RESEARCH PAPER

Column-Specific Versus Bicolumnar Fixation for Schatzker Type V and VI Tibial Plateau Fractures: A Retrospective Observational Study of Functional and Radiological Outcomes

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ABSTRACT
Background: Schatzker type V and VI tibial plateau fractures represent the highest-complexity tier of periarticular knee injuries and carry a disproportionate risk of long-term functional impairment. Two principal operative strategies— bicolumnar (dual-plate) fixation and column-specific fixation guided by CT-based three-column morphological analysis—are in widespread clinical use; however, comparative outcome data for these high-grade fractures remain limited.
Methods: This retrospective observational study analysed prospectively collected data from 100 skeletally mature patients who underwent operative fixation for Schatzker type V or VI tibial plateau fractures at the Department of Orthopaedics, SRM Medical College Hospital and Research Centre, Kattankulathur, between April 2024 and December 2025. Patients were categorised according to fixation technique: column-specific fixation (Group A; n = 50) or bicolumnar fixation (Group B; n = 50). Primary outcomes were the Modified Rasmussen Clinical Score and Modified Rasmussen Radiological Score at six months. Secondary outcomes included operative time, intraoperative blood loss, time to radiological union, time to partial weight-bearing, return to activities of daily living, knee flexion, VAS pain scores, postoperative complications, and hospital stay. Independent samples t-tests and chi-square tests were used; statistical significance was set at $p < 0.05$.
Results: Both groups were comparable at baseline (all $p > 0.05$). Column-specific fixation was associated with significantly lower intraoperative blood loss (210 ± 75 vs. 305 ± 92 ml; $p < 0.001$), earlier radiological union (14.2 ± 2.8 vs. 15.6 ± 3.1 weeks; p = 0.02), superior functional outcome (excellent grade: 44% vs. 30%; overall satisfactory: 84% vs. 68%; p = 0.048), greater mean knee flexion at six months (126.8 ± 11.4° vs. 118.5 ± 13.6°; p = 0.002), earlier weight-bearing (7.8 ± 1.9 vs. 9.1 ± 2.3 weeks; p = 0.003), earlier return to daily activities (16.5 ± 3.4 vs. 19.2 ± 4.1 weeks; $p < 0.001$), and shorter hospital stay (5.8 ± 1.7 vs. 7.2 ± 2.1 days; $p < 0.001$). Specific radiological parameters were significantly superior in Group A: residual articular depression (1.2 ± 0.8 vs. 1.9 ± 1.1 mm; p = 0.004) and condylar widening (2.4 ± 1.3 vs. 3.1 ± 1.5 mm; p = 0.03). Composite radiological score distributions were comparable (p = 0.18). Complication rates were numerically lower in Group A but did not reach statistical significance.
Conclusion: Column-specific fixation guided by CT-based three-column fracture analysis demonstrated consistent advantages over bicolumnar fixation across functional recovery, articular restoration, rehabilitation trajectory, and resource utilisation. These findings support CT-guided column-specific fixation as the preferred operative strategy when advanced preoperative planning is available.
Keywords: Tibial plateau fracture; Schatzker classification; column-specific fixation; bicolumnar fixation; dual plating; three-column concept; CT-guided surgery; functional outcome; Modified Rasmussen Score.
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INTRODUCTION

Tibial plateau fractures, while representing approximately 1% of all skeletal fractures, carry a disproportionate clinical burden owing to the critical weight-bearing and stabilising functions of the knee joint [1,2]. Disruption of articular congruity, compromise of ligamentous integrity, and aberrant lower-limb axial alignment collectively underpin the high risk of long-term functional impairment observed in inadequately treated cases [1,2]. The aetiology is distinctly bimodal: high-energy trauma—road traffic accidents and falls from height—predominates in younger active populations, while low-energy mechanisms suffice in elderly patients with diminished bone mineral density [2,3]. Irrespective of aetiology, failure to reconstruct near-anatomical joint geometry is strongly associated with chronic joint pain, progressive instability, loss of range of motion, and accelerated post-traumatic degenerative arthropathy [4].

Bicondylar variants—Schatzker type V and type VI—constitute the highest-complexity tier within the Schatzker classification system [5,6]. The widespread adoption of computed tomography (CT) has transformed fracture characterisation by enabling three-dimensional visualisation of fragment geometry and articular depression depth [7]. Luo and colleagues introduced a three-column classification framework that re-conceptualises the proximal tibia as three biomechanically distinct structural columns—medial, lateral, and posterior—profoundly influencing surgical planning by directing fixation toward the specific columns involved [7].

Two contrasting operative strategies define current standard practice. Bicolumnar fixation employs dual plating across both condyles to maximise biomechanical construct rigidity [9]; column-specific fixation, informed by CT- based morphological characterisation, directs stabilisation exclusively toward structurally compromised columns, thereby limiting soft-tissue disruption without sacrificing construct stability [10]. Despite the widespread use of both techniques, well-powered comparative evidence specifically addressing Schatzker type V and VI injuries remains limited [7,8]. The present study retrospectively analysed prospectively collected data from 100 patients to evaluate and compare functional and radiological outcomes of column-specific versus bicolumnar fixation at a single tertiary referral centre.

1. METHODS

1.1 Study Design and Setting

This was a retrospective observational study based on a prospectively maintained clinical database within the Department of Orthopaedics, SRM Medical College Hospital and Research Centre, Kattankulathur—a tertiary academic teaching hospital with a high-volume trauma catchment area. Data were extracted from operative records, inpatient case notes, structured outpatient follow-up documentation, and radiological archives spanning April 2024 to December 2025.

1.2 Data Source and Study Period

Records of all patients who underwent open reduction and internal fixation (ORIF) for Schatzker type V or VI tibial plateau fractures during the 21-month study period were systematically reviewed. Preoperative, intraoperative, and postoperative data were collated from the prospective surgical logbook, structured follow-up proformas, and the institutional picture archiving and communication system (PACS).

1.3 Inclusion and Exclusion Criteria

Records were included if they documented: skeletally mature patients (age ≥18 years); closed tibial plateau fractures classified as Schatzker type V or VI on both plain radiography and CT; ORIF as the operative intervention; and complete clinical and radiological follow-up at six months. Records were excluded for: age below 18 years; paraplegia or quadriplegia; peripheral diabetic neuropathy; osteogenesis imperfecta; hemimelia; or terminal systemic illness including haematological malignancy.

1.4 Patient Groups

Patients were categorised according to the fixation technique documented in operative records. Group A (n = 50) received column-specific fixation guided by CT-based three-column analysis; Group B (n = 50) received bicolumnar (dual-plate) fixation. In the original operative series, treatment allocation was determined by computer- generated randomisation using sealed opaque envelopes; the current analysis draws on outcomes data from that cohort in a retrospective observational framework.

1.5 Surgical Techniques

Column-Specific Fixation (Group A)

Fracture fragments were mapped preoperatively according to the Luo three-column classification on axial CT images. Operative stabilisation was directed exclusively at the fractured columns using column-tailored implants— plates and screws selected and positioned specifically for the medial, lateral, or posterior column as required by individual fracture morphology. Operative dissection was confined to anatomical zones requiring direct reduction, deliberately limiting exposure of uninvolved tissue planes. The posteromedial approach was used for medial or posteromedial column involvement; the anterolateral approach for lateral column fractures.

Bicolumnar Fixation (Group B)

Patients received dual plating using an anterolateral locking plate combined with a medial buttress plate through concurrent medial and lateral surgical exposures. Standard operative principles—anatomical articular reduction, stable fragment fixation, and preservation of the periarticular soft-tissue envelope—

were adhered to in both groups.

1.6 Postoperative Protocol

A standardised postoperative protocol was implemented uniformly across both groups, encompassing analgesia, antibiotic prophylaxis per institutional guidelines, wound surveillance, and structured physiotherapy incorporating early knee mobilisation. Serial follow-up assessments were conducted at 2 weeks, 6 weeks, 3 months, and 6 months postoperatively.

1.7 Outcome Measures

The primary functional outcome was the Modified Rasmussen Clinical Score (maximum 30 points across five domains: pain, walking capacity, knee extension lag, range of motion, and stability), graded as excellent (27–30), good (20–26), fair (10–19), or poor (<10) [14,17]. The primary radiological outcome was the Modified Rasmussen Radiological Score assessing articular depression, condylar widening, and plateau alignment [17]. Secondary outcomes included operative time, intraoperative blood loss, time to radiological union, time to partial weight- bearing, return to daily activities, knee flexion at six months, VAS pain scores at three and six months, postoperative complications, and hospital stay.

1.8 Statistical Analysis

Continuous variables were summarised as mean ± SD. Categorical variables were reported as frequencies and proportions. Intergroup differences in continuous variables were assessed with independent-samples t-tests; categorical variables with chi-square tests. All tests were two-tailed; $p < 0.05$ was considered statistically significant.

2. RESULTS

One hundred patients with Schatzker type V or VI tibial plateau fractures were identified: 50 in the column-specific fixation group (Group A) and 50 in the bicolumnar fixation group (Group B).

2.1 Baseline Demographic Characteristics

Demographic profiles were comparable between groups across all parameters (Table 1). Mean age was 41.8 ± 12.6 years in Group A and 43.1 ± 11.9 years in Group B (p = 0.58). Male patients predominated in both groups (68% vs. 64%; p = 0.67). Right-sided injuries were present in 54% and 58% respectively (p = 0.69). High-energy mechanisms accounted for 62% and 66% of injuries respectively (p = 0.68), consistent with the established epidemiological pattern in which tibial plateau fractures in the working-age population predominantly arise from road traffic collisions and occupational falls [12,13].

Table 1. Baseline Demographic and Injury Characteristics

Variable	Group A – Column-Specific (n=50)	Group B – Bicolumnar (n=50)	p-value
Mean age, years (mean ± SD)	41.8 ± 12.6	43.1 ± 11.9	0.58*
Male sex, n (%)	34 (68%)	32 (64%)	0.67†
Right-sided injury, n (%)	27 (54%)	29 (58%)	0.69†
High-energy mechanism, n (%)	31 (62%)	33 (66%)	0.68†

Independent samples t-test. †Chi-square test. SD = standard deviation.

2.2 Fracture Classification

Schatzker type V fractures were the predominant pattern in both groups (56% in Group A vs. 58% in Group B); type VI fractures comprised the remainder (44% vs. 42%). The fracture-type distribution was statistically equivalent (p = 0.84), confirming balanced baseline fracture severity (Table 2).

Table 2. Fracture Classification by Schatzker Type

Schatzker Type	Group A, n (%)
Type V (bicondylar)	28 (56%)
Type VI (bicondylar + metaphyseal split)	22 (44%)

†Chi-square test.

2.3 Operative Parameters

Mean operative duration was significantly shorter in Group B (96.4 ± 18.2 minutes) than in Group A (118.7 ± 20.5 minutes; $p < 0.001$), reflecting the greater technical complexity of CT-guided multi-column dissection. Conversely, intraoperative blood loss was significantly lower in Group A (210 ± 75 ml vs. 305 ± 92 ml; $p < 0.001$), consistent with the anatomically circumscribed dissection inherent in targeting only the fractured columns (Table 3, Figure 1).

Table 3. Intraoperative Parameters

Parameter	Group A (mean ± SD)	Group B (mean ± SD)	p-value
Operative time (minutes)	118.7 ± 20.5	96.4 ± 18.2	<0.001*
Intraoperative blood loss (ml)	210 ± 75	305 ± 92	<0.001*

**Independent samples t-test. SD = standard deviation.*

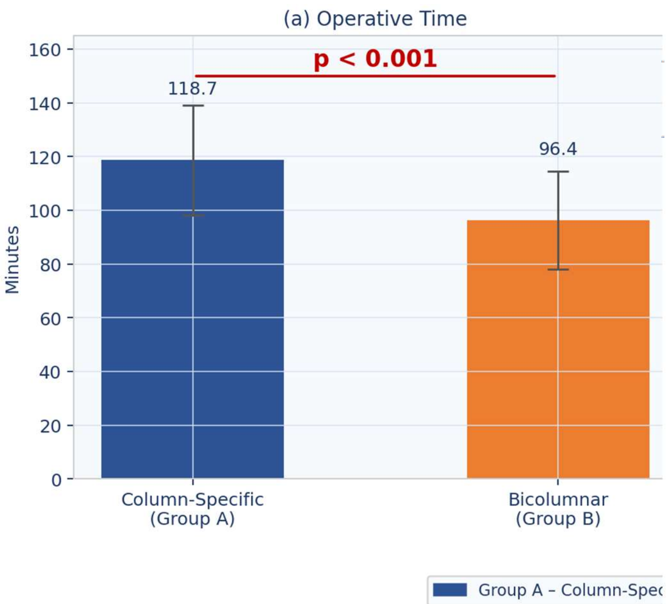

Figure 1. *Intraoperative Parameters: Operative Time and Blood Loss (mean ± SD). Group A had longer operative time but significantly lower blood loss. *p < 0.001 for both comparisons. Error bars represent ±SD.*

2.4 Time to Radiological Union

Radiological fracture union was achieved significantly earlier in Group A (14.2 ± 2.8 weeks) compared with Group B (15.6 ± 3.1 weeks; p = 0.02) (Table 4). The complete rehabilitation timeline is depicted in Figure 4.

Table 4. Time to Radiological Union

Outcome	Group A (mean ± SD)	Group B (mean ± SD)	p-value
Time to radiological union (weeks)	14.2 ± 2.8	15.6 ± 3.1	0.02*

Independent samples t-test. SD = standard deviation.

2.5 Functional Outcome

Modified Rasmussen Clinical Score grading revealed a statistically significant intergroup difference (p = 0.04). Excellent results were recorded in 44% of Group A patients versus 30% in Group B; fair or poor outcomes in 16% versus 28%. Overall satisfactory outcomes (excellent + good) were achieved in 84% of Group A versus 68% of Group B (p = 0.048) (Table 5, Figure 2; proportional breakdown in Figure 8).

Table 5. Functional Outcome: Modified Rasmussen Clinical Score

Outcome Category	Group A, n (%)	Group B, n (%)	p-value
Excellent (27–30)	22 (44%)		
Good (20–26)	20 (40%)		
Fair/Poor (<20)	8 (16%)	14 (28%)	—
Satisfactory (Excellent + Good)	42 (84%)		

†Chi-square test.

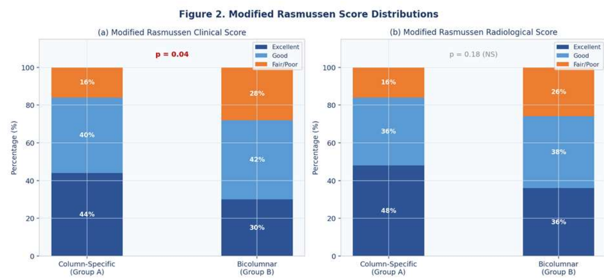

Figure 2. *Modified Rasmussen Score Grade Distributions (Clinical and Radiological). (a) Clinical score distribution significantly favoured Group A (p = 0.04). (b) Radiological score distributions were comparable (p = 0.18).*

2.6 Radiological Outcome

Modified Rasmussen Radiological Score distribution numerically favoured Group A (excellent: 48% vs. 36%; fair/poor: 16% vs. 26%) but did not reach statistical significance (p = 0.18) (Table 6). However, specific radiological restoration parameters were significantly superior in Group A: residual articular depression (1.2 ± 0.8 vs. 1.9 ± 1.1 mm; p = 0.004) and condylar widening (2.4 ± 1.3 vs. 3.1 ± 1.5 mm; p = 0.03). Malalignment exceeding 5° was present in 6% of Group A versus 14% of Group B (p = 0.18) (Table 7, Figure 3).

Table 6. Radiological Outcome: Modified Rasmussen Radiological Score

Outcome Grade	Group A, n (%)	Group B, n (%)	p-value
Excellent	24 (48%)	18 (36%)	0.18†
Good	18 (36%)	19 (38%)	—
Fair/Poor	8 (16%)	13 (26%)	—

†Chi-square test.

Table 7. Specific Radiological Parameters of Articular Restoration

Parameter	Group A (mean ± SD)	Group B (mean ± SD)	p-value
Residual articular depression (mm)	1.2 ± 0.8	1.9 ± 1.1	0.004*
Condylar widening (mm)	2.4 ± 1.3	3.1 ± 1.5	0.03*
Malalignment >5°, n (%)	3 (6%)	7 (14%)	0.18†

**Independent samples t-test. †Chi-square test. SD = standard deviation.*

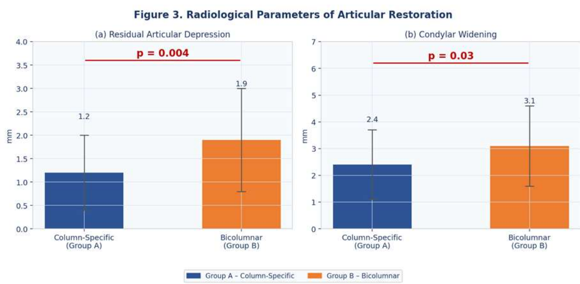

Figure 3. *Specific Radiological Parameters of Articular Restoration (mean ± SD).*
*Residual articular depression and condylar widening were both significantly lower in Group A. *p = 0.004 and p = 0.03 respectively.*
Error bars represent ±SD.

2.7 Postoperative Complications

Complication rates were consistently numerically lower in Group A across all domains, though no individual comparison reached statistical significance (Table 8, Figure 6). Surgical site infection was recorded in 6% of Group A versus 14% of Group B (p = 0.18); knee stiffness in 10% versus 18% (p = 0.25); implant-related irritation in 8% versus 12% (p = 0.50).

Table 8. Postoperative Complications

Complication	Group A, n (%)	Group B, n (%)	p-value
Surgical site infection	3 (6%)	7 (14%)	0.18†
Knee stiffness	5 (10%)	9 (18%)	0.25†
Implant irritation	4 (8%)	6 (12%)	0.50†

†Chi-square test. NS = not significant.

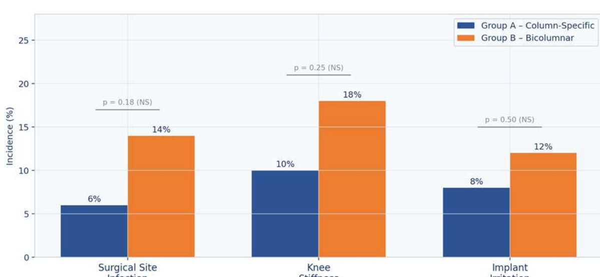

Figure 4. *Postoperative Complication Rates by Category.*
Complication rates were numerically lower in Group A across all categories, but no difference achieved statistical significance (all p > 0.05). NS = not significant.

2.8 Rehabilitation Parameters

Initiation of partial weight-bearing was significantly earlier in Group A (7.8 ± 1.9 vs. 9.1 ± 2.3 weeks; p = 0.003). Return to daily activities was similarly accelerated (16.5 ± 3.4 vs. 19.2 ± 4.1 weeks; p < 0.001), representing an approximately three-week advantage. Mean hospital stay was significantly shorter in Group A (5.8 ± 1.7 vs. 7.2 ± 2.1 days; p < 0.001); stays exceeding seven days occurred in 18% versus 36% (p = 0.

Table 9. Rehabilitation and Hospital Stay Parameters

Parameter	Group A (mean ± SD)	Group B (mean ± SD)	p-value
Time to partial weight-bearing (weeks)	7.8 ± 1.9	9.1 ± 2.3	0.003*
Return to daily activities (weeks)	16.5 ± 3.4	19.2 ± 4.1	<0.001*
Mean hospital stay (days)	5.8 ± 1.7	7.2 ± 2.1	<0.001*
Hospital stay >7 days, n (%)	9 (18%)	18 (36%)	0.04†

**Independent samples t-test. †Chi-square test. SD = standard deviation.*

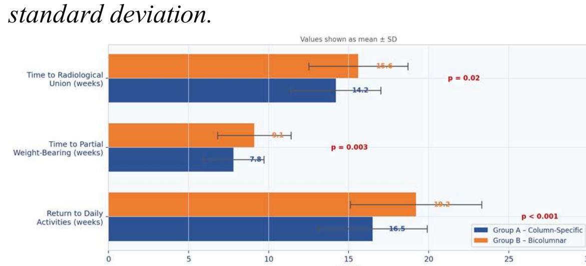

Figure 5. *Rehabilitation and Recovery Timeline (mean ± SD, weeks).*
All three rehabilitation milestones were significantly earlier in Group A. Error bars represent ±SD.

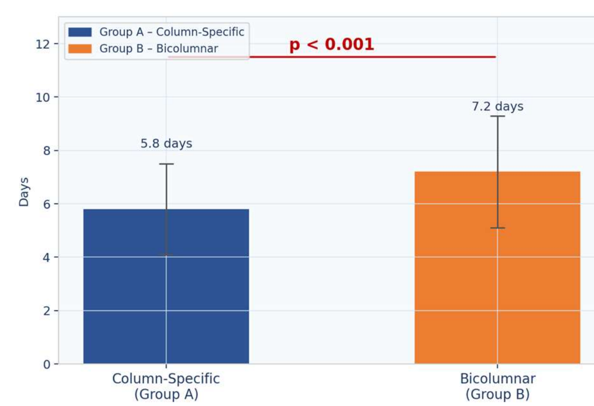

Figure 6. *Duration of Hospital Stay (mean ± SD, days).*
Mean hospital stay was significantly shorter in Group A (5.8 ± 1.7 vs. 7.2 ± 2.1 days; p < 0.001).

2.9 Knee Range of Motion and Pain

At the six-month review, mean knee flexion was significantly greater in Group A (126.8 ± 11.4° vs. 118.5 ± 13.6°; p = 0.002). A significantly higher proportion of Group A patients achieved flexion ≥120° (72% vs. 50%; p = 0.02) (Table 10). VAS pain scores were consistently lower in Group A at three months (2.8 ± 1.1 vs. 3.7 ± 1.4; p = 0.001) and six months (1.4 ± 0.9 vs. 2.1 ± 1.2; p = 0.003) (Table 11, Figure 5).

Table 10. Knee Range of Motion at Six Months

Parameter	Group A	Group B	p-value
Mean knee flexion (°, mean ± SD)	126.8 ± 11.4	118.5 ± 13.6	0.002*
Flexion ≥120°, n (%)	36 (72%)	25 (50%)	0.02†
Flexion <120°, n (%)	14 (28%)	25 (50%)	—

**Independent samples t-test. †Chi-square test. SD = standard deviation.*

Table 11. VAS Pain Scores at Follow-up

Time Point	Group A (mean ± SD)	Group B (mean ± SD)	p-value
3 months	2.8 ± 1.1	3.7 ± 1.4	0.001*
6 months	1.4 ± 0.9	2.1 ± 1.2	0.003*

**Independent samples t-test. VAS = Visual Analogue Scale (0–10). SD = standard deviation.*

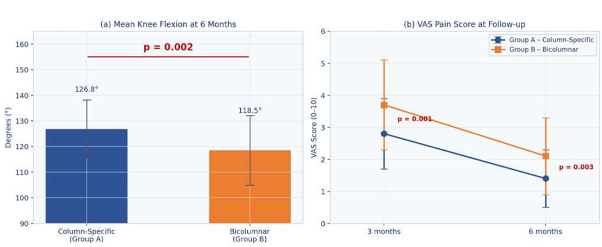

Figure 7. *Knee Range of Motion at Six Months and VAS Pain Scores at Follow-up.*
(a) Mean knee flexion was significantly greater in Group A (p = 0.002). (b) VAS pain scores were significantly lower in Group A at both 3 months (p = 0.001) and 6 months (p = 0.003). Error bars represent ±SD.

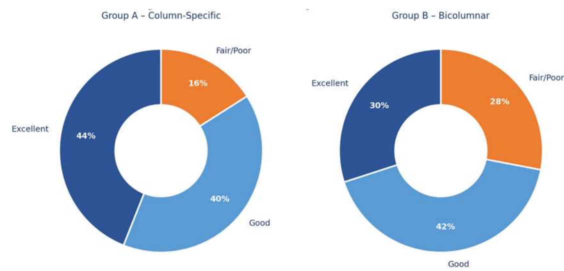

Figure 8. *Overall Satisfactory Outcome Distribution by Group.*
Satisfactory outcomes (excellent + good) achieved in 84% of Group A vs. 68% of Group B (p = 0.048).

3. DISCUSSION

This retrospective analysis of prospectively collected data from 100 patients with Schatzker type V and VI tibial plateau fractures demonstrates that column-specific fixation, guided by preoperative CT-based three-column fracture analysis, is associated with superior outcomes across a broad range of functional, radiological, and perioperative parameters compared with bicolumnar fixation.

3.1 Demographics and Fracture Characteristics

The demographic profile—predominantly male, working-age adults sustaining high-energy injuries in the fourth decade of life—is consistent with established epidemiological patterns. Elsoe et al. reported peak tibial plateau fracture incidence between the third and fifth decades, principally from vehicular and occupational trauma [12]; the male predominance (68% and 64% in Groups A and B respectively) aligns with observations by Krause et al. [21]. Prat-Fabregat and Camacho-Carrasco identified road traffic collisions and height falls as the dominant aetiologies in surgically managed cohorts [13]. The balanced fracture-type distribution (p = 0.84) and equivalent baseline demographics confirmed adequate group comparability.

3.2 Operative Parameters

The significantly longer operative duration in Group A (118.7 ± 20.5 vs. 96.4 ± 18.2 minutes; p < 0.001) reflects the inherent technical complexity of CT-guided fragment-specific fixation requiring individualised column-based dissection (Figure 1). This is consistent with published series documenting extended operative times for anatomy- tailored fixation strategies [16]. The significantly lower intraoperative blood loss in Group A (210 ± 75 vs. 305 ± 92 ml; p < 0.001) is mechanistically attributable to circumscribed dissection targeting only fractured columns. Bicolumnar fixation mandates concurrent medial and lateral exposures, creating substantially greater periosteal stripping. Neogi et al. similarly documented higher soft-tissue morbidity with bilateral exposures for bicondylar tibial plateau fractures [22].

3.3 Fracture Union

Earlier radiological union in Group A (14.2 ± 2.8 vs. 15.6 ± 3.1 weeks; $p = 0.02$) is consistent with superior preservation of periosteal vascularity associated with targeted dissection. Giannoudis et al. described the "diamond concept" of bone regeneration, emphasising that vascular integrity and a biologically undisturbed cellular environment are prerequisites for fracture consolidation [23]. The complete rehabilitation trajectory is summarised in Figure 4.

3.4 Functional Outcome

The statistically significant advantage of column-specific fixation in Modified Rasmussen Clinical Score distribution ($p = 0.04$)—higher excellent rates (44% vs. 30%) and fewer fair/poor results (16% vs. 28%)—represents the primary clinical finding of this study (Figures 2 and 8). Sameer et al., evaluating column-guided fixation directed by the three-column concept, documented good-to-excellent outcomes in approximately 90% of patients, with comparable return to pre-injury function [24]. Howell et al. demonstrated that residual articular depression and mechanical malalignment following tibial plateau fracture fixation are independent predictors of knee arthroplasty conversion [25], reinforcing the critical importance of anatomical articular reduction at index surgery.

3.5 Radiological Outcome

Although the composite Modified Rasmussen Radiological Score distribution did not achieve statistical significance ($p = 0.18$; Figure 2b), the granular radiological parameters—residual articular depression ($p = 0.004$) and condylar widening ($p = 0.03$)—were significantly superior in Group A (Figure 3). Howell et al. specifically identified these parameters as the strongest predictors of long-term arthroplasty progression [25]. Lee et al. similarly observed that while both dual-plate and locking plate constructs achieved satisfactory union, the more extensive soft-tissue dissection of dual plating carried a greater burden of wound-related complications [18]. Sameer et al. reported good- to-excellent radiological restoration with column-based fixation [24].

3.6 Postoperative Complications

A consistent numerical trend toward lower complication rates in Group A (Figure 6)—infection 6% vs. 14%, stiffness 10% vs. 18%, implant irritation 8% vs. 12%—did not achieve statistical significance, likely reflecting insufficient power for these low-frequency events. Wang et al. documented low complication rates and no cases of fixation failure in column-specific fixation patients [26]. Obana et al. highlighted the association between high- energy complex fractures and elevated infection risk, reinforcing the value of soft-tissue-preserving strategies [27]. Söylemez et al. demonstrated that targeted posteromedial buttress plating achieves reliable union and an acceptable complication profile when posterior column injury is specifically addressed [19].

3.7 Rehabilitation and Functional Recovery

Earlier initiation of partial weight-bearing ($p = 0.003$), faster return to daily activities ($p < 0.001$), and shorter hospital stay ($p < 0.001$) in Group A (Figures 4 and 7) reflect both the biomechanical adequacy of column-specific constructs and reduced periarticular soft-tissue morbidity. Canton et al. confirmed through systematic review that early weight-bearing following stable tibial plateau fracture fixation is safe [11]; Elsenosy et al. confirmed no adverse effects on union with early loading while demonstrating measurable functional benefits [15]. O'Neill et al. further emphasised the critical role of CT-based planning in identifying column involvement requiring posterior approach fixation [20]. The superior mean knee flexion (126.8 ± 11.4° vs. 118.5 ± 13.6°; $p = 0.002$) and consistently lower VAS pain scores (Figure 5) reflect the combined benefits of more precise articular restoration and earlier mobilisation. Ibrahim et al. confirmed that earlier weight-bearing after ORIF translates to significantly better pain, walking capacity, and range-of-motion outcomes [28].

3.8 Strengths and Limitations

Strengths include prospective data collection with pre-specified outcome measures, routine CT-based three-column fracture characterisation, standardised protocols across both groups, a balanced sample with equivalent baseline characteristics, and validated multidimensional outcome instruments. As a single-centre retrospective analysis, external generalisability is limited and unmeasured confounders cannot be fully excluded. The six-month follow-up horizon is insufficient to evaluate post-traumatic osteoarthritis progression, late fixation failure, or arthroplasty conversion, for which follow-up of at least two to five years is required. Surgical and rehabilitation provider blinding was not feasible, introducing potential performance bias. Patient-reported outcome instruments (Oxford Knee Score, KOOS) were not employed. Low complication frequencies may have rendered individual comparisons underpowered.

4. CONCLUSION

This retrospective observational analysis of 100 patients with Schatzker type V and VI tibial plateau fractures demonstrates that column-specific fixation, guided by systematic preoperative CT-based three-column fracture analysis, consistently outperforms bicolumnar fixation across functional recovery, articular restoration, rehabilitation trajectory, and hospitalisation outcomes. Both techniques achieved fracture union and radiological outcomes within clinically acceptable ranges, confirming their individual surgical viability. Column-specific fixation conferred significant advantages in intraoperative blood loss, time to radiological union, Modified Rasmussen functional scores, knee range of motion, pain levels, time to weight-bearing and return to daily activities, and hospital stay. These advantages are mechanistically attributable to anatomically targeted dissection that preserves the periarticular soft-tissue and vascular environment while delivering precise, fragment-specific stabilisation. Column-specific fixation is recommended as the preferred operative strategy for skeletally mature patients with complex tibial plateau fractures when CT-based planning infrastructure is available. Multicentre randomised trials with extended follow-up are required to establish the long-term durability of these advantages.

DECLARATIONS

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Data Availability: Data supporting the findings are available from the corresponding author upon reasonable request.
Author Contributions: All authors contributed to study design, data collection, analysis, manuscript preparation, and approval of the final version.

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