COMPARATIVE STUDY BETWEEN RAFTING SCREW AND BONE GRAFT IN DEPRESSED TIBIAL PLATEAU FRACTURE

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Abstract:
Background: Tibial plateau fractures affect a major joint that supports the body's weight. The difficulties arise due to the concurrent application of axial stress & varus/valgus pressures, which causes articular depression, malalignment, & an enhanced susceptibility to after-traumatic osteoarthritis. **Aim of the Work:** The objective of this research work is to assess the functional outcomes, radiographic outcomes, & clinical performance of a group of cases who sustained internal fixation & open reduction using rafting screws (3.5-6.5millimeters cortical screws) to support depressed tibial fractures for Schatzker types II & III without the use of bone graft.
Patients and Methods: Participating in this prospective investigation are thirty cases who suffered A fracture of the lateral tibial plateau.
Schatzker type II or III underwent internal fixation & open reduction at Al-Zahraa University Hospital & Al-Mataria Teaching Hospital using rafting cortical screws measuring 3.5-6.5millimeters & bone grafts, respectively.
Key word: Anterior Cruciate Ligament, Arbeitsgemeinschaft für Osteosynthesefragen and Anteroposterior

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Introduction:

The tibial plateau fractures impact a primary joint responsible for sustaining weight. Axial loading & varus/valgus applied forces lead to their development, resulting in articular depression, malalignment, & an elevated susceptibility to posttraumatic osteoarthritis [(1)].

Schatzker has provided the following definition of lateral tibial plateau fractures: type II involves a combination of cleavage & depression: A lateral wedge is divided, with different sections of the articular surface & lateral tibial plateau being fragmented & driven downward into the metaphysis. On the other hand, type III consists just of a central depression, which is identified by the depressed &driven articular surface of the lateral plateau into the lateral tibial condyle. The lateral cortex remains intact and there is an absence of a lateral wedge. [(2)].

Fractures of the depressed tibial plateau continue to present orthopedic trauma surgeons

with technical challenges [3]. One of the fundamental issues is to achieve anatomical joint reduction while maintaining secure fracture fixation. This is done to facilitate early knee flexion, which is essential for achieving positive functional outcomes **[4]**. Two more constraints that need to be taken into account are the potential for a lasting misalignment within the joint following inadequate alignment of the joint surfaces [5], & the suitability of alternate bone grafting methods to fill the empty space in the bone's metaphysis after reducing the fracture using conventional bone tamps. [6].

Anatomical reconstruction is necessary in the event of tibial plateau fractures to reduce the risk of developing posttraumatic arthritis, knee joint instability, axial malalignment, & pain [7].

The acceptable range of residual step-off for achieving the correct positioning of tibial plateau fractures varies significantly, with certain authors suggesting a range of three to four millimeters. **[8]**. This is almost certainly the consequence of substandard reduction instruments, given the universal preference for anatomic reduction. Although knee posttraumatic arthritis is more strongly associated with overall joint stability and alignment, the primary objective is to restore the anatomical structure to its original state **[1].**

The objective of surgical treatment for depression fractures (Schatzker II-III) that impact the lateral tibial plateau [2], including over fifty percent of all tibial plateau fractures, is to attain secure fixation and limit harm to the joint surface. By means of a cortical window or another fenestration in the metaphyseal bone, subchondral bone is revealed. Subsequently, an elevation or tamp is inserted & employed to en bloc raise the depression **[3]**. To preserve the elevated articular surface, the subchondral defect in the metaphysis is usually filled with bone graft from the iliac crest, or alternatively, this depression can be elevated using subchondral screws measuring 3.5-6.5 millimeters.

Pain symptoms & additional complications at the donor site are disadvantages **[9]**, along with graft resorption leading to a subsequent loss of decrease.

Currently, there is no agreement on the best weight-bearing routine to follow after surgically fixing a fracture in the tibial plateau. The weight-bearing guidelines for individuals vary, ranging from immediate partial weight-bearing for all cases to non-weight-bearing for a period of 6 to 8 weeks (or 12 to 16 weeks). **[10]**. In a recent study**, S. Langhi et al. [11]** Proposed the utilization of subchondral raft screws with plate fixation as a substitute for bone grafting in the management of split depressed fractures of the tibial plateau. This involves the use of tiny interfragmentary screws, which have a diameter ranging from 3.5 to 6.5 millimeters. Therefore, it is possible to prevent the development of illness or disease related to bone grafting without affecting the structural integrity of the fracture. **[11].**

Consequently, the previous study (**langhi, et al. 2007**) [11] gave us the idea of our study to try to treat depressed tibial plateau fracture by using subchondral screws to elevate depression and to evaluate the results versus to elevate this depression by bone grafts.

Aim of the Work

The objective of this research work is to assess the functional outcomes, radiographic results, & clinical performance of a group of cases who underwent internal fixation & open reduction using rafting screws (3.5-6.5millimeters cortical screws) to support depressed tibial fractures for Schatzker types II & III without the usage of bone graft.

Patients and methods

A total of thirty patient who underwent internal fixation & open reduction with rafting cortical screws ranging from 3.5 to 6.5 millimeters or bone grafts at Al-Zahraa University Hospital for lateral tibial plateau fracture Schatzker type II or III are involved in this prospective investigation. **Patients**

Inclusion Criteria

involved among all cases with lateral depressed tibial plateau fractures were:

1. Sex: both sexes
2. type II or III of Schatzker Fractures
3. Closed fractures.
4. Age: (18-60)

Exclusion Criteria

1. Open fractures
2. type I, IV, V & VI of Schatzker Fractures
3. Concomitant lower limb injuries that interfere with the rehabilitation process for the tibial plateau fracture
4. Fractures with vascular injury

Methods in general

History

1. Age, Sex
2. Medical co morbidities
3. Special habits

Preoperative management

1. All the cases had before surgery evaluation that includes: history, physical inspection & radiological inspection (CT & X-ray).
2. Fracture classification according to the Schatzker system of classification.
3. The measurement of depression in millimeters as determined by the axial &coronal CT sections.
4. Before surgery computed Tomography is also utilized to estimate the volume of the defect remaining following depression elevation.
5. A measurement of the defect's volume was measured during surgery.
6. All cases received X-rays & CT scans postoperatively.
7. An essential component of the process for assessing & analyzing following surgery complications &radiological outcomes.

Intraoperative Evaluation

1. Blood loss during the operation & transfusion.
2. Operational length
3. Radiation exposure
4. Wound incision.

Postoperative Evaluation

1. Complications following surgery
2. Blood loss following surgery &transfusion
3. Rasmussen score
4. The Knee Society Score (KSS)
5. Time to union

Postoperative Follow Up

1. Following 1 week, assess the condition of the wound
2. Following a two-week follow-up, the incision stitches are removed.
3. Throughout the follow-up, cases were evaluated every two weeks for the initial eight weeks, then every two months for the following four months, & finally every six months.
4. A six-month follow-up X-ray was performed after a monthly interval of two months, followed by two-monthly intervals for the following four months.

Methodology in details:

Clinical History:

Relevant clinical history to the details and injury's mechanism for all cases were reported. Details about first aids at site of injury (if it was done), Also reported were the length of time among the injury and hospitalization, provisional procedures, and medications administered from the onset of the injury until the time of the surgical procedure.

Examination:

Clinical evaluation of patients was done preoperatively, postoperatively, then every 2 weeks firstly for eight weeks, then every two months for four months, and finally every twelve months.

Local Assessment:

We conducted a thorough & meticulous local inspection of the affected knee &leg, focusing on the following: the neurovascular status of the affected limb, the sensorimotor function &soft-tissue envelope of the limb, &the presence of compartment syndrome or other soft tissue or bones injuries that may be related to the condition.

Investigations:

Initial preoperative radiological assessment included plain x-ray A-P and lateral views, and knee CT. These were used as a routine for all patients to assess the fractures. Articular depression was then measured. Following surgery radiological assessment was conducted monthly for the initial two months, then every two months for the following four months, with the last assessment occurring at twelve months.

Results

Demographic data

This study contained a total of thirty patients, of which fifteen cases were assigned to group (A) and the remaining fifteen cases were assigned to group (B). The demographic data revealed that there were eight females and twenty-two males among those with closed lateral tibial plateau fractures (twelve type III & eighteen type II). Group A has an average age of 35.73 years, while Group B has an average age of 35.66 years. The mechanism of injury for each case was as follows: road traffic accidents (RTA) accounted for sixteen fractures; falls from heights counted for eight fractures; & twisting trauma caused six fractures. Based on the collected data, no statistically significant correlation was found among the type of fracture & the age or gender of the case. Both groups had an average hospital stay of 7.6 days (ranging from: four to twelve days); there wasn't a statistically significance distinction among the two groups. Each case presents with a closed fracture, lacking any concomitant or related injuries. The surgical procedure was completed 4.66 days (ranging from: one to ten days) after admission, on average. The detailed demographic information is displayed in Table 1.

Postoperative Pain

VAS-based evaluation of discomfort following surgery as demonstrated by Table 2, the initial day pain after surgery scores for group A (average: 49.73) were significantly lower than those for group B (average: 58.93), with a P-value of below 0.05. Group B reported equivalent levels of pain at both the fracture site & the graft site.

Pain was classified as severe in one case (6.7 percent), moderate in eight cases (53.3 percent), and mild in five patient (33.3 percent) among the patient in group A. In contrast, it was severe in two patient (13.3 percent) of group B, moderate in twelve patient (eighty percent), & mild in one case (6.7 percent).

Group B (average: 40.93) continued to have a higher average VAS on the second day following surgery compared to group A (mean: 39.47), as indicated by the P-value (0.01) in Table 3. Group B reported equivalent levels of pain at both the fracture site & the graft site.

A case in group A reported moderate pain in a single case (6.7percent), mild pain in thirteen patient (86.7 percent), & no pain at all. In contrast, group B patients rated pain as moderate in three cases (twenty percent) & mild in twelve instances (80%).

The mean VAS return after three months is more in group A (average: 19.56 millimeters) compared to group B (8.9 millimeters), following surgery (p-value = 0.04). As shown in Table 4, the graft site was mostly painful.

Operative Time

As demonstrated in table five the mean operating duration for group A was 95.93 minutes (ranging from 60-180 minutes), while for group B it was 101.13 minutes (ranging from 90-180 minutes) with a Pvalue of 0.00.

Table (1): The demographic data.

		Rafting screws (A) No.=15	With graft (B) No.=15	p-value
Age	Mean	35.73	35.66	0.780
Sex	Male	11 (73.33)	11 (73.33)	1.0
	Female	4 (26.77)	4 (26.77)	
pathology	II	9 (60)	9 (60)	1.0
	III	6 (40)	6 (40)	
Hospital stay (day)		7.6	7.53	0.983
period to have surgery (day)		4.67	4.67	1.0
Co-morbidities	DM	4 (26.77)	4 (26.77)	1.0
	HTN	3 (20)	3 (20)	
Smoking		7 (46.67)	5 (33.33)	0.142
Mode of trauma	RTA	9 (60)	8 (54.33)	0.213
	Fall from height	3 (20)	4 (26.77)	
	Twisting trauma	3 (20)	3 (20)	
Affected side	RT	8 (54.33)	8 (54.33)	1.0
	LT	7 (46.67)	7 (46.67)	
Discharge day		5.13	5.2	0.774
Period of follow up (months)		6.73	7.13	0.625

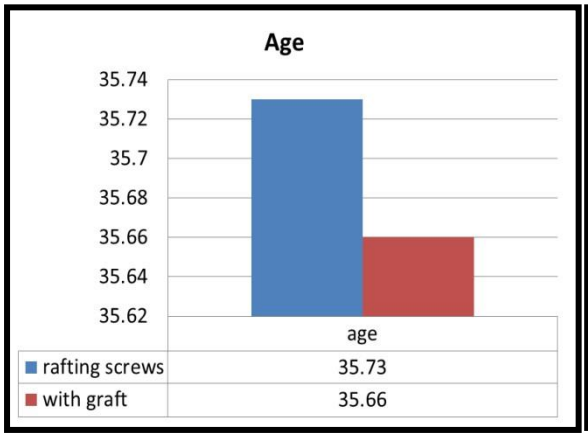

Figure (1): Age.

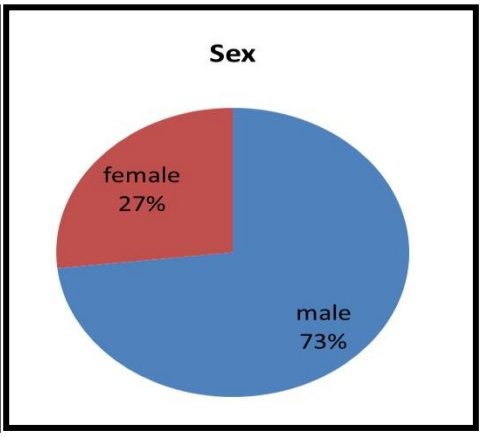

Figure (2): Sex.

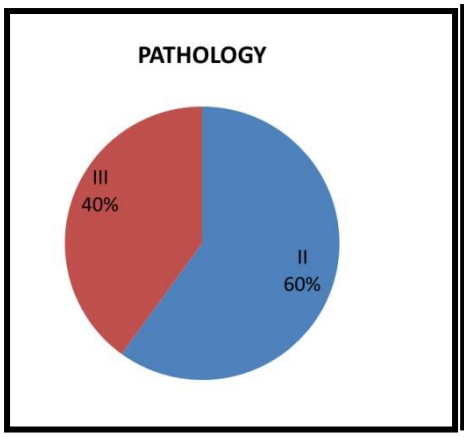

Figure (3): Pathology.

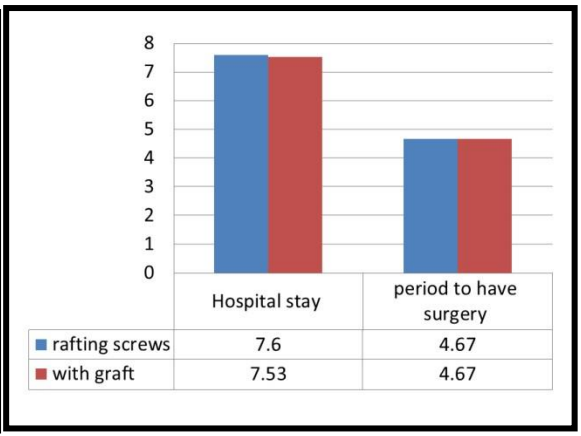

Figure (4): Hospital stay.

Table (2): VAS Measurement day1.

VAS Measurement day1		**(A)**	**(B)**	**P-value**
		No.=15	**No.=15**	
Score	Mean ±SD	49.73 ± 11.81	58.93 ± 16.80	**0.003**
	Range	30 – 75	40 – 90	
Severity	Mild	5 (33.3%)	1 (6.7%)	0.090
	Moderate	8 (53.3%)	12 (80.0%)	
	Sever	1 (6.7%)	2 (13.3%)	

Table (3): The mean of Visual Analogue Scale at day 2.

VAS Measurement day 2		**(A)**	**(B)**	**P-value**
		No.=15	**No.=15**	
Score	Mean ±SD	39.47±9.37	40.93±13.50	**0.010**
	Range	20–55	30–70	
Severity	Mild	12(80.0%)	3(20.0%)	**0.025**

Table (4): The mean of VAS score following three months.

Visual Analogue Scale Measurement day 90		**(A)**	**(B)**	**P-value**
		No.=15	**No.=15**	
Score	Mean ± SD	8.90 ± 10.73	19.56 ± 13.80	**0.04**
	Range	0 – 30	0 – 40	
Severity	Mild	7 (46.7%)	12 (80.0%)	0.03
	No pain	8 (53.3%)	3 (20.0%)	

Table (5): The mean of operative time.

		A	B	P-value
		No.=15	**No.=15**	
Operative time (min)	Mean ±SD	95.93 ± 23.45	101.13 ± 23.19	**0.000**
	Range	60 – 180	100 – 180	

Case 1

A female patient 54 years old, hypertensive, she was presented to emergency after falling on stairs by left type 2 tibial plateau fracture, and operated 4 days after admission.

We used 2 independent raft screws and supporting locked L plate, the patient was discharged 3 days postoperative.

Preoperative X-rays

Figure (5): Preoperative X-rays of case 1.

Preoperative CT scan

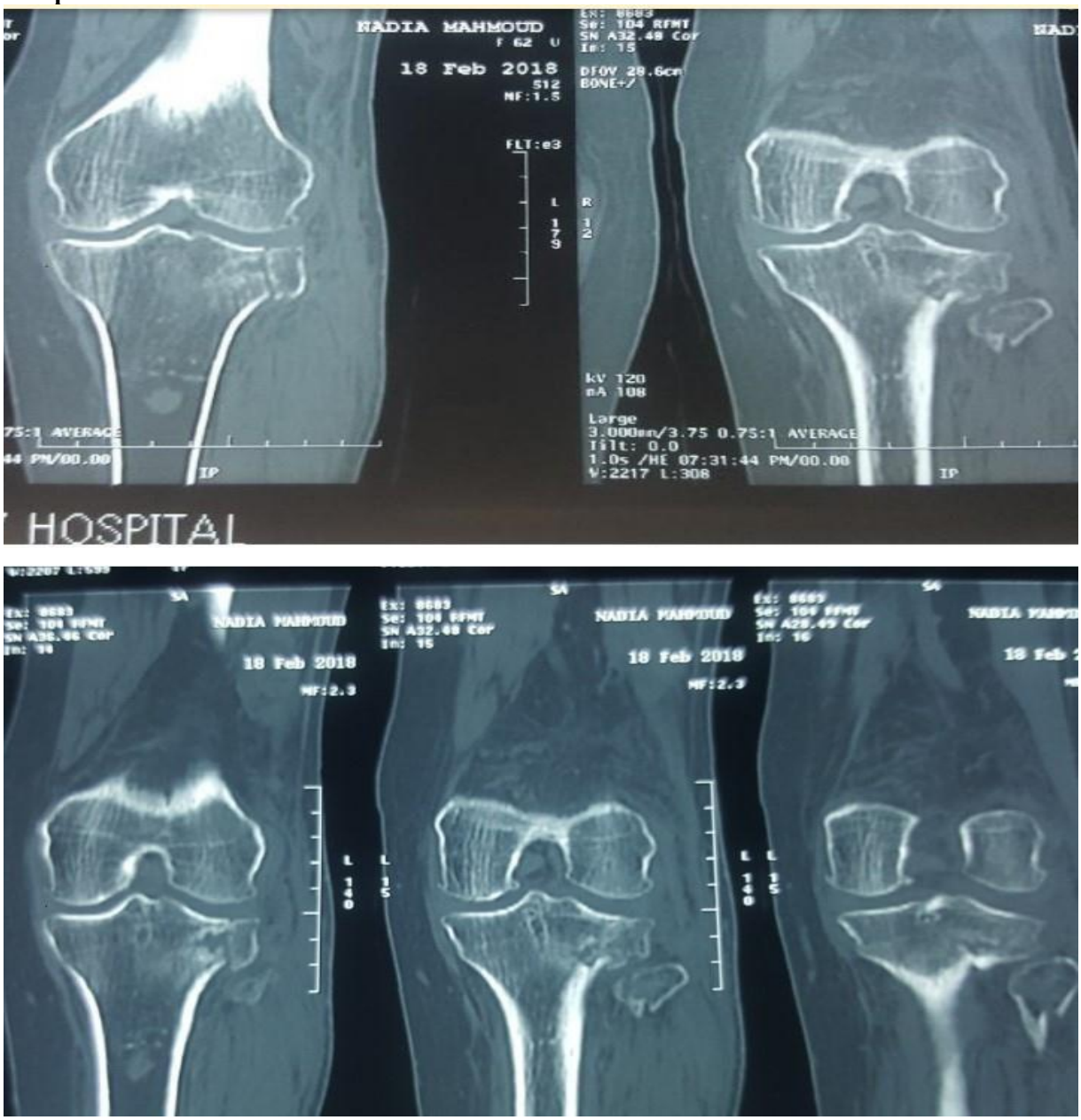

Figure (6): Preoperative CT scan of case 1

Intraoperative X-Ray

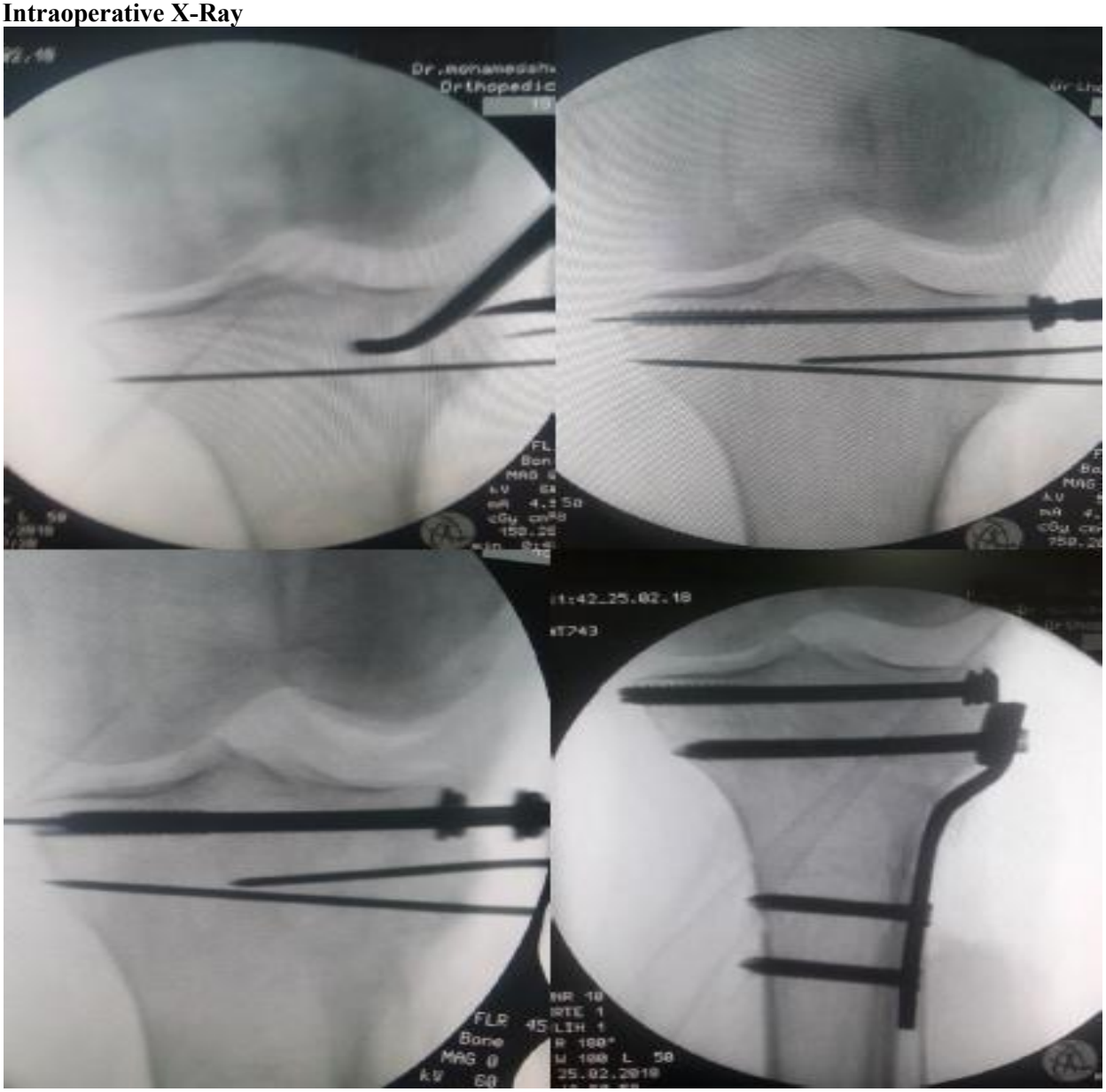

Figure (7): Intraoperative Fluoroscopic Images of case 1

Postoperative X-ray

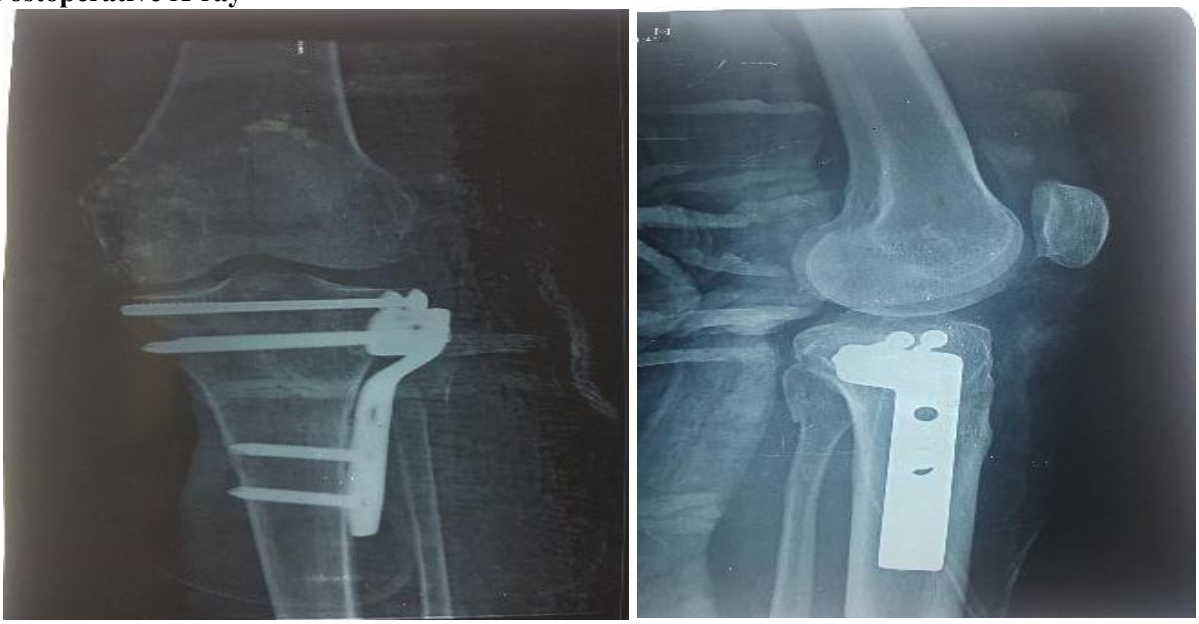

Figure (8): Immediate Postoperative X-Ray of case 1

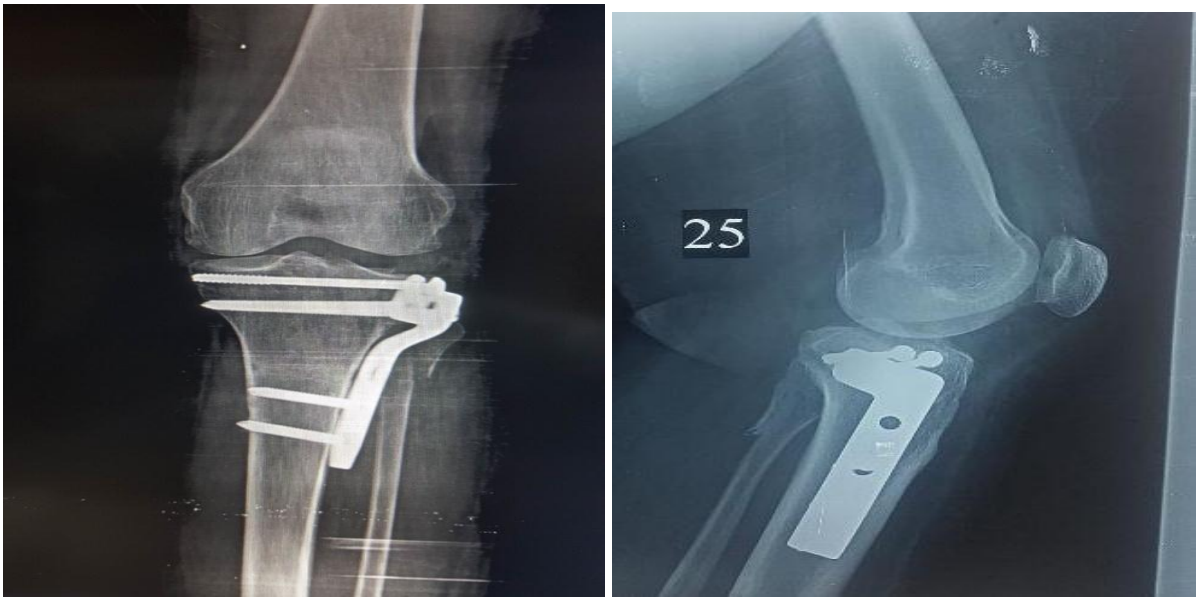

Figure (9): Three Month Follow up X-Ray of case 1

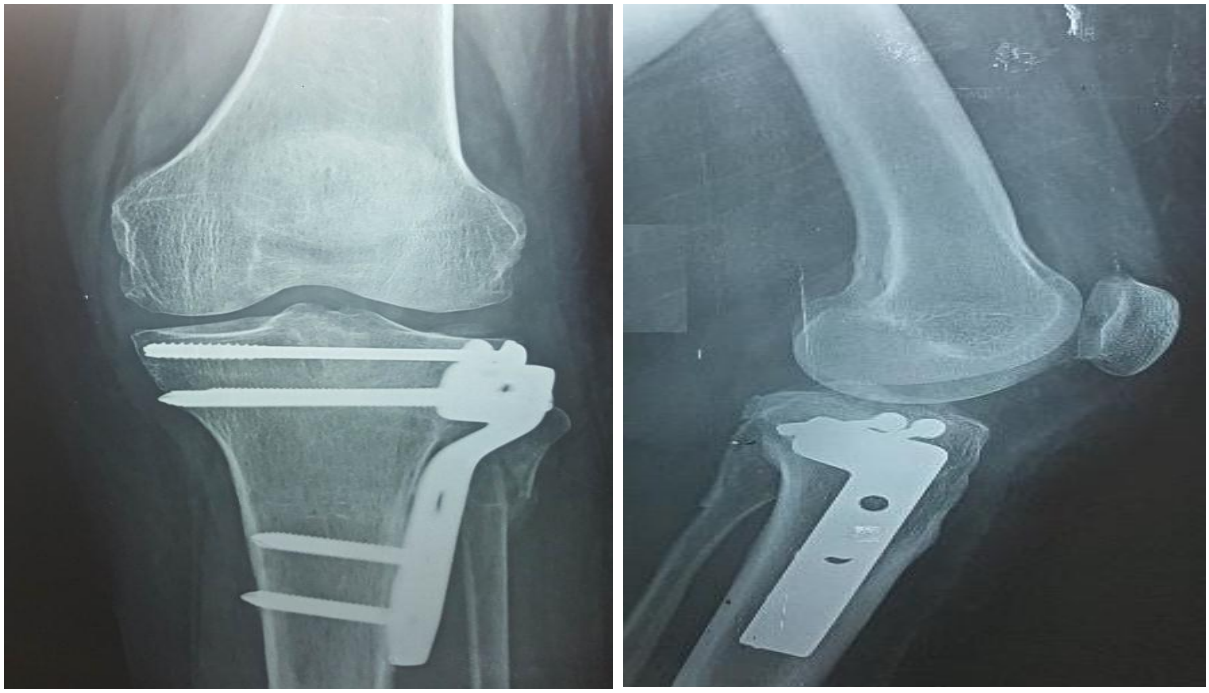

Figure (10): Six-Month Follow up X-Ray of case 1

Figure (11): Clinical Photo Showing the Postoperative Maximum Flexion and Extension of case 1

The follow up period was 6months, the patient allowed for partial weight bearing when total radiological bone healing achieved at 3 months.

The total flexion range was 125^{o}, no flexion contracture or extension lag.

The functional outcome was excellent according to the **knee society score (KSS) = 95** with no recorded complications.

Case 2

A male patient 46 years old, he was presented to emergency after an RTA by left type 2 tibial plateau fracture, and operated 2 days after admission.

We used 2 independent raft screws and supporting L plate, the patient was discharged 3 days postoperative.

Preoperative X-rays

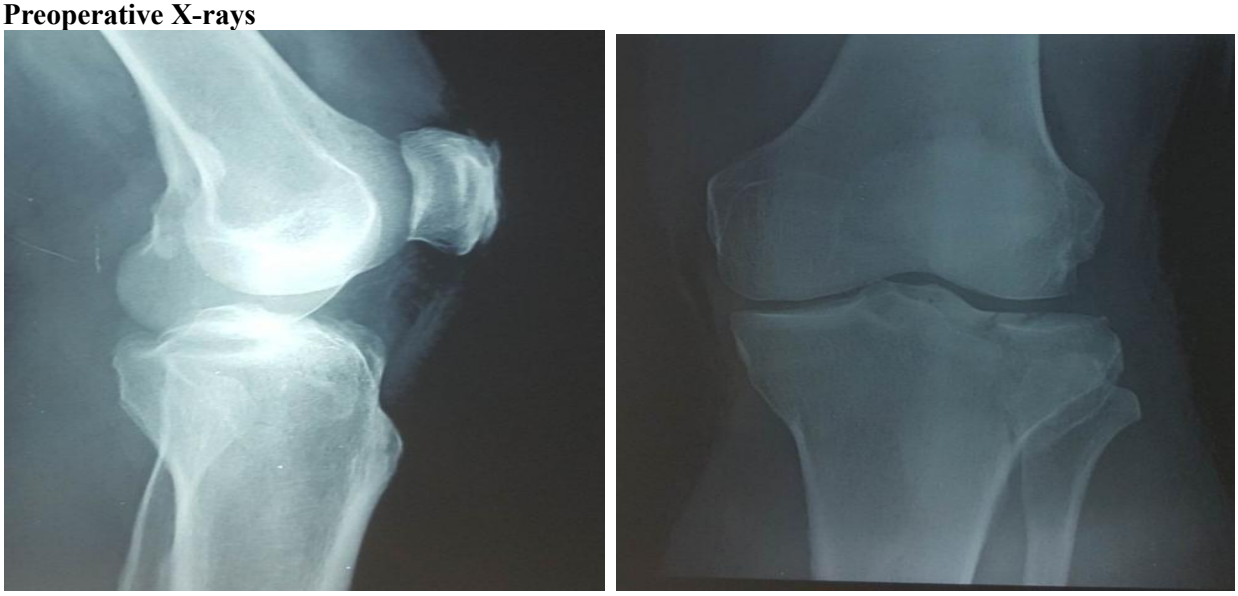

Figure (12): Preoperative X-rays of case 2

Preoperative CT scan

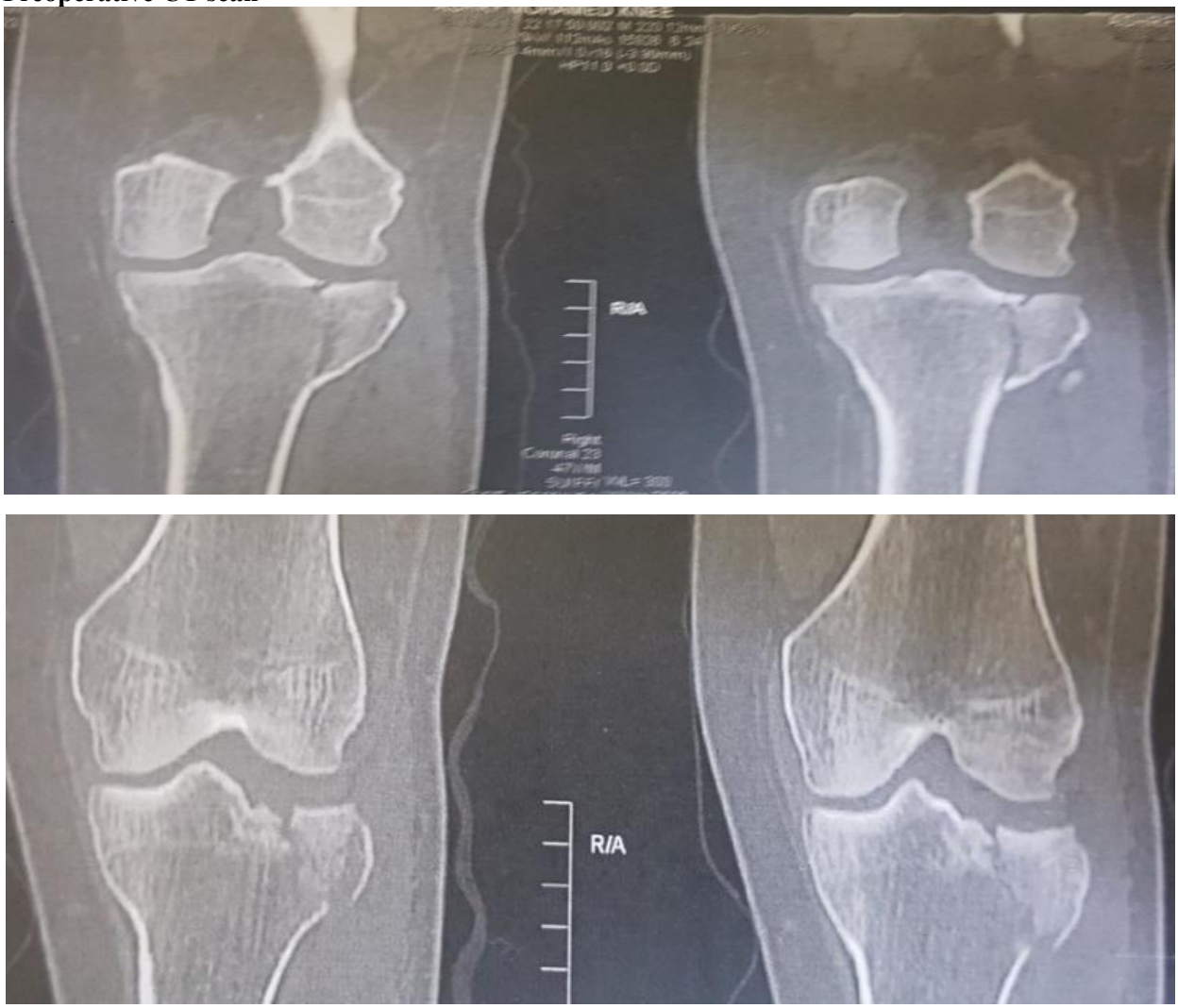

Figure (13): Preoperative CT scan of case 2

Postoperative X-ray

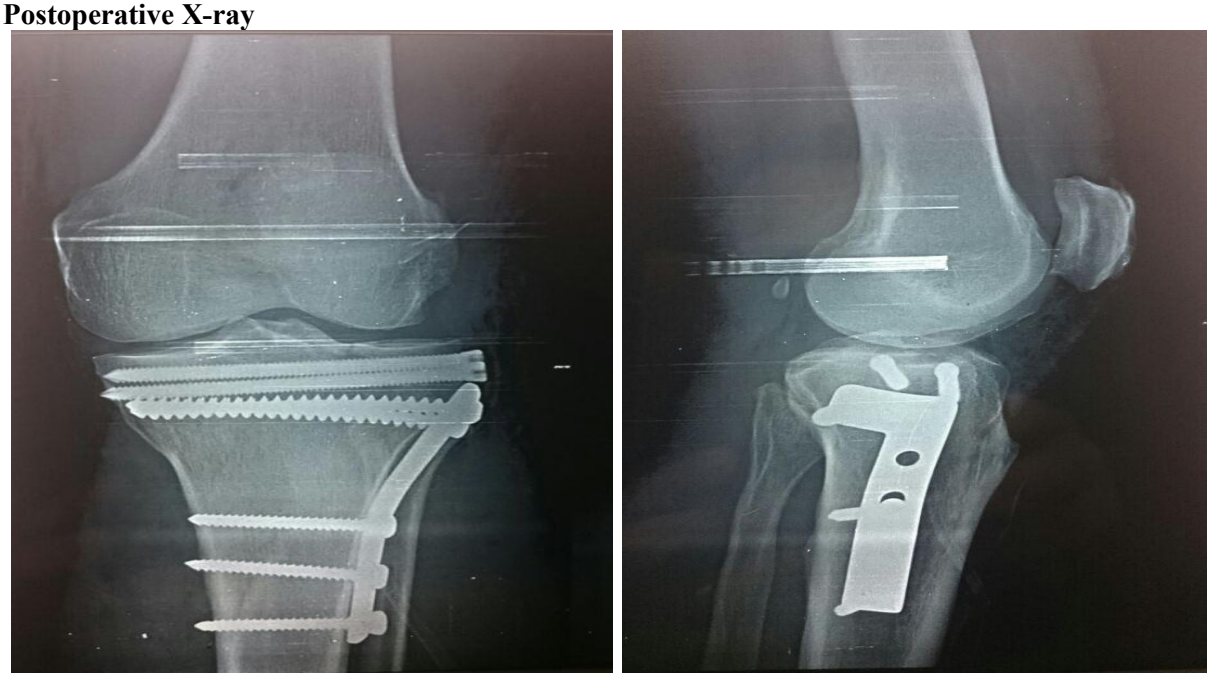

Figure (14): Immediate Postoperative X-Ray of case 2

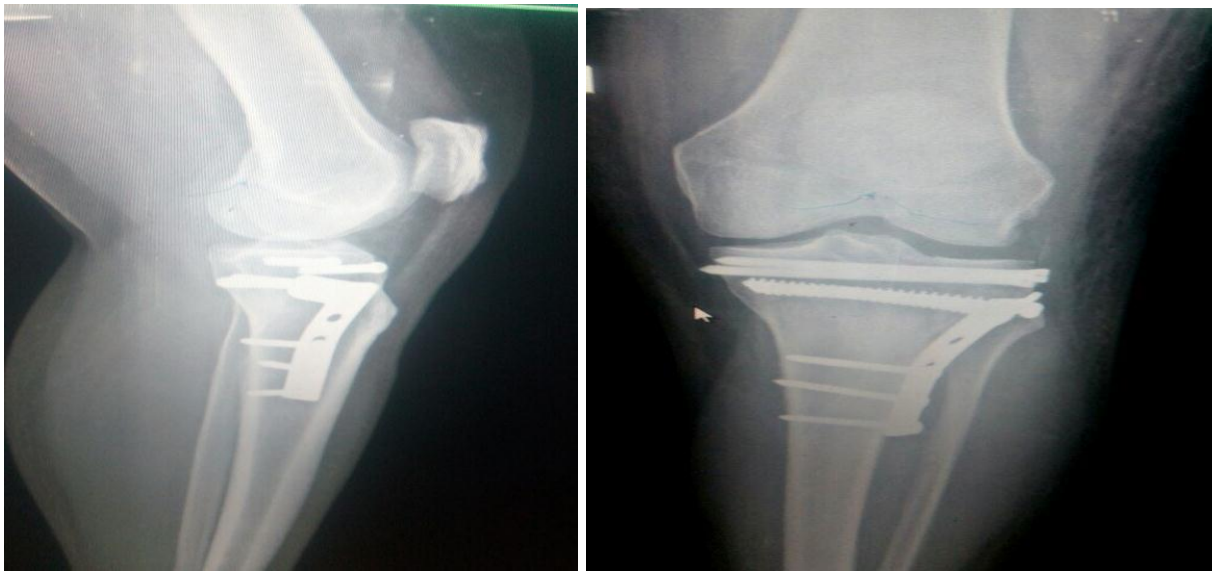

Figure (15): One-Month Follow up X-Ray of case 2

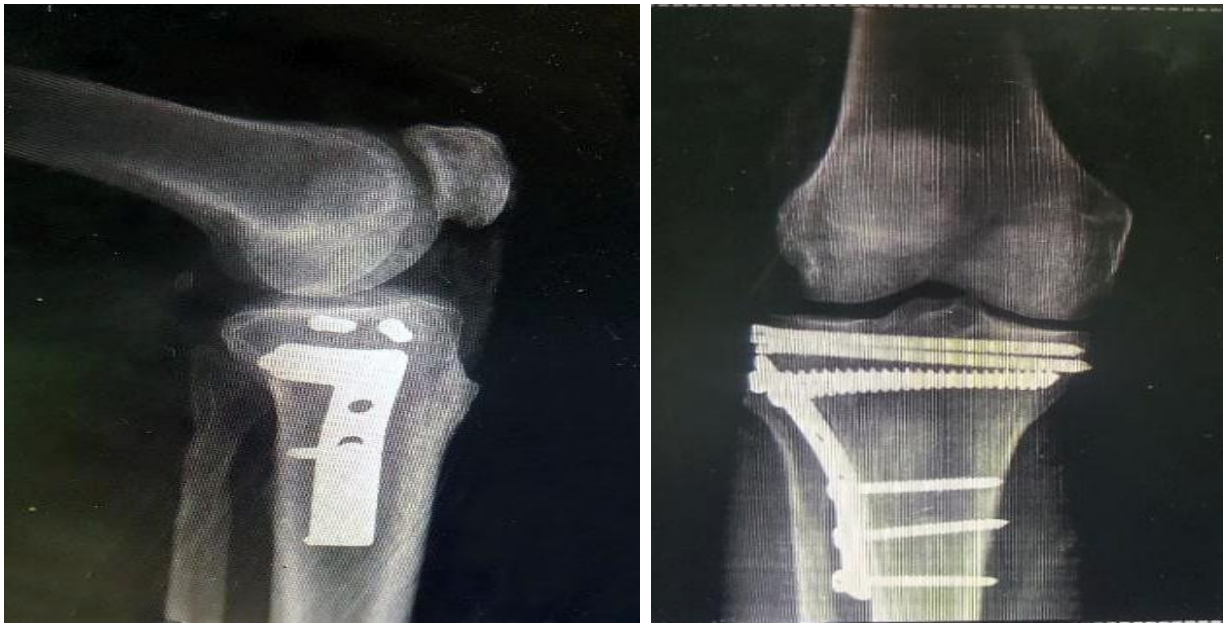

Figure (16): Six-Month Follow Up X-Ray of case 2

Figure (17): Clinical Photo Showing the Postoperative Maximum Flexion and Extension of

DISCUSSION

Fractures of the tibial plateau are relatively frequent. Still, this presents a challenging problem for the orthopedic surgeon. The occurrence of this condition is bimodal, manifesting as either high-energy trauma in younger cases or low-energy falls in geriatric cases who have osteoporosis. Their shape is influenced by a combination of axial loading & varus/valgus applied forces. [12] Although multiple categories exist for tibial plateau fractures, the Schatzcker classification is the most frequently applied. [13] The most frequently encountered forms of tibial plateau fractures are type III (pure depression) & type II (split depressed) fractures. Typically, patients present with knee swelling that is both painful and immobile on the affected side. The critical assessment of these cases requires an extensive physical exam as well as radiological examinations, such as X-ray & CT. [13] It seems that the therapy of tibial plateau fractures is contentious. The selection of the surgical approach, the timing of definitive operations, the method of fracture reduction & stabilization, & the rehabilitation following surgery regimen are all subjects of debate. However, a consensus exists with regard to management principles, particularly with regard to the simplest & complicated fracture patterns. [14] The objectives of therapy are to attain anatomical alignment of the articular surface, adequately restore mechanical alignment, & ensure secure fixation to enable early range of motion. There is a suggestion that prioritizing the surgical recovery of limb alignment & overall length is more important than repairing individual articular fracture lines. This is because any remaining articular incongruity is usually well tolerated & doesn't lead to progressive degenerative joint changes or have a negative impact on long-term functional outcomes. [15] Prior to anatomical reduction, there was a general agreement regarding the need for bone graft or bone graft substitute support of the raised depressed fragment in type II & III tibial plateau fractures.[15] Nevertheless, it offers a minor complication rating of 20.6 percent , which involves cutaneous nerve injury, persistent discomfort, &local wound complications, & a major complication rating of 8.6 percent, which includes massive loss of blood and avulsion of the anterior superior iliac spine. Illiac crest autologous cancellous bone implants are associated with a considerable morbidity, including two years of postoperative pain, immobility, hematoma, and donor site infection. Additionally, the use of bone transplant substitutes is costly. [16] The sample size for the controlled investigation was thirty cases. We conducted a follow-up study on 15 cases who had type III & type II fractures. These fractures were treated utilizing radiological and functional methods, including open reduction & internal fixation. No bone grafts were used in the treatment. Additionally, depression was corrected by employing rafting screws to elevate the affected area. Furthermore, we conducted a comparative analysis with another cohort consisting of fifteen cases who had type III & II fractures and were also treated via the same protocol, which involved the utilization of rafting screws or bone grafting.

The research sample consisted of twenty-two males & eight females who had closed lateral tibial plateau fractures, of which eighteen were categorized as type II fractures & twelve as type III fractures.

The average age at the time of surgery was 35.67 years, & the mean duration of the follow-up period was 14 months, ranging from twelve to eighteen months. Group A attained skeletal union in 14.86 weeks (ranging from 11–19 weeks), while group B did so in 14.93 weeks (ranging from: 8–17 weeks).

The investigation excluded fractures that met the following criteria: Schatzker type IV, I, VI & V, open fractures, fractures accompanied by vascular injury, concurrent lower limb injuries that would impede tibial plateau fracture rehabilitation, joint depression exceeding two centimeters, or the presence of medical comorbidities.

A detailed history taking, meticulous physical examination and radiological investigations were obtained preoperatively, postoperatively and in the follow up.

Intraoperatively, the anterolateral approach for the knee was used for all patients. rafting screws and plates or bone graft were used. All efforts were made to put the proximal screws close to the articular surface to act as a raft.

In the following surgery &follow-up periods, all cases in both groups were evaluated functionally & radiologically using the Rasmussen functional score, Knee Society score, Rasmussen radiological score, & VAS (Visual analogue score) for measuring pain.

In terms of radiological outcome, the two groups didn't differ significantly. Both the functional outcomes and the outcomes themselves were virtually equivalent. The mean functional results for group A were determined to be 23.63, whereas for group B they were 24.13.

In general, the Visual Analogue Scale exhibited minimal variation in group A in comparison to group B (on day one, day two, two weeks, and three months) due to the lack of graft site discomfort in group A.

The duration of the operation & intraoperative & following surgery blood loss was assessed. Additionally, group A had a reduced operational time (96 minutes) than group B (101 minutes). Group A experienced negligible blood loss (mean: 206 mm) in contrast to group B (average: 236 millimeters), and no other significant complications appeared.

Unfortunately, there are few articles and studies about treating depressed tibial plateau fractures without graft, most of them evaluate small set (3.5 ml) rafting screws for type II fractures.

In 2015, **Molenaars et al.** [17] examined the outcome of thirty-eight cases who had split-depression (up to five millimeters) tibial plateau fractures following open reduction & internal fixation. Without utilizing bone grafting, a locking plate was employed to construct a periarticular raft. [17]

The monitoring period was 22.8 months on average (ranging from: 6–36 months). In twenty-seven cases, the Rasmussen radiological score was excellent, while in nine it was good, and in two it was fair. In fifteen cases, the Rasmussen clinical score was excellent, while in twenty-one it was good, and in two it was fair. After regaining full weight bearing, just a single case with severe comminution suffered reduction in weight. All patients did not suffer any serious complications during the operation, including osteoarthritis, osteomyelitis, breakage, implant failure, or screw backout.

One possible method for treating split-depression proximal tibial plateau fractures is to use fixation with a periarticular raft construct and a locking plate, eliminating the need for bone substitution or bone transplant. [17]

In 2013, Cross et al. [18] conducted a retrospective investigation on 105 cases who had suffered tibial plateau fractures; of these, fifty-one had split depressed type II fractures among January 2008 and March 2011. Without the usage of bone graft or bone substitute, they were treated with open reduction & fixation utilizing 6.5 millimeters cancellous screws to achieve intercondylar reduce by lag technique, followed by the application of a periarticular anatomic plate. With a mean monitoring of 28.24 months (10-43) months, the participants had an average age of 43.02 years. [18] Optimal surgical time was 55 minutes (ranging from 40 to 110 minutes).

The results showed positive outcomes, as there were no significant reports of joint depression, misalignment of the joint in either the front-to-back or side-to-side direction, failure of the fixation, or loosening of the implant. Complications manifested as superficial infections in four of the cases. The x-rays obtained at the latest monitoring didn't indicate any signs of delayed joint collapse, despite the utilization of the fixation technique. [18]

Their suggestion was to add 6.5 cancellous lag screws to periarticular plates is an effective treatment modality for depressed proximal having thereby preventing the need for bone substitutes or grafts, regardless of the implants, fracture patterns, or underlying bone quality. [18]

Singleton N. et al. [16] conducted an additional study in **2017** involving 97 cases who underwent open reduction & internal fixation with bone transplantation of the resultant defect for a depressed tibial plateau fracture between 2007 & 2012, with a minimum follow-up of 12 months.

Only 41 patients participated in the follow-up. Among the forty-one cases, nineteen patients exhibited type II fractures and two cases presented with type III fractures. After fracture, the average monitoring period was 3.9 years, with an average age of fifty-four among all patients. Six patients had been managed non-operatively, while thirty-five had undergone surgical treatment. [16]

The study's results indicated that individuals who demonstrated reduced residual articular depression after 3.9 years achieved notable reductions in knee range of motion deficits. The average knee range of motion for the intact knee was determined to be 0–131 degrees, but for the injured knee it varied between 4–119 degrees, across all groups. Patients exhibiting reduced levels of residual articular depression demonstrated significantly

higher functional & pain scores, as well as decreased disability. **(16)**

The mean VAS score for cases with depression measured less than 2.5 millimeters was 7.77 in their study, 6.50 for cases with depression ranging from 2.5 to 5 millimeters, & 6.56 for cases with depression above five millimeters. Age & gender hadn't significant impact on the outcome, according to additional research. A negative correlation was observed between the severity of fracture grades & functional outcome scores, as well as larger reductions in knee range of motion. Infected nonunion accounted for a single case. (16)

In **1991**, a study was done by **Hohl.** (19) on 20 patients underwent operative treatment for different types of tibial plateau fracture. Of those patients, 7 patients with type II fracture underwent open reduction & internal fixation with augmentation with autologous bone graft. The average of age was 45.5 years. The average preoperative depression was 7.8 mm while the mean postoperative depression was 2 mm with mean functional score of 89 out of 100. (19)

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