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Comparative Outcomes of Tibial Plateau Fracture Fixation with and without Bone Grafting

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Abstract

Background: *Despite the widespread use of bone grafting in tibial plateau fracture fixation, there remains uncertainty about its routine necessity and impact on healing and function. Therefore, the purpose of this study is to compare the functional and radiological outcomes of tibial plateau fracture fixation performed with versus without bone grafting.*

Aim of the study: *The aim of the study was to compare functional and radiological outcomes of tibial plateau fracture fixation performed with versus without bone grafting.*

Methods: *This observational, comparative study was conducted at Holy Family Red Crescent Medical College Hospital, Dhaka (2023–2024), involving 30 patients with tibial plateau fractures equally divided into grafting and non-grafting groups. All underwent open reduction and internal fixation. Outcomes assessed included healing time, reduction quality, complications, and functional scores, with analysis performed using appropriate statistical tests ($p < 0.05$)..*

Results: *Among 30 patients (15 per group), those with bone grafting had faster union (90.5 ± 11.3 vs. 108.4 ± 14.9 days, $p=0.001$), less reduction loss (1.2 ± 0.8 vs. 3.5 ± 1.6 mm, $p<0.001$), and higher Lysholm scores (85.2 ± 7.9 vs. 77.8 ± 9.6, $p=0.029$) compared to those without grafting. Both groups were similar in age (34.2 vs. 35.0 years) and gender distribution. Complications like knee stiffness (20% vs. 33.3%), malunion (6.7% vs. 13.3%), and varus deformity (0% vs. 13.3%) were more frequent without grafting.*

Conclusion: *Bone grafting in tibial plateau fracture fixation significantly improves healing time, reduces reduction loss, and enhances functional outcomes compared to fixation without grafting.*

Keywords: *Tibial Plateau Fracture, Bone Grafting, Functional Outcomes.*

1. INTRODUCTION

Tibial plateau fractures are among the most frequently encountered intra-articular fractures and have a significant impact on knee joint stability and range of motion. They represent about 1% of all fractures and roughly 8% of fractures among the elderly population. [1]. These fractures usually result from a combination of axial loading and varus or valgus stress, leading to articular surface depression, shearing, and disruption of the mechanical axis alignment [2]. While the lateral tibial condyle is most often involved, the medial or both condyles can also be affected. The Schatzker classification system is the most commonly used method to assess fracture patterns and inform appropriate treatment strategies [3].

Tibial plateau fractures pose a significant management challenge due to their involvement of the joint surface [4]. Achieving precise anatomical reduction and maintaining proper limb alignment are critical to ensuring favorable outcomes [5]. Open reduction and internal fixation (ORIF) is a standard approach but is not without notable complications [6]. Periarticular locking plates offer a key benefit in treating

complex bicondylar fractures, as a single laterally placed plate can often maintain stable reduction, reducing the need for extensive surgical exposure and lowering the risk of postoperative varus malalignment [7]. Nonetheless, despite improvements in implant design and surgical methods, complications such as nonunion, malalignment, and joint stiffness continue to be of concern, particularly in cases with severe comminution [8, 9].

Buttressing the lateral compartment with bone grafting is considered the gold standard treatment for Schatzker type II fractures, as it offers rigid support that helps prevent collapse, varus deformity, and the development of secondary osteoarthritis. However, this approach often involves extensive dissection through already damaged soft tissues, which can increase the risk of wound complications and compromise the stability of the fixation [10]. Consequently, the routine use of bone grafts in fixation remains controversial, highlighting the need for further investigation into their role in promoting bone healing and improving functional outcomes.

Despite the established use of bone grafting in managing certain tibial plateau fractures, there remains a lack of consensus regarding its routine application in all fixation cases. Previous studies have reported mixed results on whether bone grafting significantly enhances radiological healing or functional recovery compared to fixation without grafts. Additionally, concerns about increased soft tissue disruption and potential complications have fueled ongoing debate. This uncertainty underscores the need for comparative studies to clarify the true benefits and drawbacks of bone grafting in tibial plateau fracture fixation. The purpose of this study is to compare the functional and radiological outcomes of tibial plateau fracture fixation performed with versus without bone grafting.

2. Objective

- To compare functional and radiological outcomes of tibial plateau fracture fixation performed with versus without bone grafting.

3. Methodology & Materials

This observational, comparative study was conducted at the Department of Orthopaedics, Holy Family Red Crescent Medical College Hospital between January 2023 and December 2024. A total of 30 patients diagnosed with tibial plateau fractures were included based on specific inclusion criteria and divided equally into two groups: the bone grafting group (n = 15), who underwent fracture fixation with bone grafting, and the non-grafting group (n = 15), who underwent fixation without bone grafting.

Inclusion Criteria

- Patients aged 18 years and above
- Diagnosed with closed tibial plateau fractures
- Fractures classified according to the Schatzker classification
- Indicated for surgical fixation

Exclusion Criteria

- Open fractures
- Pathological fractures
- Polytrauma patients with multiple injuries
- Patients with systemic diseases affecting bone healing (e.g., uncontrolled diabetes, osteoporosis)
- Patients unwilling or unable to provide informed consent

The study was conducted after obtaining written informed consent from all participants, ensuring they were fully aware of the study objectives and procedures while maintaining confidentiality. Each patient underwent thorough clinical and radiological examination, including preoperative assessment and classification of the fracture type according to the Schatzker system. Patients were categorized into two groups based on the surgical technique used: the bone grafting group, who received autologous bone grafts during fixation, and the non-grafting group, who underwent fixation without bone grafting.

Open reduction and internal fixation (ORIF) were performed under standardized protocols by experienced orthopedic surgeons. In the graft group, autologous bone grafts were harvested intraoperatively to fill bone defects and support articular reduction. Postoperative care included scheduled clinical follow-ups and radiographic assessments to evaluate fracture healing, time to union, articular reduction maintenance, and complications. Functional outcomes were measured using the Lysholm Knee Score, KOOS pain subscale, and knee range of motion (ROM).

Data on demographics, injury characteristics, radiological findings, functional scores, and complications were systematically recorded. Statistical analyses included descriptive summaries and comparative tests between groups, with a significance threshold set at $p < 0.05$.

4. RESULTS

Table 1. *Demographic and Injury Characteristics of the Study Population (n = 30)*

Variable		With Bone Grafting (n=15)	Without Bone Grafting (n=15)	p-value
Age (in years)	18–30	6 (40.0%)	5 (33.3%)	0.966
	31–40	5 (33.3%)	6 (40.0%)	
	41–50	3 (20.0%)	3 (20.0%)	
	51–60	1 (6.7%)	1 (6.7%)	
	Mean ± SD	34.2 ± 9.9	35.0 ± 9.5	
Gender	Male	10 (66.7%)	9 (60.0%)	0.704
	Female	5 (33.3%)	6 (40.0%)	
Mechanism Of Injury	Road traffic accident	8 (53.3%)	7 (46.7%)	0.758
	Low energy fall	5 (33.3%)	4 (26.7%)	
	High energy trauma	1 (6.7%)	3 (20.0%)	
	Fall from height	1 (6.7%)	1 (6.7%)	

Table 1 presents the baseline demographic characteristics and mechanisms of injury among the 30 patients undergoing tibial plateau fracture fixation, evenly divided between bone grafting and non-grafting groups. The mean age was 34.2 ± 9.9 years in the bone graft group and 35.0 ± 9.5 years in the non-graft group, with the majority of patients (73.3% in both groups) falling within the 18–40 years range. Males predominated in both cohorts, comprising 66.7% of the graft group and 60.0% of the non-graft group. The leading cause of injury was road traffic accidents, responsible for 53.3% of cases in the graft group and 46.7% in the non-graft group, followed by low-energy falls and high-energy trauma.

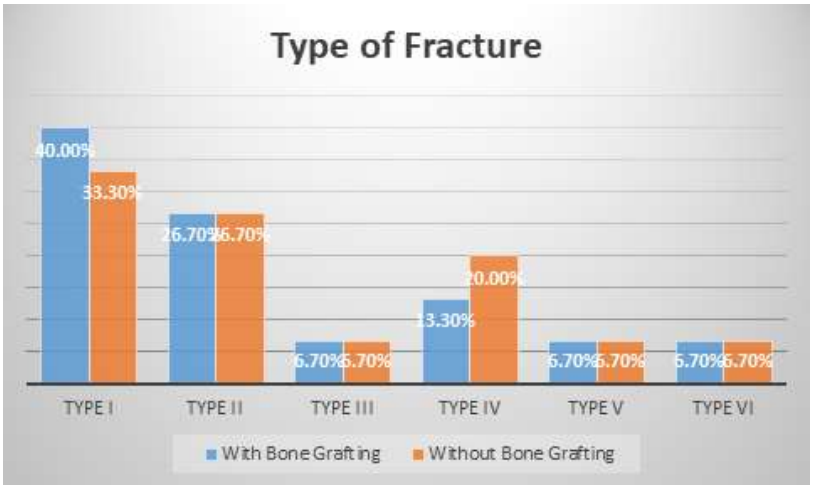

Figure 1. *Distribution of Tibial Plateau Fractures Based on Schatzker Classification (n = 30)*

Figure 1 illustrates the fracture type distribution using Schatzker classification. Type I fractures were most common in both groups, observed in 6 patients (40.0%) in the graft group and 5 patients (33.3%) in the non-graft group. Type II fractures followed, occurring equally in 4 patients (26.7%) in each group. The remaining types (III–VI) were less frequent and similarly distributed, indicating a predominance of simple fracture patterns across both treatment groups.

Table 2. *Comparison of Radiographic and Functional Outcomes between Groups (n = 30)*

Outcome		With Bone Grafting (n=15)	Without Bone Grafting (n=15)	p-value
Radiographic Outcomes	Time to union (days)	90.5 ± 11.3	108.4 ± 14.9	0.001
	Articular reduction loss (mm)*	1.2 ± 0.8	3.5 ± 1.6	<0.001
	Nonunion, n (%)	1 (6.7%)	3 (20.0%)	0.317
Functional Outcomes	Lysholm Knee Score	85.2 ± 7.9	77.8 ± 9.6	0.029
	KOOS Pain Subscale	82.4 ± 11.7	74.9 ± 14.8	0.136
	Range of Motion (ROM, degrees)	114.2 ± 13.7	118.6 ± 19.3	0.480

Table 2 compares radiographic healing and functional recovery outcomes between the two groups. The bone graft group showed significantly faster fracture union (90.5 ± 11.3 days) than the non-graft group (108.4 ± 14.9 days, p = 0.001). Articular reduction was better

maintained in the graft group, with significantly less reduction loss (1.2 ± 0.8 mm vs. 3.5 ± 1.6 mm, $p < 0.001$). Although nonunion occurred more often in the non-graft group (20.0%) than the graft group (6.7%), the difference was not statistically significant. Functionally, the graft group had higher Lysholm scores (85.2 ± 7.9 vs. 77.8 ± 9.6, $p = 0.029$), while differences in KOOS pain subscale and range of motion were not significant.

Table 3. *Postoperative Complications in Patients between Groups (n = 30)*

Complication	With Bone Grafting (n=15)	Without Bone Grafting (n=15)
Knee stiffness	3 (20.0%)	5 (33.3%)
Malunion	1 (6.7%)	2 (13.3%)
Varus deformity	0 (0.0%)	2 (13.3%)
Extensor lag	1 (6.7%)	1 (6.7%)

Table 3 outlines the incidence of postoperative complications in each group. Knee stiffness was observed in 3 patients (20.0%) in the graft group and 5 patients (33.3%) in the non-graft group. Malunion occurred in 1 patient (6.7%) with bone grafting and in 2 patients (13.3%) without grafting. Varus deformity was exclusively noted in the non-graft group (13.3%), while extensor lag was equally distributed (6.7%) in both groups. Overall, the group that did not receive bone grafting experienced a slightly higher frequency of complications.

5. Discussion

This study explores the comparative outcomes of tibial plateau fracture fixation performed with and without bone grafting at a tertiary care hospital in Bangladesh. Tibial plateau fractures, which significantly impact knee function and joint stability, require meticulous management to restore anatomical alignment and promote healing. The findings reveal that patients receiving bone grafts experienced faster union, better maintenance of articular reduction, and improved functional scores compared to those treated without grafting. These results emphasize the potential benefits of bone grafting in enhancing radiological and functional outcomes following surgical fixation, especially in cases with articular depression or bone loss.

In our study, the mean age of participants was 34.2 ± 9.9 years in the bone graft group and 35.0 ± 9.5 years in the non-graft group, with the majority in both groups falling within the 18–40 years age range. This aligns with the findings of Musa et al. [11], who reported a mean age of 45.28 years, with 35.48% of cases in the 31–40 age group, and with Rahman et al. [12], who also noted the highest incidence among patients aged 30–39 years—supporting the observed predominance of younger adults in tibial plateau fractures. Both groups in our study also showed a male predominance (66.7% vs. 60.0%), consistent with the gender distribution reported by Musa et al.[11] and Rahman et al.[12], where male patients constituted the majority. Regarding the mechanism of injury, road traffic accidents were the leading cause in both groups (53.3% and 46.7%, respectively), mirroring the pattern observed by Musa et al.[11] These demographic and etiological similarities across both study groups suggest a well-balanced sample, Strengthening the validity of our outcome comparisons and reinforcing the generalizability of our findings to similar clinical populations.

In the present study, Type I fractures were the most commonly observed in both groups—40.0% in the bone graft group and 33.3% in the non-graft group—followed by Type II fractures, each comprising 26.7% of cases. This pattern reflects a predominance of less complex fracture types across both groups. Similar distributions were reported by Chowdhury et al.[13] and Musa et al.[11], who also identified Schatzker Type I as the most frequent fracture type in their cohorts, reinforcing the trend of simple split fractures being most prevalent in tibial plateau injuries. In contrast, Nazibullah et al. [14] found Type V fractures to be the most common, likely due to differences in trauma severity, referral bias, or patient demographics. The relatively low incidence of complex fracture types (Types V and VI) in our study suggests that both groups largely consisted of patients with less severe injuries, likely resulting from low- to moderate-energy trauma. This comparable fracture type distribution supports the validity of our outcome comparisons between groups and minimizes the confounding influence of injury complexity.

In our study, patients who received bone grafting demonstrated a significantly shorter time to union (90.5 ± 11.3 days) compared to those without grafting (108.4 ± 14.9 days), highlighting a key benefit of graft augmentation. This finding supports Mao et al.[15], who

reported that autograft use significantly accelerated bone healing at one year ($p = 0.031$). Rahman et al.[12] similarly noted a comparable mean union time in grafted cases, along with a mean range of motion (ROM) of $113.5 \pm 14.4°$, closely aligning with the ROM observed in our graft group ($114.2 \pm 13.7°$). Articular surface integrity was also better maintained in the graft group, as reflected by significantly lower reduction loss (1.2 ± 0.8 mm vs. 3.5 ± 1.6 mm, $p < 0.001$), echoing the findings of Kitchen et al.[16], who associated delayed intervention with increased step-off and reduced Lysholm scores. Consistently, our graft group had a significantly higher Lysholm Knee Score (85.2 ± 7.9 vs. 77.8 ± 9.6, $p = 0.029$), indicating superior functional recovery. While the difference in nonunion rates was not statistically significant, the lower incidence in the graft group (6.7% vs. 20.0%) mirrors the outcome reported by Nazibullah et al.[14], where grafted cases had a nonunion rate of just 1.79%. These results underscore the comparative advantages of bone grafting in facilitating union, preserving joint alignment, and enhancing early postoperative function in tibial plateau fracture fixation.

In this study, knee stiffness emerged as the most common postoperative complication, reported in 20.0% of patients in the bone graft group and 33.3% in the non-graft group. These rates are consistent with Chowdhury et al.[13], who also identified knee stiffness as a frequent complication following tibial plateau fracture fixation. Similarly, Gálvez-Sirvent et al.[17] documented a 20% incidence of stiffness—defined as ≥5° flexion contracture—closely matching the rate observed in our graft group. Malunion occurred more frequently in the non-graft group (13.3%) than in the graft group (6.7%), and varus deformity was noted exclusively in the non-graft group (13.3%), suggesting a higher tendency toward mechanical misalignment without grafting. Extensor lag was observed equally in both groups (6.7%). While overall complication rates remained low, the comparatively higher incidence of alignment-related issues and joint stiffness in the non-graft group supports the notion that bone grafting may enhance structural stability and contribute to better postoperative outcomes.

6. Limitations of the Study

This study had some limitations:

- The study was conducted in a selected tertiary-level hospital.
- The sample was not randomly selected.
- The study's limited geographic scope may introduce sample bias, potentially affecting the broader applicability of the findings.

7. Conclusion

This study demonstrates that tibial plateau fracture fixation with bone grafting provides superior radiological and functional outcomes compared to fixation without grafting. Patients receiving bone grafts experienced significantly faster fracture union and better maintenance of articular reduction, reflected by lower reduction loss and higher Lysholm Knee Scores. Although nonunion and postoperative complications such as knee stiffness, malunion, and varus deformity were more frequent in the non-graft group, these differences were generally not statistically significant. These findings suggest that bone grafting enhances fracture healing and functional recovery, supporting its use as an effective adjunct in the surgical management of tibial plateau fractures.

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