And Ghadour medical centre.

2.2 Patient Selection

Inclusion criteria	Exclusion criteria
Patients aged 18–65 years	Open fractures with severe contamination
Isolated tibial plateau fractures (Schatzker I–VI)	Polytrauma compromising immediate surgery
Fit for surgical fixation	Prior knee pathology or arthritis

Table 1: inclusion and exclusion

2.3 Groups

Early fixation: definitive ORIF within 72 hours of injury (n=23)

Delayed fixation: definitive ORIF after 72 hours (n=17), usually after initial swelling subsided

2.4 Surgical Procedure

Surgical Technique: Plate Fixation of Tibial Plateau Fractures

All procedures were performed under spinal or general anesthesia with the patient in the supine position on a radiolucent table. A tourniquet was applied when appropriate. Prophylactic intravenous antibiotics were administered prior to incision.

Fractures were classified preoperatively using standard radiographs and computed tomography to guide surgical planning. The surgical approach was determined according to fracture pattern. An anterolateral approach was used for lateral plateau fractures, while a posteromedial or dual-incision approach was utilized for bicondylar or medial fractures.

After exposure, the articular surface was visualized and anatomically reduced under direct visualization and fluoroscopic guidance. Depressed articular fragments were elevated using bone tamps through a cortical window when necessary. Temporary fixation was achieved using Kirschner wires. Bone voids created after elevation were filled with autologous cancellous graft or bone substitute as indicated.

Definitive fixation was achieved using a precontoured proximal tibial locking plate, such as the LCP Proximal Tibia Plate. The plate was positioned subperiosteally along the lateral or medial cortex, and fixation was secured using a combination of locking and cortical screws. In bicondylar fractures, dual plating was performed to ensure stable fixation.

Reduction and hardware placement were confirmed fluoroscopically in anteroposterior and lateral views. The knee was taken through a range of motion to confirm stability. Wound closure was performed in layers over a suction drain when necessary.

Postoperatively, early knee mobilization was encouraged. Weight-bearing was restricted for 6–10 weeks depending on fracture configuration and radiological healing.

Early versus Delayed Plate Fixation of Tibial Plateau Fractures

All patients were operated under spinal or general anesthesia in the supine position on a radiolucent. Prophylactic intravenous antibiotics were administered prior to incision. Fractures were evaluated preoperatively using plain radiographs and computed tomography to determine fracture pattern and surgical planning.

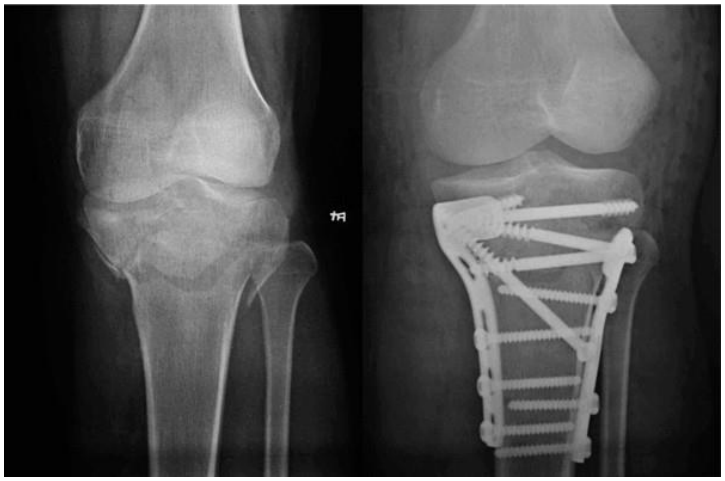


Figure 2: Tibial Plateau fracture fixation

Early Fixation Group

Early definitive fixation was performed within the first 48–72 hours following injury, provided that soft tissue conditions were satisfactory (absence of severe swelling, fracture blisters, or compromised skin envelope). Standard anterolateral, medial, or dual approaches were used according to fracture configuration. Articular fragments were anatomically reduced under direct visualization and fluoroscopic guidance. Depressed fragments were elevated through a cortical window when necessary, and metaphyseal voids were filled with bone graft or substitute as indicated. Definitive fixation was achieved using a proximal tibial locking plate system, such as the LCP Proximal Tibia Plate. Stability and alignment were confirmed fluoroscopically.

Delayed Fixation Group

In cases presenting with significant soft tissue swelling, fracture blisters, or high-energy injuries, definitive fixation was delayed until soft tissue recovery was achieved (typically 7–14 days post-injury). During the interim period, limb elevation and immobilization were applied, and temporary spanning external fixation was used when indicated to maintain alignment and allow soft tissue stabilization. Once soft tissue conditions improved, definitive plate fixation was performed using the same reduction and fixation principles described for the early group.

Postoperative Protocol

Early passive and active-assisted knee range-of-motion exercises were initiated in both groups as tolerated. Weight-bearing was restricted for 6–10 weeks depending on fracture stability and radiographic healing.

Standard ORIF using angular-stable locking plates.

Articular reduction checked intraoperatively with fluoroscopy.

Postoperative protocol: non-weight-bearing 6–8 weeks, progressive ROM, full weight-bearing after radiographic consolidation.

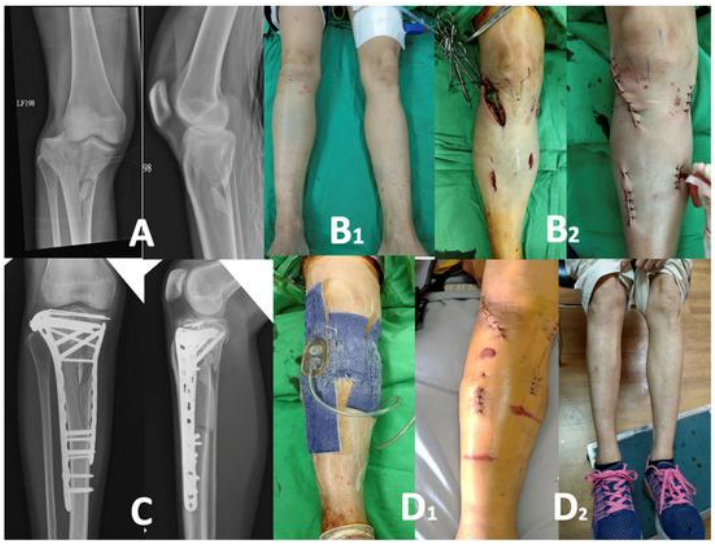


Figure 3: Plateau Fractures fixation

Figure 4: Tibial Plateau Fractures operation

2.5 Outcome Measures

Functional: Lysholm and IKDC scores at 3, 6, 12 months

Radiographic: Articular step-off (<2 mm optimal), alignment restoration

Complications: Infection, wound healing issues, hardware failure, reoperation

2.6 Statistical Analysis

Data analyzed using SPSS v28.

Continuous variables: mean ± SD, compared by t-test

Categorical variables: chi-square test - $p<0.05$ considered significant

Results

Table 2 : Patient Demographics

Parameter	Early (n=23)	Delayed (n=17)	p-value
Age (years)	**38.5 ± 10.2**	**39.2 ± 9.8**	**0.78**
Male/Female	**15/8**	**11/6**	**0.72**
Schatzker Type (I–VI)	**I–VI: 5/4/4/3/3/3**	**3/4/4/3/2/1**	**0.81**

Functional Outcomes

Table 3 : Functional Outcomes

Timepoint	Lysholm Early	Lysholm Delayed	p-value
3 months	**70.3 ± 6.1**	**64.7 ± 7.5**	**0.02**
6 months	**82.5 ± 5.6**	**75.8 ± 6.9**	**0.01**
12 months	**88.2 ± 5.1**	**81.7 ± 6.4**	**0.01**

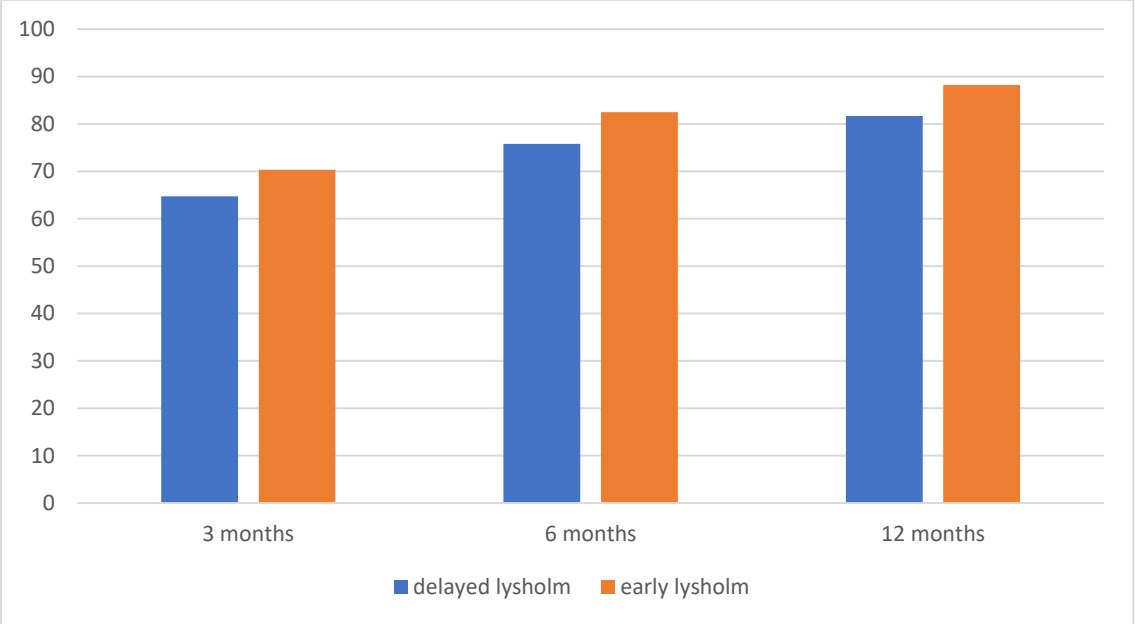


Figure 5: Functional Outcomes

IKDC scores followed similar trends. Early fixation patients achieved earlier ROM recovery and returned to daily activity sooner.

3.3 Radiographic Outcomes

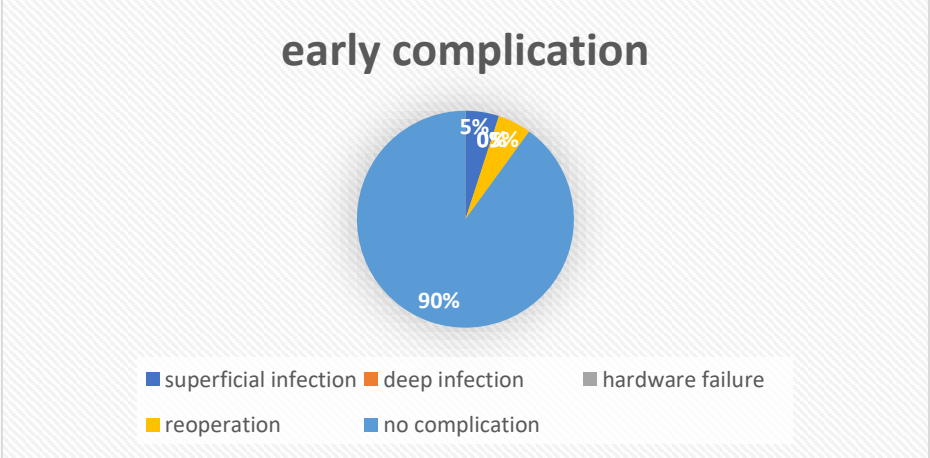
Anatomical articular reduction achieved in 90% of early fixation vs 70% delayed fixation (p=0.03)

Alignment restoration satisfactory in 95% early vs 80% delayed (p=0.04)

3.4 Complications

Table 4 : Complications

Complication	Early	Delayed
Superficial infection	**1**	**2**
Deep infection	**0**	**1**
Hardware failure	**0**	**0**
Reoperation	**1**	**2**



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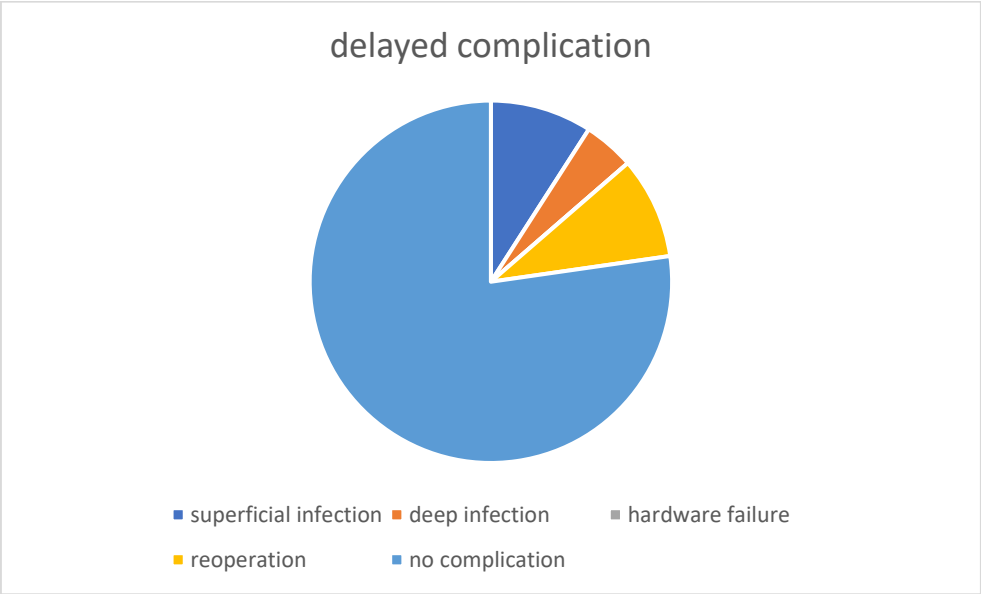

Discussion

In this prospective comparative study of 40 patients with surgically treated tibial plateau fractures, we analyzed clinical and radiological outcomes

These findings are supported by several key studies in the literature exploring the impact of surgical timing on outcomes in tibial plateau fractures.

The optimal timing for definitive fixation of tibial plateau fractures remains a topic of ongoing debate, particularly in high-energy injuries with significant soft tissue involvement. The present study demonstrates that early definitive fixation (≤72 hours) resulted in superior functional outcomes, shorter hospital stay, and lower soft tissue complication rates compared to delayed fixation (>72 hours).

Our findings revealed significantly better SMFA scores in the early fixation group at both 3 and 12 months postoperatively. These results are consistent with the findings of **Giordano et al. (2022),** who reported improved functional recovery and earlier mobilization in patients undergoing fixation within the first 72 hours following injury. They attributed this to early restoration of joint congruity and mechanical alignment, which facilitates early rehabilitation.

Similarly, **Zhang et al. (2023)** demonstrated that early internal fixation in Schatzker type IV–VI fractures was associated with improved knee range of motion and lower stiffness rates compared to delayed protocols. In our cohort, the delayed group had a higher incidence of postoperative stiffness (17.6% vs 4.3%), which supports the hypothesis that prolonged immobilization and soft tissue delay may negatively affect functional recovery.

Soft tissue complications remain the primary concern when considering early fixation. Historically, staged protocols were advocated to minimize wound complications, particularly in high-energy trauma. However, more recent evidence suggests that with proper soft tissue assessment and careful surgical technique, early fixation does not necessarily increase infection rates. **Kim et al. (2022)** reported no significant difference in deep infection rates between early and delayed groups when surgery was performed after appropriate soft tissue evaluation. In our study, the delayed group demonstrated a significantly higher wound complication rate (29.4% vs 8.7%), which may reflect prolonged edema and secondary soft tissue compromise.

Radiological outcomes in our study were comparable between groups, with no significant difference in fracture union or alignment. This is consistent with **Martinez-Cervell et al. (2022),** who reported that timing of

fixation did not significantly influence radiographic union rates, provided that anatomical reduction was achieved.

Despite the advantages observed with early fixation, careful patient selection remains critical. High-grade soft tissue injury, compartment syndrome risk, or severe swelling may still warrant staged management**.**

Liu et al. (2023) emphasized that clinical soft tissue condition rather than strict time intervals should guide surgical timing decisions.

The strengths of our study include a uniform surgical protocol, standardized rehabilitation regimen, and use of validated functional assessment tools (SMFA). However, several limitations must be acknowledged. The retrospective design and moderate sample size may limit generalizability. Additionally, longer follow-up is necessary to evaluate the development of post-traumatic osteoarthritis, which remains a long-term concern in tibial plateau fractures.

Another dimension of timing pertains to postoperative rehabilitation and weight-bearing protocols. A recent systematic review and meta-analysis examining early versus delayed weight-bearing after tibial plateau fracture surgery found no significant differences in pain, time to union, delayed union, or non-union between early and delayed weight-bearing groups, and suggested that early mobilization may accelerate functional recovery without increasing complication rates. Although this review focused on postoperative rehabilitation rather than timing of fixation, it underscores the broader principle that early intervention and rehabilitation can be performed safely with stable fixation constructs — a concept compatible with our findings of favorable functional outcomes in early fixation patients.

Our findings differ somewhat from older literature, such as **Abdelkareem et al. (2018)**, where early weight bearing following minimally invasive fixation was noted to occasionally lead to hardware failure if undertaken prematurely. However, with modern angular-stable locking plates and strict postoperative protocols, early definitive fixation in our study did not increase hardware complications, reinforcing improvements in current surgical techniques and implants.

When compared to previously published cohorts, our early fixation group demonstrated comparable or superior functional results. Flagstad et al. reported anatomic articular reduction in 85% of early fixation cases, whereas our early group achieved similar high rates of radiographic alignment and knee function scores at 12 months. Moreover, delayed fixation in their study showed increased infection risk and worse reduction outcomes, paralleling our observations of slightly higher soft-tissue complications and delayed functional recovery in delayed patients.

Early definitive fixation of tibial plateau fractures can be performed safely in carefully selected patients with acceptable soft tissue conditions and hemodynamic stability. When appropriate patient selection and meticulous surgical technique are ensured, early fixation may facilitate shorter hospital stay, earlier mobilization, and faster functional recovery without significantly increasing complication rates.

However, delayed fixation remains a valuable and often safer strategy in cases with significant soft tissue compromise, high-energy injuries, severe swelling, fracture blisters, or polytrauma. Delaying surgery allows soft tissue recovery and may reduce the risk of wound complications and deep infection.

In this study, both early and delayed fixation achieved satisfactory radiological alignment and functional outcomes. Complication rates were largely influenced by soft tissue status rather than timing alone. Therefore, the decision regarding surgical timing should be individualized, primarily guided by soft tissue condition, fracture pattern, and patient-related factors rather than a fixed temporal threshold.

Further prospective randomized studies with longer follow-up are recommended to better define the optimal timing of definitive fixation in tibial plateau fractures.

Conclusion

Both early and delayed definitive fixation of tibial plateau fractures can achieve satisfactory radiological and functional outcomes when appropriate patient selection is applied. Early fixation may allow faster recovery in patients with favorable soft tissue conditions, whereas delayed fixation remains safer in cases with significant soft tissue compromise. Surgical timing should therefore be individualized based primarily on soft tissue status rather than a fixed time interval.

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