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Original Article

SHORT TERM RADIOLOGICAL AND CLINICAL OUTCOMES OF FIXATION OF SCHATZKER II TIBIAL PLATEAU FRACTURES BY SCREWS ONLY

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Abstract

Background: *Schatzker type II tibial plateau fractures involve a split and depression of the lateral tibial plateau and require effective treatment to restore joint stability and prevent long-term complications. This study aimed to evaluate short-term clinical and radiological outcomes of closed reduction and percutaneous cannulated screw fixation in such cases.* ***Methods:*** *This prospective clinical study included 20 skeletally mature patients (aged 35–62) with isolated Schatzker type II fractures treated with percutaneous screw fixation. Patients were followed clinically and radiographically for one year. Statistical analysis included one-way ANOVA and Chi-square tests.* ***Results:*** *The average operative time was 85.80 ± 3.47 minutes. Radiological scores declined significantly over time (mean: 9.25 to 6.75, p < 0.0001), though MPTA improved significantly from 88.38° to 91.42° (p < 0.0001). The average clinical score was 23.80 ± 2.73, with 55% of patients rated excellent or good. Radiological union occurred at a mean of 16.85 ± 0.88 weeks, and the average rehabilitation period was 12.65 ± 2.96 weeks. Complications included malunion (20%), nonunion (15%), osteoarthritis (10%), and stiffness (5%), while 50% of patients experienced no complications.* ***Conclusions:*** *Percutaneous screw fixation for Schatzker II fractures is a reliable and minimally invasive technique that provides acceptable clinical and radiological outcomes in the short term. Although radiological grading may decline over time, overall functional recovery remains favorable. Proper patient selection and careful intraoperative technique are essential to minimize complications and optimize results.*

Keywords: *Schatzker II fracture, Tibial plateau, Screw fixation, Clinical outcome, Radiological outcome.*

1. Introduction

Tibial plateau fractures primarily affect young adults and elderly individuals, targeting a critical load-bearing region within the knee—the most biomechanically intricate joint in the body. These injuries typically result from a combination of axial compression and a coronal plane force (varus or valgus), leading to articular surface depression, shear injury, and disruption of the mechanical alignment of the limb [1]. The fundamental objectives of surgical intervention include restoring joint congruity and alignment while enabling early mobilization of the knee [2]. Standard initial imaging consists of anteroposterior (AP), lateral, and oblique radiographs; however, plain films alone often fail to delineate fracture components accurately. Post-CT evaluation has been shown to alter the initial classification in 5% to 24% of cases (average 12%) and modify treatment plans in as many as 26% of cases, reducing the clinical reliance on oblique views [3]. Even in relatively simple fracture types, intra- and periarticular soft tissue damage is common. Radiographs or CT scans may also suggest associated injuries such as lateral or medial meniscal tears. Specifically, an articular depression greater than 6 mm or a joint line widening exceeding 5 mm may indicate injury to the lateral meniscus, lateral collateral ligament (LCL), or posterior cruciate ligament (PCL) [4]. The Schatzker classification system, first introduced in 1974, remains a cornerstone for characterizing these fractures and guiding treatment decisions [5]. While surgical fixation is generally indicated for tibial plateau fractures, the decision must account for fracture configuration, condition of the soft tissues, the patient's overall health status, and the likelihood of achieving anatomical alignment and articular surface restoration. Commonly, the depressed articular fragments require elevation to their anatomical position, followed by internal fixation, and often bone grafting to fill any subchondral voids left beneath the restored joint surface [6]. The aim of this study is to evaluate the clinical and radiological outcomes of Schatzker type II tibial plateau fractures treated with closed reduction and percutaneous cannulated screw fixation.

2. Patients and Methods

This prospective clinical study was conducted on 20 skeletally mature patients, aged between 35 and 62 years, diagnosed with Schatzker type II fractures (closed split depression of the lateral tibial plateau). The study was carried out at Sohag University Hospitals from Sep. 2023 to Sep. 2024, following approval from the institutional Ethical Committee. Informed written consent was obtained from all participants.

2.1. *Selection criteria*

2.1.1. Inclusion criteria

Patients with isolated Schatzker type II tibial plateau fractures confirmed by clinical and radiographic evaluation.

2.1.2. Exclusion criteria

Patients with severe comminution with >5 mm depression, open fractures, associated compartment syndrome, or vascular injury were excluded.

2.2. *Preoperative assessment*

All patients underwent comprehensive preoperative evaluation, including medical history, clinical examination, and radiological assessment with anteroposterior and lateral X-rays of the knee, in addition to computed tomography (CT) scans for detailed fracture visualization. Full neurological and vascular examination was performed, along with routine laboratory investigations.

2.3. *Antibiotic prophylaxis*

Chemoprophylaxis was administered using a first-generation cephalosporin—one dose given 1 hour preoperatively and two doses postoperatively to reduce the risk of infection.

2.4. *Surgical positioning and preparation*

Patients were positioned supine on a radiolucent operating table. The injured limb was sterilized from foot to groin. A C-arm image intensifier was positioned on the side opposite to the injured limb and oriented perpendicular to the patient to allow intraoperative imaging. A pneumatic tourniquet was applied at the root of the limb and inflated to a pressure 100-150 mmHg above the systolic blood pressure.

2.5. *Surgical technique*

Surgery was conducted with the patient in a supine position under either general or spinal anesthesia, unless restricted by other associated injuries. To enhance joint exposure and visualization during the procedure, a pillow was placed to allow knee flexion. Fracture reduction was guided by fluoroscopy, using traction techniques. A pointed reduction clamp was utilized for condylar fracture alignment, while an elevator was used to elevate and restore depressed fragments, fig. (1).

Figure (1) Positioning the patient for minimally invasive fixation of tibial plateau fractures.

A small anterolateral parapatellar incision was made, with dissection carried down to open the deep fascia anterior to the iliotibial tract. The depressed articular fragment was elevated using an elevator, followed by fluoroscopy-guided insertion of a guide wire or Kirschner wire through the fracture site, aligned parallel to the joint line and perpendicular to the fracture line. Partially threaded cancellous screws were then inserted over the guide wire using a direct measuring device. Cannulated screws were positioned close to the articular surface to achieve anatomical reduction of the condylar fracture. Postoperatively, the limb was immobilized in an above-knee cast for five weeks, after which it was removed to allow initiation of knee flexion and extension exercises, fig. (2).

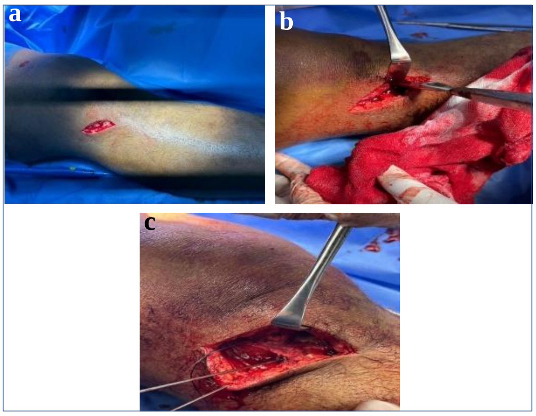

Figure (2) **a.** A limited anterolateral parapatellar skin incision was made, **b.** The joint capsule was incised to expose the articular surface (capsulotomy), **c.** Screws were inserted following fluoroscopy-guided placement of guide wires through the fracture site.

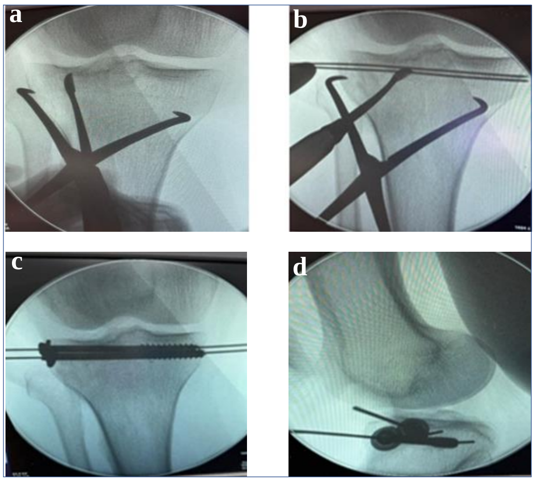

Figure (3) **a.** The depressed bone fragment was elevated using an elevator, **b.** Two guide wires were inserted across the fracture fragments, aligned parallel to the joint line, **c.** Partially threaded cancellous screws were placed over the guide wires, **d.** A lateral fluoroscopic view of the knee joint was taken to confirm proper reduction.

2.6. *Post-operative follow-up*

Postoperative surveillance included vigilant monitoring of the tibial compartments, with particular attention during the initial 48-hour period to promptly identify any emerging signs suggestive of compartment syndrome. Comprehensive neurovascular examinations of the operated limb were systematically performed throughout the recovery phase to ensure the integrity of peripheral circulation and neural function. All patients were managed postoperatively with immobilization using an above-knee cast maintained for a duration of five weeks. Upon removal of the cast, a structured rehabilitation protocol was initiated, involving progressive knee flexion and extension exercises to restore joint mobility. Partial weight-bearing with the aid of crutches was introduced at six weeks post-surgery, contingent on individual tolerance. Patients were also advised to perform regular isometric quadriceps contractions and active toe movements to preserve muscle tone and minimize the risk of thromboembolic events. Postoperative management further included appropriate analgesic regimens and prophylactic antibiotic therapy. The knee joint was systematically assessed for clinical indicators of inflammation or infection, including localized tenderness and swelling. Long-term follow-up evaluations were scheduled at six and twelve months postoperatively, followed by annual reviews thereafter. Functional outcomes were quantified using the clinical Rasmussen scoring system, with scores interpreted as excellent (27-30), good (20-26), moderate (10-19), or poor (<10). Radiographic evaluation was conducted using the Modified Rasmussen criteria, classifying outcomes as excellent (28-30), good (24-27), fair (20-23), or poor (<20), based on standardized radiological parameters.

2.7. *Statistical analysis*

Statistical analysis was performed using IBM SPSS Statistics version 25 (IBM Corp., Chicago, IL, USA). Continuous variables were expressed as means with corresponding standard deviations (SD), while categorical variables were summarized as frequencies and percentages. The Shapiro-Wilk test was employed to evaluate the normality of data distribution. For analysis of continuous variables across multiple time points, one-way analysis of variance (ANOVA) was used to assess statistical significance. Chi-square test was employed to evaluate associations between categorical variables. A two-tailed p-value less than 0.05 was considered statistically significant, with a 95% confidence interval.

3. Results

The study included 20 patients with a mean age of 48.75 ± 7.43 years and a median age of 48 years, ranging from 35 to 62 years. The majority of the participants were male (65.0%, n=13), while females comprised 35.0% (n=7) of the cohort. The mean operative time was 85.80 ± 3.47 minutes, with a median duration of 86 minutes and a range between 80 and 90 minutes, tab. (1). The Modified Rasmussen Radiological scores showed a statistically significant decline over time. The mean score was 9.25 ± 0.44 at the 1st X-ray, decreasing to 7.75 ± 0.72 at the 2nd X-ray, and further to 6.75 ± 0.97 at the 3rd X-ray, with a highly significant p-value (< 0.0001). Correspondingly, the distribution of radiological grades shifted over the follow-up period. At the initial assessment, 100% (n=20) of patients were graded as excellent. By the 2nd X-ray, only 5% remained excellent, while 95% were graded as good. At the 3rd X-ray, 60% were graded good, 35% fair, and only 5% excellent, with the shift in grade distribution also reaching statistical significance ($p < 0.0001$). These findings indicate a progressive decline in radiological outcomes over time, tab. (2). The Medial Proximal Tibial Angle (MPTA) showed a statistically significant increase across the follow-up X-rays. The mean MPTA was 88.38 ± 0.98° at the 1st X-ray, increasing to 91.34 ± 1.24° at the 2nd X-ray and 91.42 ± 1.86° at the 3rd X-ray. This upward trend in MPTA values over time was found to be highly significant, with a p-value of < 0.0001, indicating a consistent correction and maintenance of tibial alignment following the intervention, tab. (3). The mean Modified Rasmussen Clinical Assessment score among the study group was 23.80 ± 2.73 points. Based on the grading scale, 15.0% (n=3) of patients achieved an excellent outcome, 40.0% (n=8) were graded as good, another 40.0% (n=8) were classified as fair, and 5.0% (n=1) had a poor clinical outcome. These results reflect a generally favorable functional recovery in the majority of patients, tab. (4). The mean time to radiological union was 16.85 ± 0.88 weeks, while the average rehabilitation period was 12.65 ± 2.96 weeks. Regarding complications, malunion occurred in 20.0% (n=4) of patients, and nonunion in 15.0% (n=3). Other complications included osteoarthritis in 10.0% (n=2) and joint stiffness in 5.0% (n=1). Notably, 50.0% (n=10) of the patients experienced no complications, and no cases of superficial infection were reported. These findings suggest that while half of the cohort had an uncomplicated recovery, the remaining patients experienced a range of postoperative challenges, tab. (5). The average time to radiological union in the study group was 16.85 ± 0.88 weeks, while the mean duration of rehabilitation was 12.65 ± 2.96 weeks. Postoperative complications included malunion in 20.0% (n=4) of patients, nonunion in 15.0% (n=3), osteoarthritis in 10.0% (n=2), and joint stiffness in 5.0% (n=1). Half of the patients (50.0%, n=10) experienced no complications during follow-up. Notably, no cases of superficial infection were reported. These findings indicate that while most patients had favorable healing and recovery timelines, a significant portion encountered structural or functional complications, tab. (2).

Table (1) Demographic and clinical data of the study group (n=20).

Parameter		**Mean/ frequency**
Age (years)	▪ ***Mean ± SD***	48.75 ± 7.43
	▪ ***Median (Range)***	48.00 (35.00-62.00)
Gender	▪ ***Female***	7(35.0%)
	▪ ***Male***	13(65.0%)
Operative time (min)	▪ ***Mean ± SD***	85.80 ± 3.47
	▪ ***Median (Range)***	86.00 (80.00-90.00)

Table (2) Modified Rasmussen Radiological 1st, 2nd and 3rd X-ray scores among the study group.

Parameter		**Mean/frequency**	**P-value**
Modified Rasmussen Radiological 1st X-ray		9.25 ± 0.44	**<0.0001***
Modified Rasmussen Radiological 2nd X-ray		7.75 ± 0.72	
Modified Rasmussen Radiological 3rd X-ray		6.75 ± 0.97	
Modified Rasmussen Radiological 1st X-ray Grades	▪ ***Excellent***	20 (100.0%)	**<0.0001****
Modified Rasmussen Radiological 2nd X-ray Grades	▪ ***Excellent***	1(5.0%)	
	▪ ***Good***	19 (95.0%)	
Modified Rasmussen Radiological 3rd X-ray Grades	▪ ***Excellent***	1 (5.0%)	
	▪ ***Fair***	7 (35.0%)	
	▪ ***Good***	12 (60.0%)	

****One-Way ANOVA, ** Chi-square***

Table (3) Medial Proximal Tibia Angle (MPTA) 1st, 2nd and 3rd X-ray among the study group

Parameter	Mean ± SD	P-value
MPTA 1st X-ray	88.38 ± 0.98	**<0.0001***
MPTA 2nd X-ray	91.34 ± 1.24	
MPTA 3rd X-ray	91.42 ± 1.86	

Table (4) Modified Rasmussen Clinical Assessment (points) among the study group.

Parameter		Mean/ frequency
Modified Rasmussen Clinical Assessment (points)	▪ ***Mean ± SD***	23.80 ± 2.73
Modified Rasmussen Clinical Assessment (grades)	▪ ***Excellent***	3(15.0%)
	▪ ***Good***	8(40.0%)
	▪ ***Fair***	8(40.0%)
	▪ ***Poor***	1(5.0%)

Table (5) Postoperative outcomes and complications among the study group.

Parameter		Mean/Frequency
Time to union (weeks)		16.85 ± 0.88
Time in rehabilitation (weeks)		12.65 ± 2.96
Complications	▪ ***Mal union***	4 (20.0%)
	▪ ***Non union***	3 (15.0%)
	▪ ***Osteoarthritis***	2 (10.0%)
	▪ ***Stiffness***	1 (5.0%)
	▪ ***No complications***	10 (50.0%)
	▪ ***Superficial infection***	0 (0.0%)

4. Discussion

Schatzker type II tibial plateau fractures involve a split and depression of the lateral plateau and are typically caused by high-energy trauma, often leading to significant functional limitations if not properly treated [7,8]. Effective management is essential to restore joint congruity, maintain stability, and prevent long-term issues such as post-traumatic arthritis. Common surgical options include screw fixation alone or in combination with a plate [9]. While screw-only fixation is less invasive, it may be inadequate in cases with marked depression or fragmentation. The addition of a plate can enhances stability and anatomical restoration but may increase operative time and complication risk. Selecting the optimal fixation technique is key to achieving favorable clinical outcomes and guiding treatment strategies [10]. The average operative time in this study was 85.80 ± 3.47 minutes, with a narrow range of 80 to 90 minutes. This reflects the efficiency and reproducibility of the percutaneous screw fixation technique when performed on Schatzker type II tibial plateau fractures. Compared to more extensive open reduction procedures, the shorter operative duration may contribute to reduced intraoperative blood loss and lower risk of soft tissue complications. Frank et al. [11] reported that the use of screw fixation in orthopedic procedures was associated with increased operative time, reflecting the technical demands of this method. Cofano et al. [12] noted that screw fixation was not associated with excessive intraoperative blood loss, supporting its safety and reliability as a fixation technique. The Modified Rasmussen Radiological scores demonstrated a statistically significant decline over time, indicating progressive deterioration of radiological appearance. The mean score decreased from 9.25 at the first postoperative X-ray to 6.75 at the third, with corresponding shifts in grade distribution—highlighting a reduction in the proportion of excellent outcomes from 100% to 5%. While initial reduction was satisfactory, this decline may reflect settling of fracture fragments, delayed subsidence, or limitations in maintaining long-term articular congruity using screw fixation alone. These findings raise concern about the durability of isolated screw fixation in preserving joint integrity over time. Cavalié et al. [13], the combination of plate and screws provides superior radiological outcomes at the follow-up stage. While some studies have highlighted limitations, screw fixation remains a commonly used technique due to its minimally invasive nature and straightforward application [14]. Additionally, screw fixation has been utilized in cases requiring direct compression across fracture lines, supporting its role in achieving initial mechanical stability [15]. Despite the decline in radiological scores, the MPTA significantly improved and remained stable throughout follow-up. The increase from 88.38° to 91.42° ($p < 0.0001$) suggests effective and lasting correction of tibial alignment. This supports the role of percutaneous screw fixation in restoring the mechanical axis, even if some joint surface remodeling or depression occurs over time. Li et al. [16] observed that screw fixation may be associated with alignment changes over time, which could reflect the mechanical behavior of this fixation method during the healing process. Baraka et al. [17] reported that screw-only fixation was linked to higher MPTA values, suggesting a pattern of progressive angular shift during follow-up. In clinical assessments, patients who underwent screw fixation showed variable outcomes, with a portion achieving fair to good results. Patient-reported outcome measures in screw fixation cases have been explored in systematic reviews, indicating room for improvement in functional recovery and satisfaction levels [14]. Additional findings also noted variability in recovery time and clinical scores among patients treated with screws alone [18]. Functionally, the mean Modified Rasmussen Clinical score was 23.80 ± 2.73, indicating generally favorable outcomes. A combined 55% of patients were rated as excellent or good, while 40% were fair and only 5% poor, tab. (4). These results suggest that, despite some radiological deterioration, many patients were able to recover meaningful knee function. This reflects the importance of early motion, joint alignment, and rehabilitation in driving functional recovery beyond imaging findings alone. Zyskowski et al. [19] examined outcomes in patients treated with traditional screw fixation and documented longer durations to fracture union and rehabilitation milestones. These findings highlight aspects of the healing process associated with screw fixation that may require extended follow-up and support during recovery. Li et al. [16] also reported on the use of screw fixation in various fracture types, noting that healing times could be prolonged depending on fracture complexity and biomechanical demands. Radiological union was achieved on average at 16.85 ± 0.88 weeks, with rehabilitation lasting approximately 12.65 ± 2.96 weeks. While half of the patients experienced an uncomplicated course, complications were reported in the remaining 50%, including malunion (20%), nonunion (15%), osteoarthritis (10%), and joint stiffness (5%), tab. (5). The absence of superficial infections is noteworthy and may reflect the minimally invasive nature of the procedure. However, the relatively high rate of structural complications highlights the need for careful patient selection and possible augmentation strategies—such as bone grafting or supplemental fixation—in cases with significant depression or comminution. Nicholson et al. [20] observed that screw fixation was associated with a measurable incidence of nonunion across various fracture types, suggesting the need for careful case selection and monitoring during follow-up. Foruria et al. [21] noted that patients treated with screw fixation required longer-term observation for potential complications related to joint function and integrity, particularly in cases involving intra-articular fractures.

5. Conclusions

This study demonstrates that percutaneous cannulated screw fixation for Schatzker type II tibial plateau fractures offers satisfactory short-term clinical and radiological outcomes with a relatively short operative time and acceptable complication profile. While the mechanical alignment, as indicated by MPTA, was effectively restored and maintained, a gradual decline in radiological scores was noted over time, possibly due to fragment settling or limited support in cases with articular depression. Nevertheless, most patients achieved good to fair functional recovery, and half experienced no complications. These findings support the use of screw fixation as a minimally invasive, efficient treatment option, although careful patient selection remains critical—particularly in cases with severe comminution or joint depression that may benefit from augmented fixation.

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