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Augmentation by Rafting Screw on Fixation of the Lateral Tibial Plateau Fractures

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Tibial plateau fracture is considered one of the most common intra-articular fractures, especially lateral condyle fractures. The purpose of this study is to evaluate clinical, radiological, and functional outcomes of using subchondral periarticular rafting screw above a lateral plate without bone grafting or substitute for Schatzker type II and type III fractures.
Methods: This prospective study was carried out on 43 patients above the age of 18, fit for surgery with closed tibial plateau fracture [lateral split depression (type II) and lateral depression (type III) according to Schatzker classification] time of trauma less than 14 days with no other skeletal injuries. All patients were followed up for at least six months. All patients were treated by open reduction and internal fixation (ORIF) and using subchondral periarticular screws as rafting construct to maintain articular surface and protect it from collapse. Analysis of clinical outcome was clinically based on Modified Rasmussen clinical scoring system and radiologically based on Rasmussen radiological knee scoring system.
Results: In our study, 28 females and 15 males with a mean age of 49.5 years, mechanisms of trauma were road traffic accidents in 26 cases, and fall from height in 17 cases, 24 cases with Schatzker type II fracture, and 19 with type III. According to functional Rasmussen score, acceptable results were 93.1%, (76.8% excellent & 11.6% good) while non-acceptable results were

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6.9%, (4.6% fair & 2.3% poor). According to radiological Rasmussen score, acceptable results were 83.7%, (65% excellent & 18.7% good) while non-acceptable results were 16.3%, (9.3% & 7%). No significant difference was found between the studied groups regarding sex, side affected, type of fracture, and type of trauma. The final outcome was significantly affected by age, medical history.

Conclusions: Fixation using a subchondral periarticular rafting screws for lateral split-depression and lateral depression tibial plateau fractures without using bone graft or bone substitutes is a viable and good option during open reduction and internal fixation, helps surgeons achieve and preserve the anatomic joint line and normal mechanical axis, with superior functional results in the short term. Therefore, avoiding morbidity associated with bone grafting without compromising the fracture stability.

Keywords: Augmentation; rafting screw; lateral; tibial plateau; fracture.

1. INTRODUCTION

Tibial plateau fracture is considered one of the most common intra-articular fractures it represents around 1% of all fractures in adults and 3% of lower limb fractures. It is a major traumatic injury occurring as a result of road traffic accident (RTA), fall from height, violence, etc. It may be associated with soft tissue or other bony injuries. Any fracture around a joint (especially weight-bearing joint as the knee) has significant morbidity and adverse effects on quality of life; hence the treatment of complex tibial plateau fractures remains a challenge in many aspects [1].

A tibial plateau fracture is an intra-articular fracture that always involves various degrees of splitting, depression, and displacement [2]. Schatzker type II and type III fractures are the most common tibial plateau injuries which represent about 25% and 36% of all tibial plateau fractures respectively. These types of fractures occur as a result of axial loading and/or bending forces. These types of fractures usually contain more than one fragment because the lateral tibial plateau is convex to the femur and features a substantial proportion of cancellous bone. Articular surface depression is widely seen in older patients because of osteoporosis [3,4].

The goal of treatment for intra-articular fractures is to restore joint mobility, stability, articular surface congruence, and axial alignment and to avoid posttraumatic osteoarthritis. [5] Schatzker type II & III tibial plateau fractures have been traditionally treated with open reduction, the elevation of articular surface, cancellous autograft or allograft, and rigid internal fixation [6].

The purpose of this study is to evaluate clinical, radiological, and functional outcomes of using rafting screws without bone grafting or substitute for lateral split-depression and lateral pure depression type of tibial plateau fractures.

2. SUBJECTS AND METHODS

All patients were subjected to the following:

1. Full history taking: personal history (name, age, sex, residency, and smoking), mode of trauma, duration, medical history, and previous regional surgeries,
2. Clinical Examination: a- general examination b- local examination: Full local examination, including soft tissue evaluation.
3. Investigations: a- laboratory investigations b- Radiological [Plain X-ray:(AP and Lateral views), CT Scan with 3D construction.

2.1 Preoperative Preparation

Limb elevation and anticoagulant, analgesic administration, above knee resting slab to control the pain and decrease soft tissue edema. The type of fracture was determined according to Schatzkar's classification.

2.2 Surgical Technique

After the induction of spinal anesthesia, a prophylactic antibiotic was given. A pneumatic tourniquet was used. All patients were positioned supine on a radiolucent table. The injured limb was maintained in a slightly flexed position at 30° with a folded pillow under the knee to allow knee flexion.

An extended inverted L-shaped anterolateral approach was used in all cases. Skin incision started about 1 to 3 cm distal to the joint line just lateral the patella tendon. Curving the incision anteriorly over Gerdy's tubercle and then we extend it distally, staying about 1 cm lateral to shin tibia.

Deep fascia was opened anterior to the iliotibial tract, then in some cases, we need to release the proximal attachment of Tibialis Anterior muscle. With the knee flexed in a varus and internally rotated position, the articular surface was exposed through a horizontal capsulotomy between the deep edge of the meniscus and tibia.

In pure depression fracture, a cortical window is created on the anterolateral tibial metaphysis 3–5 cm below the articular surface. Elevation of the articular surface depression could be done using a rod or any blunt towel (curette) to reduce the articular surface anatomically directly under fluoroscopic vision (Fig. 1).

The articular surface congruency was checked under fluoroscopy, then temporary Kirschner wire was implanted into the subchondral bone beneath the reduced articular surface before definitive fixation using rafting screws (Fig. 2).

Rafting screws with or without washers were inserted just in the sub-chondral periarticular region from lateral to medial for permanent stable fixation of the articular surface and hold it from collapse. Then we supported the fixation with proximal tibial anatomical plate or locked plate below the rafting construct (Fig. 3).

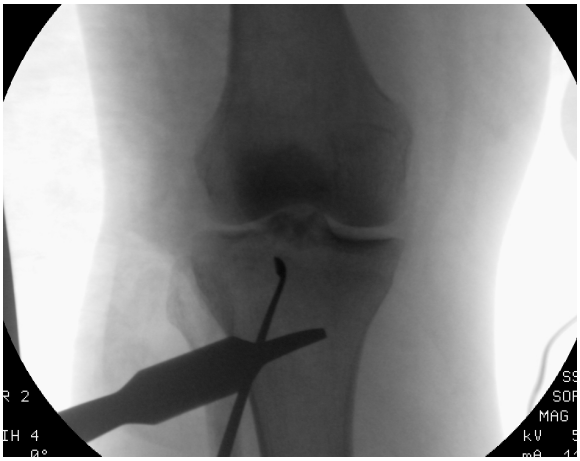


Fig. 1. Elevation of the articular surface

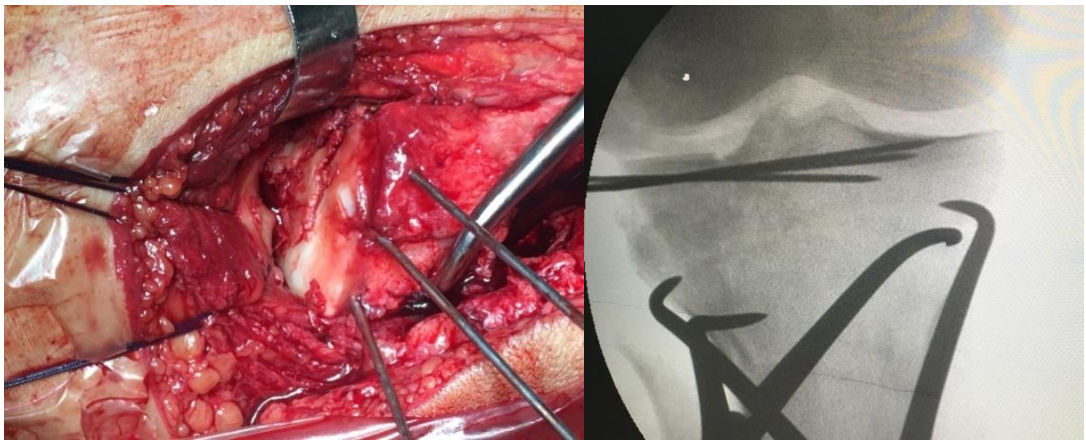


Fig. 2. Reduction and stabilization of articular surface

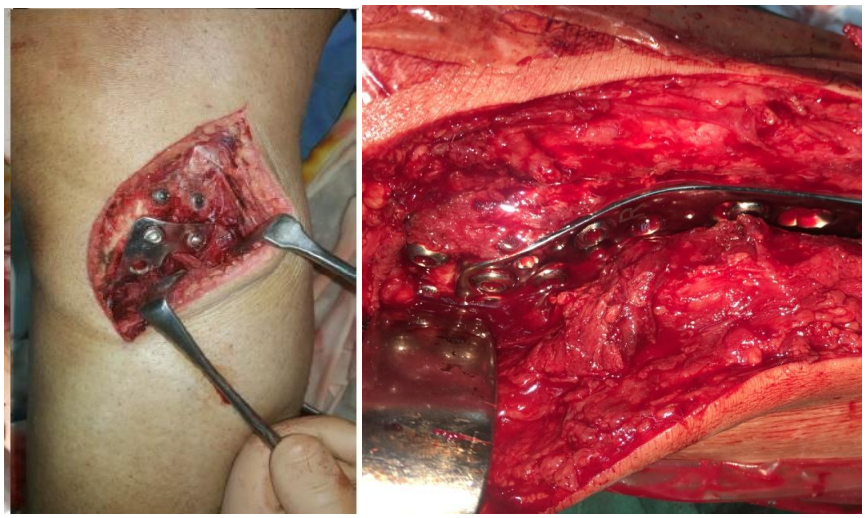


Fig. 3. Insertion of rafting screws, supporting plate and screws

2.3 Choice of the Implant

Plates used were either conventional L-plates or proximal tibial locked plates. Conventional L-plates were used for the fixation of 14 patients. A proximal tibial locked plate was used for the fixation of 29 patients with osteoporosis. Gentle traction was applied to the limb, followed by a gross realignment of the tibia. The plate and screws were placed under fluoroscopic guidance.

2.4 Postoperative Care

Postoperative IV antibiotics, anticoagulants, analgesics & anti-inflammatory were given, and anti-embolic stockings were applied. After 48 hours, gentle knee bending exercise and passive knee movement, and non-weight bearing walking exercises were started.

3. EVALUATION OF RESULTS

3.1 Clinically

Data collection and analysis of the outcome was completed based on Modified Rasmussen clinical scoring system [7] in the form of the degree of pain, walking capacity, extension, total range of motion, and stability. The total score is 30. A Functional score was considered excellent if the points were between 27 to 30 ىpoints. Good results between 20-26 points while fair results between l0-19 points and results were considered poor if the range was less than l0 (Table 1).

3.2 Radiologically

Standard radiographs (AP and lateral X-ray images) were obtained at each appointment, and analysis will be based on Rasmussen radiological knee scoring system [7] (Table 2) which consists of 3 parameters, including assessment of condylar widening, joint depression, and angulation. The total score is 18 points. It was considered excellent if the score is l8. Good if the range between l2-l7, while fair score range between 6-11 and poor score less than 6 points.

Subsequent x-rays were performed at regular follow-ups to look for signs of radiological bone healing that was stated when the fragments appeared united and there was no radiolucency and narrow uniform band of scleroses. Moreover, to check for residual or secondary displacement or joint depression or articular mal-alignment by comparing sets of radiographs for each patient: the immediate postoperative films and follow-up radiographs at 1 month, 3 months, 6 months, with latest follow up x-ray to check for late collapse.

3.3 Statistical Analysis

Data were entered and analyzed using SPSS version 25. Categorical variables were described as frequency and percent. Quantitative data were described as mean ± SD and range. Chi-square was used for comparison between categorical variables. A two-tailed P value <0.05 was considered significant.

Table 1. Rasmussen clinical knee score [8]

Functional Grading	Points	*Acceptable*		*Unacceptable*	
		Excellent	Good	Fair	Poor
A- Subjective complaints					
a- Pain					
1- No pain	6				
2- Occasional ache, bad weather pain	5				
3- Stabbing pain in certain positions	4				
4- Afternoon pain, intense, constant pain around the knee after activity	2	5	4	2	0
5- Night pain at rest	0				
b- Walking capacity					
1- Normal walking capacity (in relation to age)	6				
2- Walking outdoors at least one hour	4				
3- Short walks outdoors >15 minutes	2				
4- Walking indoors only	1	6	4	2	1
5- Wheel-chair/bedridden	0				
B. Clinical signs				2	2
a- Extension					
1- Normal	6				
2- Lack of extension (0 to 10 degrees)	4	6	4		
3- Lack of extension > 10 degrees	2				
b. Total range of motion					
1- At least 140 degrees	6				
2- At least 120 degrees	5	5			
3- At least 90 degrees	4				
4- At least 60 degrees	2		4	2	1
5- At least 30 degrees	1				
6- 0 degree	0				
c. Stability				2	
1- Normal stability in extension and 20 degrees of flexion	6	6			2
2- Abnormal instability 20 degrees of flexion	5				
3- Instability in extension < 10 degrees	4		4		
4- Instability in extension > 10 degrees	2				
Sum *(minimum)*		27	20	10	6

Table 2. Anatomical grading of rasmussen knee score [8]

Anatomical grading	Points	Excellent	Good	Fair	Poor
A- Depression					
1.Not present	**6**				
2. <5 mm	**4**				
3. 6-10 mm.	**2**	**6**	**4**	**2**	**0**
4.> 10 mm	**0**				
B- Condylar Widening					
1. Not present	**6**				
2. <5 mm	**4**				
3. 6-10 mm	**2**	**6**	**4**	**2**	**0**
4. > 10mm	**0**				
C- Angulation **(varus & valgus)**					
1. Not present	**6**				
2. < 10 Degrees	**4**				
3. 10-20 Degrees	**2**				
4. > 20 Degrees	**0**	**6**	**4**	**2**	**0**
Sum(minimum)		**18**	**12**	**6**	**0**

4. RESULTS

4.1 Patients' Demographics

As regard age, in our study, the age of patients ranges from 30 to 65 years. As regard gender, in our study, the number of females was more than males. Females were 28 (67%) while males were 15 (33%). In our studied patients, there were twenty-four patients with no medical history; seven were diabetic, seven were hypertensive, and five of them were smokers. In 26 patients, the mechanism of injury was due to RTA. While 17 patients had fractures due to fall from height. According to Schatzker classification, 24 cases had lateral tibial plateau split depression fractures (Schatzker 2), and 19 cases had lateral tibial plateau depression fracture (Schatzker 3) fractures. In our studied patients, there were 31 patients were Rt. Sided and 12 patients were Lt. Sided (Table 3).

Patients were discharged after mean 5.2 days (range 3-8) when passive knee movement crossed 90 degrees, and there was no soakage on daily dressing (for detection of early sign for infections) with a clean suture line with the instruction of knee bending exercise, quadriceps extension exercise and non-weight bearing walking and stitch removal on 14th postoperative day. The follow-up period was at least for 6 months. Weight-bearing was allowed between 8 and 16 weeks after surgery, progressing from partial weight bearing till full weight-bearing, after achieving clinical union and radiological union.

4.2 Functional Outcome

After six months of follow-up of all patients, the functional outcomes of all patients were assessed according to the functional Rasmussen Knee Scoring system; the mean functional Rasmussen Knee Scoring system was 27.4, which is considered excellent (ranged from 9 to 30). Acceptable results were 93.1%, (76.8% were excellent & 11.6% were good) while non-acceptable results were 6.9%, (4.6% fair & 2.3% poor) (Fig. 4).

4.3 Anatomical Outcome

Anatomical or near-anatomical joint line reconstruction was achieved in all cases. After 6 months of follow-up of all patients, the anatomical outcomes of all patients were assessed according to radiological Rasmussen Knee Scoring system. The mean radiological Rasmussen Knee Scoring system was 17.6, which is considered good (ranged from 12 to 18). 65% of patients were excellent, 18.7% were good, while 9.3% were fair, and 7% poor results (Fig. 5).

Table 3. Patients' characteristics of the studied patients (n = 43)

	No. of patients	Percentage %
Age group		
≤ 50 years old	28	65
> 50 years old	15	35
Sex		
Males	15	33
Females	28	67
Medical history problems		
Hypertension	7	16
DM	7	16
Smoker	5	12
Type of trauma		
RTA	26	60
Fall from Height	17	40
Schatzker classification		
Type II	24	56
Type III	19	44
The affected side		
Right	31	72%
Left	12	28%
Operation day of studied patients (Time Lag)		
≤ 2 days	13	30%
> 7 days	30	70%

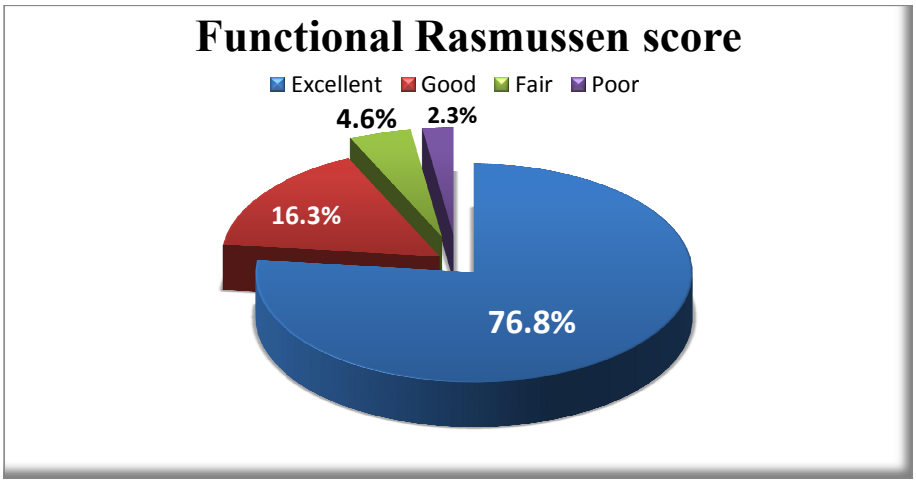


Fig. 4. Functional results of studied patients

4.3.1 Relation between anatomical and clinical results

After six months follow up, there was a significant association between anatomical and clinical score (X^2 = 33.66, P value <0.001) (Table 4).

4.3.2 Radiological bone healing time (Table 5)

The radiological bone healing time was between l.5 and 3.5 months; the mean time of healing was 2.3 months. In our study, nine cases showed radiological bone healing in less than two months, twenty-two cases in 2-3 months, while twelve cases had radiological bone healing in more than three months.

4.3.3 Effect of demographic data on clinical Rasmussen score

In our study, there were two groups of age, 28 cases less or equal 50 years old, 26 of them (93%) had excellent results and 15 cases above 50 years old, only 7 of them (47%) had excellent results (P value = 0.006). There were 15 males; 12 of them developed excellent results, while there were 28 females; 21 of them developed excellent results (P value = 0.476). In our study 26 patients had RTA trauma 20 developed excellent results and 6 good with no fair or poor results. 16 patients had falling trauma; 13 excellent, 1 good, 2 fair & 1 poor (P value = 0.091). In our study 24 cases with Schatzker II fracture; 18 showed excellent results, 4 good, 0 fair& 1 poor. 19 cases with Schatzker III fracture; 14 showed excellent results, 3 good, 2 fair & 0 poor (P value = 0.339). In our study, seven patients were diabetic, seven hypertensive, five smoker and twenty-four with no medical history. Relation between the medical history and functional score was significantly different (P value = 0.004) (Table 6).

4.4 Complications

In our study, we found that eight patients have recorded complications. Two cases developed superficial infections, which improved with frequent dressing and IV antibiotics according to culture and sensitivity. One case developed deep infection treated with surgical debridement and IV antibiotics. Two cases had residual flexion contracture (10°& 5°). Two cases had residual extension lag (5°). One case had DVT (although she took oral anticoagulant) treated with a therapeutic dose of parenteral anticoagulant (Fig. 6).

Table 4. Relation between anatomical and functional results

Anatomical	Clinical Rasmussen Score				P value
	Excellent	Good	Fair	Poor	
Excellent	26	2	0	0	<0.001
Good	6	2	0	0	
Fair	1	2	1	0	
Poor	0	1	1	1	

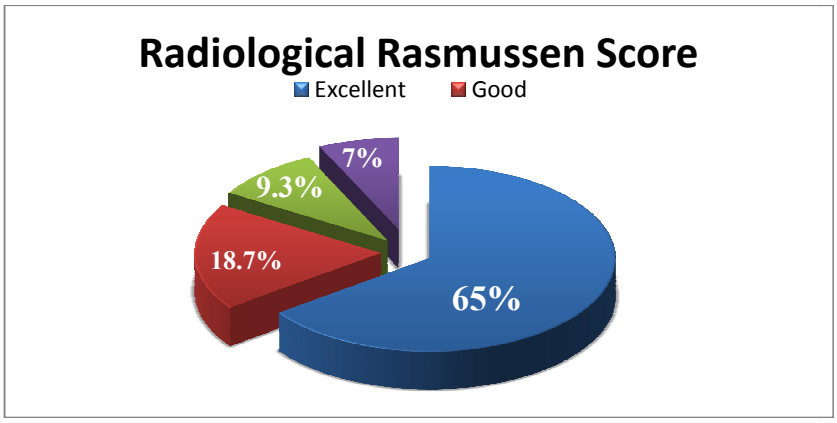


Fig. 5. Radiological results of studied patients

Table 5. Time of radiological bone healing

Time of bone healing (months)	No. of patients	Percentage %
< 2 months	9	21 %
2-3 months	22	51 %
> 3 months	12	28 %

Table 6. Relation between demographic data and functional Rasmussen knee score

	No. of patients	Clinical Rasmussen score				P value
		Excellent	Good	Fair	Poor	
Age Group						
≤ 50 years old	28	26	2	0	0	0.006
> 50 years old	15	7	5	2	1	
Time Lag						
≤ 2 days	13	9	3	1	0	0.689
> 7 days	30	24	4	1	1	
Sex						
Male	15	12	2	1	0	0.476
Female	28	21	5	1	1	
Type of trauma						
RTA	26	20	6	0	0	0.091
Fall from height	17	13	1	2	1	
Type of the fracture						
Type 2	26	20	6	0	0	0.091
Type 3	17	13	1	2	1	
Medical history						
No	24	21	3	0	0	0.339
Hypertension	7	7	0	0	0	
DM	7	2	1	2	2	
Smoker	5	3	1	1	0	

4.4.1 Effect of demographics on anatomical rasmussen score

In our study, there were two groups of age, 28 cases less or equal 50 years old, 21 of them (75%) had excellent results and 15 cases above 50 years old, only 7 of them (47%) had excellent results. The P value is 0.019 significant. In our study, the mean Rasmussen score of patients who operated before 48 hours was anatomically 16.1 (good). Patients who operated after 7 days had a mean anatomical score 16.8 (good). The P value is 0.352 insignificant. In our study, there were 15 males; twelve of them developed excellent results while there were 28 females; twenty one of them developed excellent results

(P value = 0.654). In our study 26 patients had RTA trauma 17 developed excellent results and 6 good, 2 fair and 1 poor. 17 patients had falling trauma; 11 excellent, 2 good, 2 fair & 2 poor. The P value is 0.612. In our study 24 cases with Schatzker II fracture; 18 showed excellent results, 4 good, 1 fair& 1 poor. 19 cases with Schatzker III fracture; 10 showed excellent results, 4 good, 3 fair & 2 poor (P value = 0.379). Relation between medical history and anatomical outcome as described in (Table 7) (P value <0.001).

Fig. 7 shows "54 years old woman, hypertensive, she was presented to emergency after fall from height by left type 2 split depression tibial plateau fracture and operated 2 days after admission. The follow up period was 6 months, the patient allowed for partial weight bearing when total radiological bone healing achieved at 1.5 months. The total flexion range was 140°, no flexion contracture or extension lag. The functional outcome was excellent according the Modified Rasmussen clinical scoring system = 30 with no recorded complications. The anatomical outcome was excellent according to Rasmussen radiological score system = 18".

5. DISCUSSION

Schatzker type II and type III are traditionally treated with open reduction, elevation of articular surface, cancellous autografting or allografting, and rigid internal fixation. Complications after bone graft have been reported. In patients with iliac crest bone graft, up to 3% developed an infection, about 22% developed minor complications such as persistent discomfort, cutaneous nerve damage, local wound complications (superficial wound infection, seroma, and hematoma), and up to 38% had pain after six months and in some cases beyond 2 years [9]. In addition, donor-site morbidity after iliac crest bone graft includes arterial injury, ureteral injury, herniation, chronic pain, nerve injury, infection, fracture, pelvic instability, cosmetic defects, hematoma, and tumor transplantation. Cancellous bone grafts have very low mechanical strength and hence can lead to collapse of the articular surface [10].

Allo-grafts are associated with the transmission of viral infections, histological incompatibility, and low union rates. Full weight-bearing is delayed in most patients with allografting [11].

Bone substitutes provide minimal structural support, expensive, and have potential immunogenic reactions. Synthetic bone substitutes such as injectable calcium phosphate cement have problems associated with mechanical strength, bone remodeling, graft resorption, and long-term preservation of articular congruency [12].

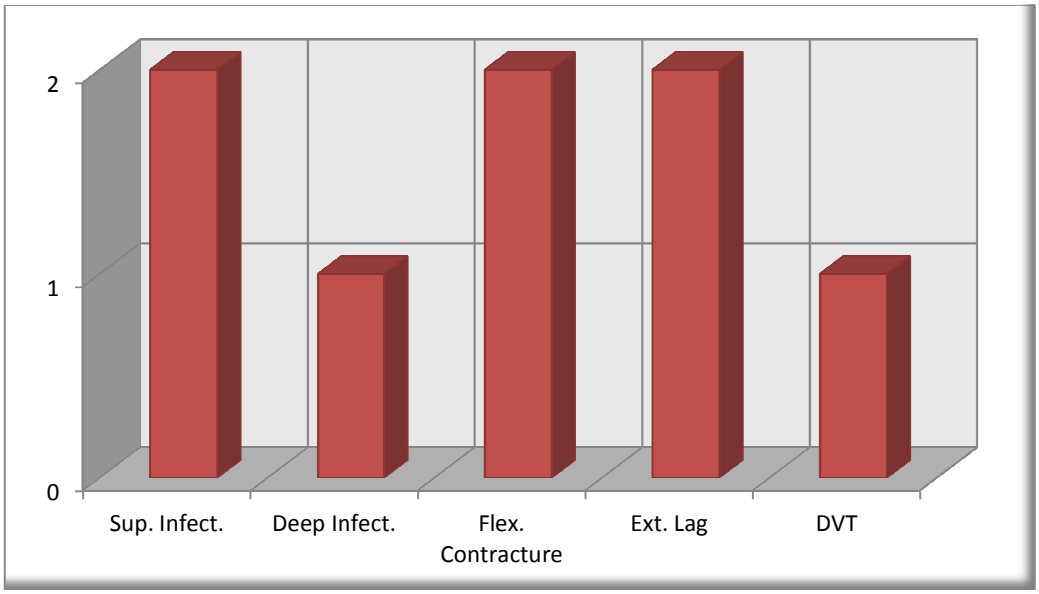
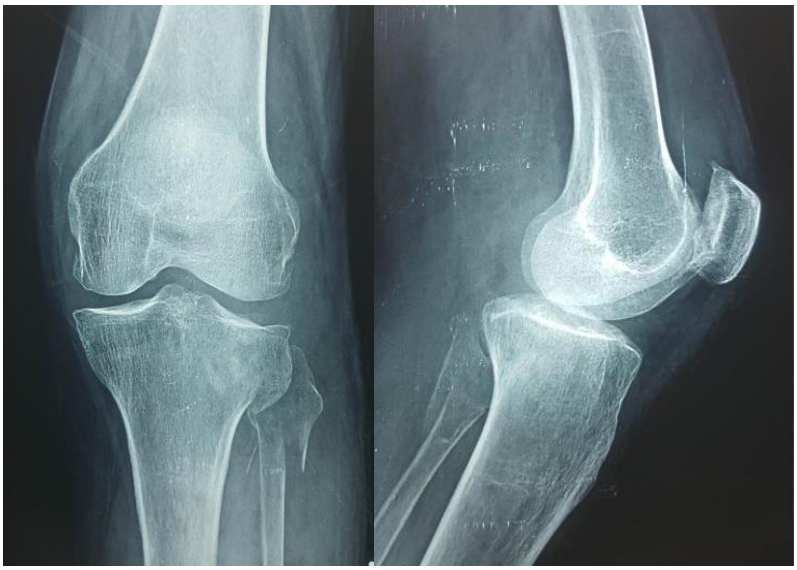


Fig. 6. Complications in our study



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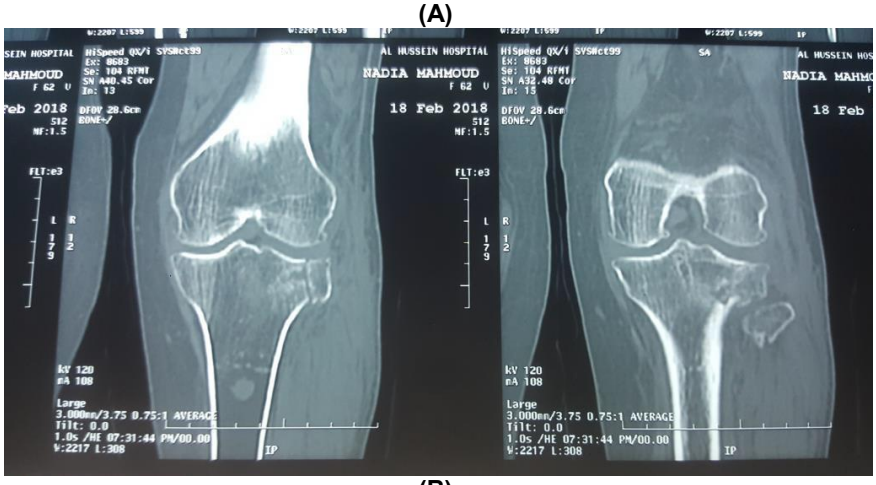
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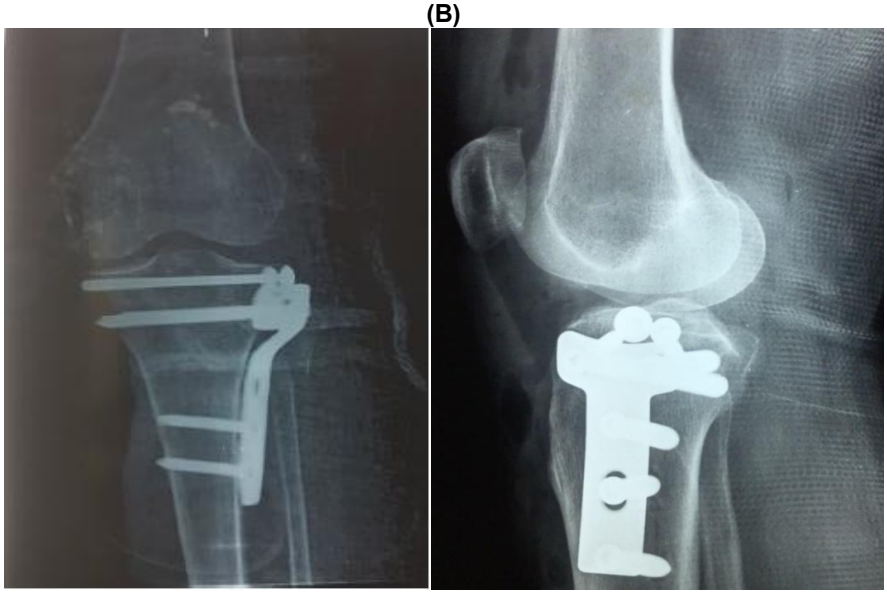

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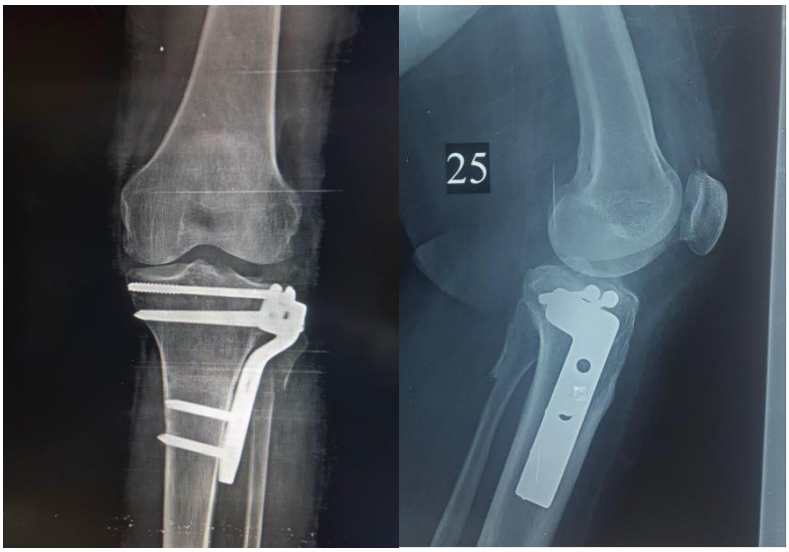

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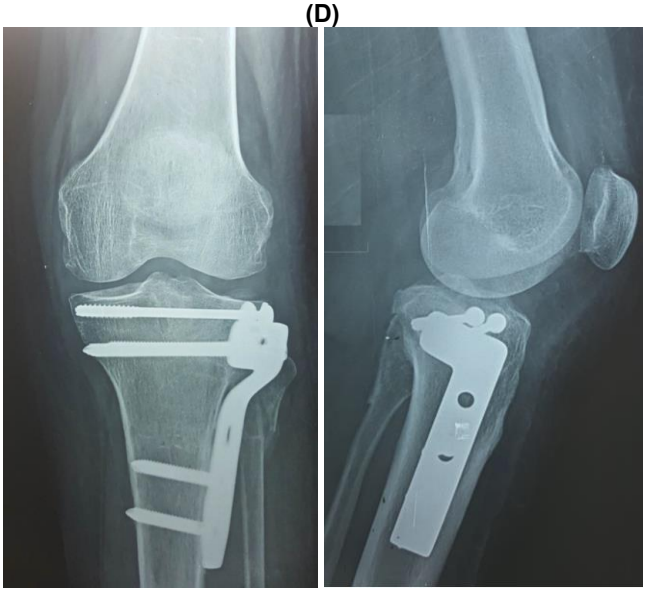

(E)

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Fig. 7. (A) Preoperative X-rays (B) Preoperative CT scan (C) Immediate postoperative X-ray (D) Three month follow up X-ray (E) Six month follow up X-ray (F)Six month postoperative maximum flexion & extension

Table 7. Relation between demographic data and anatomical Rasmussen knee score

	No. of patients	Anatomical Rasmussen score				P value
		Excellent	Good	Fair	Poor	
Age Group						
≤ 50 years old	28	21	6	1	0	0.019
> 50 years old	15	7	2	3	3	
Time Lag						
≤ 2 days	13	6	4	2	1	0.352
> 7 days	30	22	4	2	2	
Sex						
Male	15	9	3	1	2	0.654
Female	28	19	5	3	1	
Type of trauma						
RTA	26	17	6	2	1	0.612
Fall from height	17	11	2	2	2	
Type of the fracture						
Type 2	24	18	4	1	1	0.380
Type 3	19	10	4	3	2	
Medical history						
No	24	19	5	0	0	<0.001
Hypertension	7	7	0	0	0	
DM	5	1	1	3	2	
Smoker	5	1	2	1	1	

In this study, after restoring the anatomical articular surface, we used periarticular subchondral screws as rafting without graft to maintain the reduced articular surface and supporting plate as a rigid internal fixation.

In our study, the age of patients ranged from 30 and 65 years with an average of 49.5 years and the highest incidence in the age group of 40-50 years (49%). Most literature discussing tibial plateau fractures had the same age incidence as in our study. Honkonen SE, [13] and Albuquerque et al. [14] showed age incidence 30-60 years with an average of 49 years, which correlates with our study. Lee et al. [15] also showed that the average age of tibial plateau fractures in patients was 43 years. Vasanad et al. [16] showed that age incidence was 20-60 years with a maximum incidence in the productive age group of 31-40 years (50.25%). High energy injuries are more common in youngers, and low energy fractures in elderly patients.

The age was significant factor that affected the final clinical results in our study as 93% of patients below the age of 50 years old had excellent outcomes. While only 47% of patients above 50 years old had excellent outcomes.

In this study, females were more than males with an incidence of 67% and 33% respectively. This is in accordance with the series of 45 patients reported by Lee et al. [15] in which 21 (46%) were males and 24 (54%) were females. In contrast, Eggli et al. [17] had 71% males and 29% females and also Walia et al. [18] reported high male predominance with male to female ratio 9:1.

In our study, road traffic accidents (RTA) and fall from height were the cause of injury in all patients with RTA to Falling ratio 3:2 this is correlated with Kayali et al. [19] who reported that RTA was common than falling with ratio 2:1. And also in study of 38 patients reported by Kulkarni et al. [11] 28 had RTA and only 8 patients had Falling trauma. But in study reported by Albuquerque et al. [14] falling trauma was common with ratio of 4:1. In our study, incidence was more on right side – 72% in right side and 28% in left side this was the same result reported by Sampath [20] While Cross et al. [21] and Kayali et al. [19] reported that incidence of right & left fractures were equal.

Kulkarni et al. [11] Cross et al. [21] and Kayali et al. [19] used periarticular rafting construct only on Schatzker type II fracture tibial plateau (lateral split depression). But in study of Langhi et al. [6] all samples were Schatzker type III. In our study we had both type II & III with incidence of 54% and 46% respectively this is correlated with study published 2018 by Kripalani et al. [22] in which type II was 62% and type III was 38%. In study published by Sampath, [20] Schatzker type II

was found in 15% of patients, type IV in 5%, type V in 35% and type VI in 45%.

In this study, bone healing was achieved after a mean of 9.2 weeks (range from 6 to 14 weeks), this was superior to Kulkarni et al. [11] who found that all patients achieved bone union after a mean of 13.2 (range, 8–26) weeks. Kripalani et al. [22] reported that bone healing was achieved in range 8-24 weeks with mean of 12.87 weeks. In study reported by Sampath. R, [20] all patients showed bone healing after 11-16 weeks, the mean was 13.5 weeks.

Cross et al. [21] described the debate on ideal internal fixation for preventing subsequent loss of reduction during postoperative rehabilitation. Adequate maintenance in the postoperative period is important to avoid this outcome, due to the risk of posttraumatic arthritis. The subchondral raft technique is a well-known method to resist depression and loss of reduction and can be performed using a Kirschner wire, lag screw, conventional screw and locking screw either through the plate or individually. Raft construction has also been addressed by other authors.

Cole, [19] reported that comminuted, unstable areas could be supported in their reduced position by placing a raft of parallel smaller-diameter screws close below and parallel to the articular surface. After elevation and support using bone void filler, fixation of the lateral cortex is then achieved with a buttress plate or periarticular "raft" plate. This author recommended that the subchondral raft of screws be placed through the plate so the screws are fixed laterally at the plate and medially in the intact medial column of bone.

Sampath.R, [20] compared two method of internal fixation: buttress plate with graft and subchondral raft screws through a periarticular locked raft plate. This author found raft screws placed in the subchondral bone provide adequate construct stiffness and support to prevent articular depression and proximal tibial locking plate with raft screws technique is a better and effective method for achieving good to excellent results providing almost full range of motion and maintaining articular congruity in the treatment of tibial plateau fractures.

Karunakar et al. [3] compared biomechanical characteristics of 4 fixation options: the L-buttress plate, four 3.5 mm subchondral raft screws with an antiglide plate, an L-buttress plate with cancellous allograft and four 3.5 mm subchondral raft screws through a periarticular plate for type II fractures. These authors found no significant differences between these constructions, but the raft of subchondral screws demonstrated more resistance to local depression loads.

In another biomechanical study, Cross et al. [21] evaluated three different raft types: raft construction outside the plate, non-locking raft screws through the plate and locking raft screws through the plate. These authors reported achieving statistically significant stability with the raft through plate over screws outside the plate. However, they did not find that locking screws were superior to non-locking screws and recommended considering raft construction through the plate versus outside the plate.

In our study we applied one or two lag screws; conventional screws, cannulated screws and locking screws as rafting screws to support depressed osteo-chondral fragments against collapse with supporting side plate and screws. 1st 8 cases we used large-fragment 6.5 mm cancellous screws as rafting screws and next 35 cases we used 4 mm cancellous screws and 5 mm locking screw.

The use of small-fragment screws for fixation of tibial plateau fractures is recommended [23,24]. Biomechanical studies show that smaller screws placed nearer to the subchondral bone have adequate construct stiffness while providing greater support to prevent depression and more favorable elasticity underneath the articular cartilage than larger screws [3].

The buttress plate has greater stiffness than lag screws alone [25]. Bone graft did not contribute to faster healing as metaphyseal fractures can be expected to heal fast even without grafting. In the report published by Eggli et al. [17].

Two points are important to lower arthritis rate: obtaining the anatomic joint line and normal mechanical axis during surgery and maintaining this reduction throughout the healing period. [21,26] In addition to all, initial articular cartilage damage was accused for the development of osteoarthritis [27].

In this study, the radiological and functional results are promising. According to functional Rasmussen score, the functional results ranged from 9 to 30 & the mean was 27.5 points, acceptable results were 93.1%, (76.8% were

excellent & 11.6% were good) while non-acceptable results were 6.9%, (4.6% fair & 2.3% poor). According to anatomical Rasmussen score, the anatomical results ranged from 12 to 18 & the mean was 17.6 points, acceptable results were 83.7%, (65%were excellent & 18.7% were good) while non-acceptable results were 16.3%, (9.3% fair & 7% poor).

Kripalani et al. [22] recommended use of rafting construct in Schatzker type II & III. The authors found significant results, according to functional Rasmussen score; 90.5% of patients had acceptable results while only 9.5% had non-acceptable results which correlated with our results. Although according to anatomical Rasmussen score, 90.5% acceptable results and 9.5% non-acceptable which were superior to our anatomical results.

Kulkarni et al. [11] reported that use of a periarticular raft construct in anatomically reduced split-depression tibial plateau fractures (Schatzker type II) provided sufficient rigidity and prevents collapse, irrespective of the underlying bone quality. According to functional Rasmussen score, 94.7% had excellent and good results but 5.3% had fair results. According to anatomical Rasmussen score, the authors found the same results as functional score.

6. CONCLUSIONS

Fixation using a periarticular rafting screws for lateral split-depression and lateral depression tibial plateau fractures without using bone graft or bone substitutes is a viable and good option during open reduction and internal fixation, helps surgeons achieve and preserve the anatomic joint line and normal mechanical axis, with superior functional results in the short term. Therefore, avoiding morbidity associated with bone grafting without compromising the fracture stability.

7. LIMITATIONS OF STUDY

Some patients missed the follow up. Expensive CT scan.

8. FUTURE RECOMMENDATIONS

Increasing the time of the patient's follow up. Inclusion of other modalities of fixation of the tibial plateau fractures. Specification of a selected implant type to provide accurate evaluation of the performance of the studied implants.

CONSENT

Written informed consent was obtained from every patient. Privacy of participants and confidentiality of the data was given special care and attention.

Exclusion criteria were a) Patient-related criteria (Patients unable to weight bear before fracture and non-functioning limb) b) Fracture related criteria (open fractures, pathological fractures other than osteoporosis, neurovascular injury of the lower extremities, or compartment syndrome, trauma more than 14 days).

ETHICAL APPROVAL

This prospective study was carried out on 43 patients admitted to the Orthopedics Department of Tanta University Hospitals from June 2018 to September 2019 after approval from the Ethical Committee of Faculty of Medicine, Tanta University. Patients were above the age of 18, fit for surgery with closed tibial plateau fracture [lateral split depression (type II) and lateral depression (type III) according to Schatzker classification] time of trauma less than 14 days with no other skeletal injuries. All patients were followed up for at least six months.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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