ORIGINAL ARTICLE

A modified subchondral raft technique using free 5.5-mm cannulated compression screws for depressed tibial plateau fractures: a prospective observational study

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ABSTRACT

BACKGROUND: In tibial plateau fractures, achieving anatomical restoration of the articular surface and preventing postoperative collapse are critical for successful outcomes. Bone grafting is still commonly used to fill subchondral voids after reduction; however, it carries risks such as donor-site morbidity and technical difficulties. To address these issues and enhance subchondral stability, subchondral raft techniques have been developed. Although various screw and plate configurations have been investigated in the literature, there is still no clear consensus regarding the most effective method. We aimed to evaluate the effectiveness of our modified technique using free 5.5-mm cannulated compression screws in preventing postoperative collapse and improving functional recovery in tibial plateau fractures.

METHODS: A total of 21 patients were included based on the following criteria: age ≥18 years, presence of >10 mm depression in the lateral tibial plateau, and no history of previous surgery on the affected knee. A subchondral raft construct was established without grafting using free 5.5-mm cannulated compression screws. Postoperative evaluation at 12 months included radiological and functional assessments using the Rasmussen Clinical Score (RCS) and Rasmussen Radiological Score (RRS).

RESULTS: The mean preoperative articular depression was 14.7 mm, improving to 1.1 mm at the one-year follow-up. Mean condylar widening decreased from 5.3 mm preoperatively to 0.7 mm postoperatively. The average postoperative hospital stay was 3.7 days, and the mean time to return to work was 3.5 months. At one year, radiological and functional outcomes were favorable, with a mean RCS of 26.6 and a mean RRS of 16.6.

CONCLUSION: The modified raft technique using 5.5-mm cannulated compression screws is a simple and effective option for managing depressed tibial plateau fractures, preventing articular collapse and facilitating faster recovery.

Keywords: Tibial plateau fracture; subchondral raft; cannulated compression screw; early rehabilitation; functional recovery; Rasmussen score.

INTRODUCTION

Tibial plateau fractures are periarticular injuries of the proximal tibia and represent some of the most challenging injuries in orthopedic practice. They account for approximately 1% of all fractures and are more common in men under 50 years of age due to high-energy trauma, while low-energy mechanisms predominate in elderly women with osteoporosis.[1,2] These injuries often result in significant morbidity, increased health-

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care costs, and prolonged recovery, particularly in younger patients during their most productive years.[3] Anatomical reduction and stable fixation are essential for restoring knee function and mobility.

Management of tibial plateau fractures often requires addressing metaphyseal bone defects resulting from elevation of depressed articular fragments. While bone grafting is commonly used to fill these voids, it is associated with several complications and technical difficulties.[4-7] To overcome these limitations and improve fixation stability, subchondral rafting techniques have increasingly been applied in clinical practice. The present study aimed to evaluate the effectiveness of a subchondral raft configuration reinforced with 5.5-mm free cannulated compression screws in the treatment of depressed tibial plateau fractures without the use of bone grafts. This technique was hypothesized to enhance articular stability, prevent early collapse, and promote faster functional recovery. To the best of our knowledge, no previous studies have reported the use of this specific screw configuration for subchondral rafting.

MATERIALS AND METHODS

The study was approved by the Clinical Research Ethics Committee of University of Health Sciences Prof. Dr. Cemil Taşcıoğlu City Hospital, University of Health Sciences (No: E-48670771-514.10; Date: May 24, 2021; Decision No: 212). All procedures were performed in accordance with the ethical principles of the Declaration of Helsinki. Informed consent was obtained from all patients.

This study was designed as a prospective observational study. Between May 2021 and May 2022, patients diagnosed with tibial plateau fractures at our hospital were evaluated. Twenty-one patients were included according to the following criteria: age ≥18 years, a lateral tibial plateau depression greater than 10 mm, and no history of prior surgery on the affected knee. Patients were excluded if they were younger than 18 years of age, had a history of previous knee surgery or fractures around the knee, had isolated split-type fractures or posterior column involvement, had less than 10 mm of depression in the lateral tibial plateau, or presented with open or pathological fractures.

Data were collected on a range of variables, including patient demographics (age, sex, and side of injury), mechanism of trauma, and fracture type according to the Schatzker classification. Perioperative data, such as operative time and duration of postoperative hospitalization, were also recorded. Radiological assessments included preoperative and postoperative measurements of articular depression and condylar widening on computed tomography (CT) images, evaluated by a blinded orthopedic surgeon who was not involved in the surgeries (Fig. 1). All radiological measurements were performed on coronal and sagittal CT images with a slice thickness of 1 mm to ensure precise evaluation of articular depression and condylar widening. Functional and radiological outcomes were assessed using the Rasmussen Clinical Score (RCS) and Rasmussen Radiological Score (RRS) at the one-year postoperative follow-up (Table 1).[8] Additionally, employment status prior to injury, return-to-work rates, and time to resume occupational activities were documented.

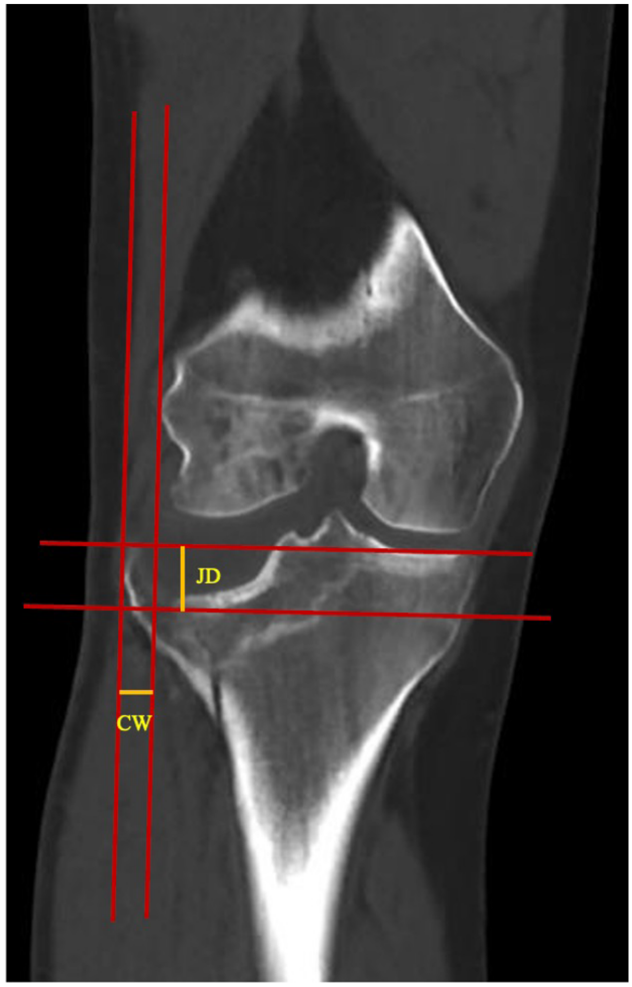

Figure 1. Method of measuring joint depression (JD) and condylar widening (CW) on computed tomography (CT) images. JD is defined as the vertical distance between the tibial joint line and the lowest point of the depressed articular surface. CW is defined as the horizontal distance between the outermost point of the femoral condyle and the outermost point of the tibial plateau.

Table 1. Evaluation criteria for Rasmussen scores

RRS	RCS	Evaluation
18 points	27–30 points	Excellent
12–17 points	20–26 points	Good
6–11 points	10–19 points	Fair
0–5 points	4–9 points	Poor

Figure 2. Intraoperative view following fixation.

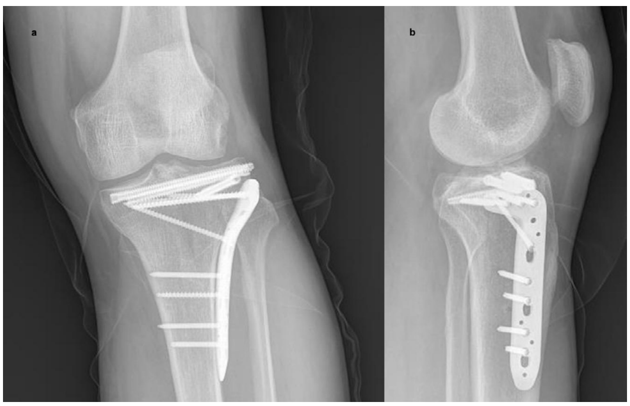

Figure 3. Postoperative one-year follow-up radiographs. **(a)** Anteroposterior view and **(b)** lateral view.

Surgical Technique

Patients with favorable soft-tissue conditions were operated on within the first 24 hours. For those with less favorable conditions, cold therapy and limb elevation were initiated, and patients were monitored for signs of compartment syndrome. Once the soft-tissue envelope was suitable for surgery, procedures were scheduled between postoperative days 3 and 5. All surgeries were performed by the same senior orthopedic surgeon.

Patients were positioned supine with a tourniquet applied, and a silicone pad was placed under the knee to maintain approximately 20–30° of flexion. Following sterile draping and skin preparation, a standard anterolateral approach was utilized. The subcutaneous tissue and fascia were incised sharply without separating the adipose layer, creating full-thickness fasciocutaneous flaps. The tibialis anterior muscle was elevated en bloc from the bone, the iliotibial band was released, and a transverse submeniscal arthrotomy was performed. Two polydioxanone (PDS) sutures were passed through the periphery of the lateral meniscus to elevate it, and the knee was placed in varus to allow visualization of the joint surface. Depressed articular fragments were elevated under direct visualization to achieve anatomical reduction. In cases involving concurrent medial plateau fractures, indirect reduction was performed using manual traction, reduction forceps, and provisional fixation with K-wires (2.0 mm). A subchondral raft construct was created using free 5.5-mm cannulated compression screws (Tasarimmed, Istanbul, Türkiye) to provide a raft effect and apply compressive force to prevent gap formation. In cases requiring additional mechanical stability based on fracture morphology and bone quality, the screws were inserted over the plate, whereas isolated screw fixation was preferred in selected cases. The screws were inserted into the subchondral region beneath the elevated fragments, with two or three screws placed—depending on the size and location of the osteochondral fragments—through the superior portion of the plate laterally and via stab incisions medially under fluoroscopic guidance. No bone grafts were used in any of the patients. The previously placed PDS sutures were secured to the plateau by passing them through the holes of the plate or around the screw heads (Fig. 2). Following hemostasis, a single drain was placed in the subfascial plane, and the surgical layers were closed anatomically.

Postoperative Care and Follow-Up

Cold therapy and limb elevation were initiated on the first postoperative day and continued until swelling subsided. Following drain removal on postoperative day 1, all patients were fitted with a hinged knee brace allowing 0–30° of flexion. Quadriceps strengthening exercises were initiated within the first postoperative week once edema had sufficiently decreased. The brace was adjusted to allow 0–60° of flexion by postoperative day 15 and 0–90° by the end of the first month, with brace removal planned at week 6. Weight-bearing was restricted until clinical examination and radiological imaging confirmed adequate fracture healing.

All patients attended their first outpatient follow-up on postoperative day 15 for incision site inspection and suture removal. Subsequent follow-ups were conducted at 1, 2, 3, and 6 months, during which routine anteroposterior and lateral knee radiographs were obtained. At the one-year follow-up, patients were additionally evaluated with CT. Clinical and radiological outcomes were assessed and scored according to the Rasmussen Clinical and Radiological Criteria (Figs. 3, 4).

Statistical Analysis

Prior to data collection, a power analysis was performed using G*Power 3.1 software to determine the minimum required sample size. Assuming an effect size of 0.8, an alpha level of 0.05, and a power (1–β) of 0.80, the analysis indicated that a minimum of 20 patients would be sufficient to detect clinically meaningful differences in postoperative outcomes based on Rasmussen scores. Accordingly, the final sample of 21 patients met the required statistical power threshold for this study design.

Statistical analyses were performed using NCSS (Number Cruncher Statistical System) 2007 Statistical Software (Utah, USA). Descriptive statistics (mean, standard deviation, minimum, and maximum) were used to summarize the data. The

Figure 4. Clinical examination images of a patient at the one-year postoperative follow-up. **(a)** Frontal view in extension; **(b)** Lateral view in extension; **(c)** Standing lateral view; **(d)** Squatting view.

distribution of variables was assessed using the Shapiro–Wilk test. For normally distributed continuous variables, the independent samples t-test was used for comparisons between two independent groups, and Pearson correlation analysis was used to evaluate relationships between continuous variables. For non-normally distributed variables, the Mann–Whitney U test and Spearman's correlation analysis were applied. A p-value <0.05 was considered statistically significant.

RESULTS

Detailed demographic data of the patients are presented in Table 2.

In our study, the mean operative time was 91.6 minutes (range, 60–150 minutes), and the mean postoperative hospital stay was 3.7 days (range, 2–7 days).

The mean preoperative articular depression was 14.7 mm, which decreased to 1.1 mm at the one-year postoperative follow-up (p<0.001). The mean preoperative condylar widening was 5.3 mm, which improved to 0.7 mm at one year postoperatively (p<0.001) (Table 3).

At the one-year postoperative follow-up, the mean RRS was 16.6, and the mean RCS was 26.6 (Table 4).

Both RCS and RRS demonstrated a significant negative correlation with preoperative and postoperative articular depression (p<0.05). However, the correlation between RCS and condylar widening was not significant in the postoperative period (Table 5).

A positive correlation was observed between radiological and clinical scores at the one-year follow-up (p=0.043).

Table 2. Demographic characteristics of the patients

Patient No	Age	Sex	Side	BMI (kg/m2)	Mechanism	Schatzker of injury	Comorbidities type	Smoking
1	60	M	R	34.2	HE	3	DM	-
2	58	F	R	25.1	LE	3	DM	+
3	46	M	L	33	HE	6	None	+
4	45	F	L	41	LE	2	HT, DM	-
5	47	M	L	26.1	HE	3	None	+
6	27	M	R	21.6	HE	6	None	+
7	36	M	R	25.2	HE	5	None	+
8	58	M	L	28.7	HE	6	HT, DM	-
9	24	M	L	29.4	HE	5	None	+
10	56	F	R	37.7	LE	2	HT, DM	+
11	50	F	L	25.7	HE	2	HT	-
12	18	M	R	24.6	HE	3	None	+
13	42	M	L	35.5	HE	2	None	-
14	61	M	R	23.5	HE	2	None	+
15	30	M	L	24.1	LE	6	None	+
16	36	F	R	25.4	LE	2	None	+
17	36	M	L	23.9	LE	2	None	+
18	29	M	L	25.9	LE	2	None	-
19	20	F	L	19.9	HE	2	None	+
20	41	M	R	27	LE	2	None	-
21	53	M	R	38.3	HE	2	DM	-

DM: Diabetes mellitus; HT: Hypertension; R: Right; L: Left; HE: High-energy trauma; LE: Low-energy trauma; M: Male; F: Female.

Table 3. Preoperative and postoperative articular depression and condylar widening measurements

Parameter	N	Min	Max	Mean±SD
Preoperative depression (mm)	21	10.5	36.8	14.74±5.62
Postoperative depression (mm)	21	0	4.2	1.14±1.48
Preoperative condylar widening (mm)	21	2.8	16.4	5.26±3.01
Postoperative condylar widening (mm)	21	0	2.8	0.69±1.01

Table 4. Mean Rasmussen Clinical Score (RCS) and Rasmussen Radiological Score (RRS) at the one-year postoperative follow-up

	N	Min	Max	Mean±SD
RCS	21	20	29	26.67±2.35
RRS	21	14	18	16.57±1.43

Of the 18 patients who were employed prior to injury, 16 returned to their previous jobs, while two transitioned to less physically demanding occupations. Among those who resumed their original employment, the mean time to return to work was 3.5 months (range, 2–9 months).

DISCUSSION

The most significant finding of our study is that the modified

Table 5. Comparison of the Rasmussen Clinical Score (RCS) and Rasmussen Radiological Score (RRS) with preoperative and postoperative articular depression and condylar widening measurements

	RCS	RRS
Preoperative depression (mm)		
r	-0.697	-0.487*
p	<0.001	0.025*
Postoperative depression (mm)		
r	-0.476	-0.777*
p	0.029	<0.001*
Preoperative condylar widening (mm)		
r	-0.573	-0.325*
p	0.007	0.150*
Postoperative condylar widening (mm)		
r	-0.365	-0.751*
p	0.104	<0.001*

RCS: Rasmussen Clinical Score; RRS: Rasmussen Radiological Score. *Statistically significant correlation (p<0.05; p<0.001=highly significant).

raft technique effectively prevented postoperative articular surface collapse. This technique is based on the raft construct concept, which has gained recognition as a reliable method for maintaining reduction, preventing collapse, and reducing additional morbidity in tibial plateau fractures. Various plate and screw configurations have been described in the literature to achieve adequate subchondral support.[9-13] However, monoaxial locking plates do not always allow optimal screw orientation.[14,15] In our study, the anatomical position of the lateral plate limited proximal screw placement into the subchondral area; therefore, we used freely placed 5.5-mm cannulated compression screws to overcome this limitation and achieve a proper raft effect. These screws were selected to avoid the fragmentation risk associated with 6.5-mm screws while providing greater support than 3.5-mm screws. As a result, the technique proved effective in preventing postoperative collapse, and all patients achieved good or excellent outcomes at the one-year follow-up.

In our study, a standardized anterolateral approach with the shortest feasible incision was applied in all patients, regardless of fracture type, and full-thickness fasciocutaneous flaps were created. Several studies have reported higher rates of infection and soft-tissue complications associated with dual-incision techniques.[16-19] In our study, we observed more rapid resolution of postoperative edema, faster soft-tissue healing, and shorter hospital stays. No cases of superficial infection, deep infection, or skin necrosis were observed. Based on our findings, the single anterolateral approach combined with a raft construct reinforced by 5.5-mm screws appears to be an effective method for achieving adequate stability in bicondylar tibial plateau fractures without medial plateau comminution while reducing the risk of soft-tissue complications. When determining the fixation strategy, it is important to consider not only biomechanical principles but also factors such as operative duration, soft-tissue condition, and patient-specific needs.

Tibial plateau fractures are significant intra-articular injuries that frequently affect young and active individuals during their most productive years, potentially leading to substantial disruptions in social life, daily functioning, and professional activities.[20] Kraus et al.,[21] in their study on this topic, reported a mean return-to-work time of 120 days, with approximately 23% of patients switching to less physically demanding jobs and 17% reducing their weekly working hours. In our study, patients returned to their previous jobs after an average of 3.5 months, with only two reporting a transition to less physically demanding work. We also observed that the mean hospital stay was relatively short, averaging 3.7 days. While return-to-work outcomes are influenced by numerous factors—including sociocultural background, economic considerations, and concomitant injuries—the surgical technique we employed enabled early mobilization, minimized postoperative complications, and facilitated earlier reintegration into both work and social life. In addition, the shorter length of hospital stay associated with this approach suggests that it may represent a cost-effective treatment option.

Recent literature increasingly supports graftless subchondral raft fixation as a reliable alternative to conventional bone graft–assisted constructs. Hassan et al.[22] demonstrated that split-depression tibial plateau fractures treated with subchondral rafting screws and locking plates without bone grafting achieved excellent radiological alignment and functional recovery, with negligible collapse and minimal complications. Similarly, Liu et al.[23] compared grafted and graft-free constructs and found no significant difference in radiologic restoration or Rasmussen scores, concluding that graft-free fixation provided comparable mechanical support while avoiding donor-site morbidity and reducing operative time. In another recent biomechanical and clinical analysis, Jiang et al.[24] reported that raft or "jail" screw configurations beneath the articular surface provided equivalent load distribution and resistance to subsidence compared to augmented graft techniques. Collectively, these findings reinforce the biomechanical rationale of the modified raft technique used in our study, highlighting that adequately oriented subchondral screws can provide sufficient metaphyseal support without the need for grafts. Moreover, graft-free fixation eliminates the risks associated with graft harvesting or substitution and facilitates earlier mobilization and functional rehabilitation.

No postoperative complications were observed in our series. None of the patients developed superficial or deep infection, hematoma, wound dehiscence, skin necrosis, neurovascular injury, or implant-related complications. During the follow-up period, no reoperations, implant removals, or additional surgical interventions were required. All patients achieved uneventful wound healing and early mobilization, supporting the safety and reproducibility of the modified subchondral raft technique.

This study was conducted at a single center, and all surgeries were performed by the same senior surgeon, which may represent a limitation in terms of selection bias. However, all eligible patients who met the inclusion criteria were consecutively enrolled during the study period to minimize this effect. To reduce measurement bias, all preoperative and postoperative radiological assessments were performed by an independent orthopedic surgeon who was not involved in the surgical procedures. All clinical and radiological assessments were performed using objective criteria, and the risk of information bias is therefore considered low. Nevertheless, several additional limitations should be acknowledged. First, the relatively small sample size may limit the generalizability of the findings to broader populations. Second, the absence of a control group—such as patients treated with bone grafts, alternative implant systems, or different reduction techniques—restricts the ability to draw direct comparative conclusions and limits the external validity of the findings. Although the present results demonstrate the effectiveness of the modified subchondral raft technique, its relative advantages or disadvantages compared to other fixation strategies remain to be clarified. Future prospective comparative studies are therefore warranted to validate these outcomes and further strengthen the level of evidence. Third, longer-term follow-up would be necessary to more comprehensively evaluate potential late-onset complications and the durability of the surgical outcomes.

CONCLUSION

In conclusion, the raft technique using free 5.5-mm cannulated compression screws effectively prevented articular surface collapse and enabled early rehabilitation, facilitating an early return to work and daily activities. Additionally, by reducing hospital stay, this approach demonstrated cost-effectiveness while offering a simple and reproducible treatment option for tibial plateau fractures.

Ethics Committee Approval: This study was approved by the Clinical Research Ethics Committee of University of Health Sciences Prof. Dr. Cemil Taşcıoğlu City Hospital, University of Health Sciences (Date: 24.05.2021, Decision No: E-48670771-514.10).

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ORİJİNAL ÇALIŞMA - *ÖZ*

Deprese tibia plato kırıklarında serbest 5.5 mm kanüllü kompresyon vidaları ile modifiye subkondral raft tekniği: Prospektif gözlemsel çalışma

AMAÇ: Bu çalışmanın temel amacı, tibia plato kırıklarının tedavisinde 5.5 mm'lik serbest kanüllü kompresyon vidaları ile oluşturulan subkondral raft konfigürasyonunun, postoperatif çökmeyi önlemede etkinliğini değerlendirmektir. Hipotezimiz, bu tekniğin eklem yüzeyi çökmesini önleyerek fonksiyonel iyileşmeyi hızlandıracağı yönündedir.

GEREÇ VE YÖNTEM: Çalışmaya; 18 yaş ve üzeri, lateral tibia platosunda 10 mm'den fazla çökme saptanan ve etkilenen dizinden daha önce geçirilmiş cerrahi öyküsü bulunmayan toplam 21 hasta dahil edildi. Tüm hastalarda tek anterolateral yaklaşımla açık redüksiyon yapılarak serbest 5.5 mm'lik kanüllü kompresyon vidaları ile subkondral raft konstrüksiyonu oluşturuldu. Hiçbir hastada greft uygulaması yapılmadı. Ameliyat sonrası 12. ayda hastalar, Rasmussen Klinik Skoru (RKS) ve Rasmussen Radyolojik Skoru (RRS) ile radyolojik ve fonksiyonel açıdan değerlendirildi.

BULGULAR: Ortalama preoperatif eklem yüzeyi depresyonu 14.7 mm iken, bir yıllık takipte 1.1 mm'ye; ortalama kondiler genişleme ise 5.3 mm'den 0.7 mm'ye geriledi. Ameliyat sonrası ortalama hastanede yatış süresi 3.7 gün, işe dönüş süresi ise 3.5 ay olarak saptandı. Postoperatif 1. yıl fonksiyonel ve radyolojik sonuçlar iyi düzeyde olup ortalama RKS 26.6 ve RRS ise 16.6 bulundu.

SONUÇ: Uygulamış olduğumuz 5.5 mm'lik kanüllü kompresyon vidaları ile oluşturulan subkondral raft tekniği, tibia plato kırıklarının tedavisinde postoperatif eklem yüzeyi çökmesini önleyen, iyileşmeyi hızlandıran, basit ve etkili bir yöntemdir.

Anahtar sözcükler: Erken rehabilitasyon; fonksiyonel iyileşme; kanüllü kompresyon vidası; Rasmussen skoru; subkondral raft; tibia plato kırığı.

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