How to Cite:
Shehata, A. E. A., Mostafa, I. A., & Abdelmotaleb, M. M. (2022). Minimally invasive fixations in management of pilon fractures in adults. *International Journal of Health Sciences*, *6*(S4), 3483–3505. https://doi.org/10.53730/ijhs.v6nS4.9665

Minimally invasive fixations in management of pilon fractures in adults

Ahmed Elsayed Abdelraouf Shehata
Orthopaedic Surgery Department, Faculty of Medicine, Al-Azhar University, Egypt & M.B.B.Ch Mansoura University
Corresponding author email: ahmed93raouf@gmail.com

Ibrahim Ahmed Mostafa
Professor of Orthopaedic Surgery, Faculty of Medicine – Al-Azhar University

Mohamed Moawad Abdelmotaleb
Lecturer of Orthopaedic Surgery, Faculty of Medicine – Al-Azhar University

***Abstract*---**Background: Pilon fractures make up one percent of all breaks in the lower extremities and five to seven percent of all fractures of the tibia. Pilon fractures are caused by events with a lot of force like car accidents and falls from a high place, which put direct axial pressure on the tibial plafond and push it into the joint. The most common way to break a pilon is to fall from a high place. Even though there have been a lot of improvements in how these fractures are treated in the last few years, there is still a lot of disagreement about which treatment is best. Aim of the Work: The goal of this study is to look at both the effectiveness of minimally invasive fixations and the results of these types of fixations in treating pilon fractures in adults. Patients and Methods: This research was carried out between January 2021 and December 2021 at the hospitals affiliated with the Al-Azhar University, which are known as the Al-Hussien and Sayed Galal hospitals. For the purpose of conducting research on the efficacy of minimally invasive fixations and the outcomes of these procedures when treating broken pilon bones in adults, a total of thirty patients were enlisted as participants in this study. Clinically, using The Mazur score, and radiologically, Patients were looked at an average of eleven months after being given a diagnosis. Results: In group A (MIPO), the average time for union was 90 days (range, 75-150 days). In group B (External fixation), the average time for union was 88.5 days (range, 60-115 days), and in group C (MIPO), the average time for union was 77 days (range, 67-100 days) (Canulated screws). Malunion was not discovered in any of the patients in group A (MIPO), but it was discovered in thirty percent of the patients in group B (External fixation), and it was not seen in any of the patients in group C. (Canulated screws). The overall

outcomes were similar, and the vast majority of patients expressed satisfaction with the outcomes. Based on these findings, it seems that the therapeutic techniques that were utilised merit a position in the process of treating distal intra-articular fractures of the tibia. Conclusion: The treatment of comminuted intra-articular tibial plafond fractures remains challenging. Delaying the surgery until the soft tissue state has improved, as well as avoiding extensive soft tissue dissection and periosteal stripping, are critical strategies to lower the risk of complications and increase therapeutic success. Complications seemed to be kept to a minimal as a result of the careful attention devoted to the soft tissue injury associated with these fractures.

***Abstract*---**MIPO, external fixation, cannulated screws, locked plate fixation, pilon.

Introduction

Interarticular fractures of the distal tibia have also been referred to as These include fractures of the tibial plafond, pilon fractures, and fractures of the distal tibial burst These terms have been used to describe tibial fractures. The French phrase "plat fond" (literally, "flat bottom") refers to the joint surface of the tibia's distal end, which is often referred to as the "ceiling." The English term for an ornately decorated ceiling is "ceiling." Fracture has also been referred to as pylon, a term that literally translates to "abridgement or stone archway." [(1)] 5% to 7% of all tibial fractures are pilon fractures, which account for 1% of all lower extremity fractures. [(2)] High-energy processes, such as car accidents or falls from a great height, may induce pilon fractures. A direct axial compression and articular impaction of the tibial plafond, which increases the likelihood of a fracture, is the outcome of these sorts of injuries. [(3)]

There is also the possibility of low-energy processes, albeit they are far less common. It was believed that they were caused by rotating forces acting on the distal tibia. As a consequence, there was much less comminution, fracture displacement, and injury to the soft tissues than there was with higher energy mechanisms. In addition, older women who suffer from osteoporosis of the bone are at an increased risk of low-energy pilon fractures. [(4)] Even though there have been a lot of improvements in how these fractures are treated in the past few years, it has been hard and challenging to find the best treatment. This is mostly because of the damage to the soft tissues, the high-energy pattern of the fracture, and the severe edoema that often goes along with these kinds of fractures. [(5)]

Aim of the work

The goal of this study is to look at both the effectiveness of minimally invasive fixations and the results of these kinds of fixations in treating pilon fractures in adults.

Patients and methods

This prospective case series research was carried out on 30 patients who had been admitted to the hospitals affiliated with the AL-Azhar university throughout the period beginning in January 2021 and ending in December 2021. These patients received treatment and were followed for an average of 11 months.

Patients

In this particular research, there were a total of 30 patients who had a closed tibial plafond fracture. All of the patients were accepted into this research after meeting the stringent requirements for inclusion and rejection outlined in the criteria. The clinical, laboratory, and radiographic examinations were performed on all of the patients in order to determine the degree of fracture comminution, the kind of fracture according to the A O classification, and to exclude patients who were not suitable for participation in this research.

A. Inclusion criteria: 1- Patients above the age of 18 and under the age of 75 are eligible, 2- Patients who had been diagnosed with Pilon fractures both clinically and radiologically, 3- Type B 1,2,3 and C 1,2 pilon fractures (intra articular distal tibial fractures) and 4- No episodes of compartment syndrome
B. Exclusion criteria: 1- Severe injury with Gustilo-Anderson type C III open fracture, 2- Pilon fractures with neurovascular deficits, 3- The distal tibial comminuted fracture is severe and difficult to repair. (type C III according to A O classification) and 4- Severe comorbidities that prevent surgical intervention. The Fracture type according to A O classification was type B (fifteen patients), type C (fifteen patient), According to method of fixation: MIPO (15 patients), External fixator (10 patients) and canulated screws (5 patients).

Patients' evaluation

Clinical evaluation

Each participant in this research had a comprehensive clinical evaluation that included an in-depth clinical history as well as a general and local physical examination.

Clinical history

Careful medical history is essential when dealing with a case of tibial plafond fracture. Age to exclude skeletally immature patients, Associated injuries such as calcaneal, tibial plateau, pelvic, acetabular, and spinal fractures must be identified and evaluated. It was essential for patients to have a history of medical problems and medications such as smoking, hypertension, diabetes, rheumatoid arthritis, haemophilia, sickle cell anaemia, systemic lupus, poliomyelitis, osteoporosis, immunosuppressive drugs, bone inhibiting medication, bone infection, and a history of radiation therapy or chemotherapy.

General examination

This was done to determine whether or not the patient was physically fit enough to undergo the surgical treatment. Checking for additional medical conditions such as high blood pressure, anaemia, systemic lupus, and chest infections are also part of the exam.

Local examination

A fracture of the distal tibia should be suspected when there is significant pain and swelling in the ankle, when the patient is unable to bear weight, and when there is a mechanism of axial loading. On first inspection, a deformity of the ankle will often be seen. Using the Oestern and Tscherne classification, you need to be very careful to make an accurate assessment of the neurovascular state of the extremities, the degree of edoema, and the condition of the soft tissues that are surrounding the extremity. A circumferential assessment of the foot and ankle should also be included in the physical examination in order to look for an open wound that is communicating with the body. The capillary refill in the nail beds should be checked when doing a vascular exam. The dorsalis pedis and posterior tibial pulses should also be palpated.

Laboratory investigations

Each patient in the research had the following tests: CBC, Coagulation profile, ESR, and CRP to rule out individuals who were already infected. Organ function testing for the kidneys and liver.

Radiological evaluation

Each patient in the study had the following radiological investigations:
Plain X-Ray: The standard radiographic examination includes anteroposterior and lateral projections and must include the entire tibia and fibula and the foot.
Full trauma survey to exclude associated fractures.
C.T. Scan.

Preoperative preparation of the patient

Routine pre-operative investigations are carried out for all patients, and included: Chest X-ray, ECG, CBC, RBS, Liver function, renal function, and Coagulation profile. All patients were instructed to fast for at least 6 hours before the operation.

Operative procedure

Anesthetic technique

The patient was given either spinal or epidural anaesthetic before the surgical operation was carried out.

Asepsis

In order to reduce the number of polluted particles, operations on patients were performed in standard operating rooms that were outfitted with high-flow ventilation systems. The number of people present in the operating theatre was maintained to an absolute minimum during the whole procedure. The amount of people entering and exiting the theatre was restricted as much as was humanly practicable.

Antibiotics

Preoperatively, one dosage of third-generation cephalosporin consisting of one gramme was administered intravenously, and postoperatively, one dose was given every twenty-four hours for three days.

Adjustment of the patient's position

After that, the patient is repositioned such that they are laying in the supine position. Verify that the views of the C-arm may be easily swapped between the anteroposterior and lateral orientations.

Fixation of fibular fracture

A cushioned sand bag is positioned under the patient's hip in order to rotate the patella into the AP plane. This is done by positioning the bag under the patient's hip. The patient's thigh is then secured with the tourniquet after the leg has been cleaned, bandaged, and prepared for the procedure above the knee. During the examination of the fracture, the proximal extent of the fracture is noted on the fluoroscopy picture. Fixation of the fractured portion of the fibula using a lateral approach and either a plate or a Kirschner wire (for segmental fractures) (fig 1). The fracture of the tibial pilon is first stabilised, then the length and alignment of the tibia are restored, and then the fracture of the fibula is stabilised.

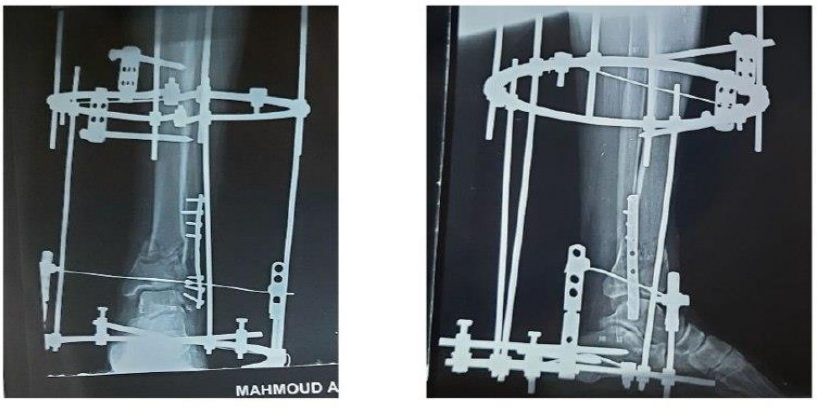


Fig. (1): Fixation of the fibula

MIPO Procedure

Manual traction and the percutaneous insertion of pointed reduction forceps are both used to produce a preliminary reduction of the fracture. It was discovered with the use of the image intensifier that the fracture had been successfully reduced to its original size. Creating a skin incision on the medial portion of the distal tibia that is either straight or slightly bent (along the posterior border of the medial malleolus). The length of the incision ranges between between three and five centimetres, and It starts at the level of the tibial plafond and extends proximally along the medial surface of the distal tibia until it reaches the level of the tibial plateau.

Fig. (2): Medial incision

The dissection is carried out all the way into the periosteum, taking care to protect the great saphenous vein as well as the saphenous nerve. A blunt tool is used to make a subcutaneous tunnel in the epiperiosteal area, and the periosteum is left intact. The tunnel is then directed toward the diaphysis (this can be done by the blunt tip of the plate).

The scalpel is used to make a very small incision in the plate at the furthest distant location it can reach. Confirming the plate's location using the image intensifier in both the AP and lateral planes helps guarantee that the plate is in the right orientation and that it is parallel to the posterior end of the distal tibia. This is done so that the patient may walk normally after the procedure. It is necessary to extend the proximal end of the plate in order to achieve the correct plate length in line with the plate span ratio. It is important that the end of the plate that is farthest away from the patient be positioned such that it is at the same level as the plafond of the tibia.

Once the correct placement of the plate has been determined, temporary fixation can be performed using K-wires. After this, a conventional screw is inserted into one of the distal holes of the plate to enable positioning of the plate close to the bone. This reduces the likelihood that the plate will irritate the surrounding soft tissue. It would be sufficient to make small stab incisions in order to complete the fixation with screws, and the location of the screws could be determined either by an image intensifier or by an identical plate that was put outside.

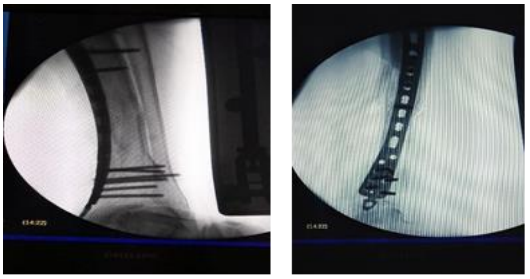


Fig. (3): checking the plate position by fluoroscopy

The wound is closed with sutures with avoidance of tension sutures and the distal and proximal incisions may need deeper sutures.

Fig. (8 -15): wound after closure

Application of external fixator

The structure of our frame was made up of two rings with a sturdy base that were separated by four threaded rods. The posterior, medial, and lateral sides of the foot plate each get a rod from our team, the rings and foot plate have been sized to provide a clearance of at least two finger widths all the way around the leg, drilling was done using a drill bit, and the image intensifier was used to evaluate the location of the drill bit to make sure that it was perpendicular to the tibial shaft and with the assistance of two AP half pins, we aligned the stable base that was located above the fracture (figure 4). A Thandle that was placed using universal Rancho cubes was used in order to apply a 6 millimetre layer of shanz.

Fig. (4): Application of stable base of frame.

A horizontal reference wire is inserted through the calcaneus (figure 5) and is positioned parallel to the talar dome (ankle orientation line). The rotation was corrected by bringing the second toe into alignment with the tibial tubercle.

Fig. (5): Application of calcaneal reference wire

Changing the tension that is being applied to the calcaneal wire. Check that the alignment is correct with the shaft of the tibia, and if it is not, make any required adjustments to the position of the talus so that it is anatomically aligned with the tibia. Drawing the working length rods equally through the stable foundation while tightening the nuts allows for the tightening of the universal cubes on the AP half pins as well as the distraction of the fracture by one to two centimetres. A thorough examination of the fracture is carried out. We To properly align the joint surface, percutaneous or micro open reduction methods might be used. Interfragmentary tiny Steinman pins and small fragment screws are used whenever it is possible, with the goal of reducing the joint surface area as much as possible.

One centimetre above the ankle joint, a horizontal reference wire has to be placed into the distal tibial metaphysis. You will need to work your way along the threaded rods with the fracture ring until you reach the reference wire. First, the fixation should be constructed all the way up to the wire, and then the wire should be stretched. After that, we continue to add more wires and half pins to the fracture fixation ring, which are afterwards angled in a manner that diverges from one another (fig 6).

Fig. (6): Immediate postoperative photo

Fixation with percutaneous cannulated screws

Through the use of manipulation and traction on the patient, the severity of the fracture might be reduced thanks to the image intensifier. The reduction was maintained at the same level by the use of reduction clamps that were placed via skin incisions that were 0.5 centimetres in length and performing blunt dissection all the way down to the bone. In order to repair each of the primary fracture pieces, guide-wires were first introduced through the skin, and then percutaneous cannulated screws were put over them.

Fig (7) Percutaneous cannulated screws are used to stabilise fractures of the tibial pilon

Postoperative components

1) Postoperative care: After surgery, each patient was given an antibiotic intravenously for the first three days, and then they were given an oral antibiotic to take for the remaining five days. The wound was dressed with saline solution every other day until it had been treated for fifteen days.In external fixation cases: Pin care by brushing it with saline to remove any crusts and then dried it three times per day. Postoperative rehabilitation: including nonweight bearing, quadriceps strengthening exercises and knee range of motion exercises were started the day following the procedure. In external fixation cases: In the orthopaedic clinic, the section of the fixator

that crossed the joint was removed between six and eight weeks after surgery. After the cast was removed, the patient began physiotherapy, which included both passive and active mobility of the ankle joint. Physiotherapy is started to avoid the development of an equinus posture of the foot.

2) Postoperative follow up: Every month until the fracture healed, have a plain x-ray taken.After then, the follow-ups continued every three months for the next year and a half.In external fixation cases: In order to dynamically stabilise the fractures, the external fixator's locking nuts were loosened.After bone union, the external fixator was withdrawn.
3) Postoperative evaluation:

Three indices will be used to evaluate results

Fracture healing

Radiographically examined by keeping an eye on the formation of calluses. Bony union was defined as the simultaneous occurrence of clinical and radiographic healing, the absence of pain when palpating the fracture, the ability to bear full weight, and the presence of three bridging cortices on orthogonal radiographs. Other characteristics of bony union included the ability to bear full weight. When there was no sign of clinical or radiological union after 9 months, a nonunion was assumed to be present. This was the case when there was nonunion. Malunion was defined as more than 7 degrees of valgus or varus, or more than 10 degrees of procurvatum/recurvatum, based on the final radiographic examination.

Healing and wound infection

Infection should be explored if there are signs and symptoms of infection around the incision. As soon as signs and symptoms of infection around a pin prompted the need for more frequent local washing and dressings, as well as for medications and surgical debridement, it was determined to be a pin tract infection.

Ankle function

The Mazur score was used to gauge this. It was possible to get a total of 100 points. It was regarded good to superb if the score was at least 87 points.

The Mazur: (one of ankle and foot scoring systems). [6]
Evaluation of the Suffering Ankle Based on Personal Opinion

Absence of any and all Symptoms 15
Mild Symptoms 10
Moderate Symptoms 5
Severe Symptoms 0

Can you walk Normally?

Yes 15

No..... 0
Can you Run Normally?
Yes 10
No 0

Descending of Stairs ?

< 18 sec 10
18–20 sec 5
> 20 sec 0

Getting up on the heel with a hurt leg

> 40 times 10
30–39 times 5
< 30 times 0

Getting up on your toes with hurt legs

> 40 times 10
30–39 times 5
< 30 times 0

One leg hurt, single-legged stance

> 55 seconds..... 10
50–55 seconds 5
< 50 seconds 0

The ankle joint is loose

Stable (5mm) 10
Moderate instability (6-10mm) 5
Severe instability (10mm) 0

Dorsiflexion ROM

10^0 10
5^0–9^0 5
Less than 5^0 0

Results

This research was carried out on thirty patients who had been admitted to the hospitals affiliated with the AL-Azhar University (the Al-Hussien and Sayed Galal hospitals) between the months of January and December 2021. These patients received treatment and were monitored for an average of eleven months. They were split up into three different groups.

Group A: MIPO. Group B: External fixation. Group C: Cannulated screws.

Table (1):Comparison between the studied groups according to demographic data

Demographic Data		Total (n = 30)		Method						χ^2	P
				MIPO (n =15)		External fixation (n =10)		Cannulated screws (n =5)			
		No.	%	No.	%	No.	%	No.	%		
Sex	Male	26	86.7	13	86.7	9	90.0	4	80.0	χ^2= 0.726	^{MC}p= 1.000
	Female	4	13.3	2	13.3	1	10.0	1	20.0		
Age	Min. – Max.	18.0 – 60.0		18.0 – 53.0		20.0 – 56.0		19.0 – 60.0		F= 0.157	0.856
	Mean ± SD.	31.90 ± 11.36		30.73 ± 10.25		32.80 ± 11.08		33.60 ± 16.74			
	Median (IQR)	30.50 (22.0 – 38.0)		27.0 (23.0 – 36.50)		31.50 (24.0 – 41.0)		31.0 (20.0 – 38.0)			
Smoking	Smokers	20	66.7	9	60.0	8	80.0	3	60.0	χ^2= 1.295	^{MC}p= 0.581
	Non smokers	10	33.3	6	40.0	2	20.0	2	40.0		

IQR: Inter Quartile Range SD: Standard deviation
χ^2: Chi square test MC: Monte Carlo F: F for ANOVA test
In terms of sex, age, and smoking, this table reveals that there was a statistically insignificant difference between the examined groups (total and method).

Table (2): Comparison between the studied groups according to site

Site	Total (n = 30)		Method						χ^2	^{MC}p
			MIPO (n =15)		External fixation (n =10)		Cannulated screws (n =5)			
	No.	%	No.	%	No.	%	No.	%		
Unilateral	28	93.3	14	93.3	9	90.0	5	100.0	0.789	1.000
Bilateral	2	6.7	1	6.7	1	10.0	0	0.0		

χ2: Chi square test MC: Monte Carlo

This table shows that there wasn't a statistically significant difference between the groups that were studied (total and method) when it came to site (unilateral and bilateral).

Table (3): Comparison between the studied groups according to mechanism

Mechanism	Total (n = 30)		Method						χ^2	^{MC}p
			MIPO (n =15)		External fixation (n =10)		Cannulated screws (n =5)			
	No.	%	No.	%	No.	%	No.	%		

Axial loading	27	90.0	13	86.7	10	100.0	4	80.0	2.012	0.389
Twisting injury	3	10.0	2	13.3	0	0.0	1	20.0		

χ2: Chi square test MC: Monte Carlo

This table shows that there was no statistically significant difference between the groups that were studied (total and method) when it came to the mechanism (axial loading and twisting injury).

Table (4): Comparison between the studied groups according to AO Type

AO Type	Total (n = 30)		Method						χ^2	^{MC}p
			MIPO (n =15)		External fixation (n =10)		Cannulated screws (n =5)			
	No.	%	No.	%	No.	%	No.	%		
B	14	46.7	9	60.0	0	0.0	5	100.0	16.441*	<0.001*
C	16	53.3	6	40.0	10	100.0	0	0.0		

χ2: Chi square test MC: Monte Carlo *: Significant from a statistical standpoint when p is less than or equal to 0.05

This table shows that there was a big difference between the studied groups (both the total group and the method group) when it came to AO type.

Table (5): Comparison between the studied groups according to soft tissue

Soft tissue	Total (n = 30)		Method						χ^2	^{MC}p
			MIPO (n =15)		External fixation (n =10)		Cannulated screws (n =5)			
	No.	%	No.	%	No.	%	No.	%		
Type I	11	36.7	7	46.7	0	0.0	4	80.0	10.900*	0.004*
Type II	19	63.3	8	53.3	10	100.0	1	20.0		

χ2: Chi square test MC: Monte Carlo *: Significant from a statistical standpoint when p is less than or equal to 0.05

This table shows that there was a statistically significant difference between the two groups (total and method) when it came to soft tissue.

Table (6): Comparison between the studied groups according to fibular fracure

Fibular fracure	Total (n = 30)		Method						χ^2	^{MC}p
			MIPO (n =15)		External fixation (n =10)		Cannulated screws (n =5)			
	No.	%	No.	%	No.	%	No.	%		
Yes	20	66.7	8	53.3	10	100.0	2	40.0	8.406*	0.016*

No	10	33.3	7	46.7	0	0.0	3	60.0		

χ2: Chi square test MC: Monte Carlo *: Significant from a statistical standpoint when p is less than or equal to 0.05

This table shows that there was a statistically significant difference between the two groups (total and method) when it came to fibular fracture.

Table (7): Comparison between the studied groups according to Time to operation

Time to operation	Total (n = 30)	Method			F	P
		MIPO (n =15)	External fixation (n =10)	Cannulated screws (n =5)		
Min. – Max.	1.0 – 25.0	3.0 – 20.0	1.0 – 19.0	2.0 – 25.0	1.695	0.203
Mean ± SD.	9.83 ± 5.84	7.93 ± 4.38	12.0 ± 5.31	11.20 ± 9.44		
Median (IQR)	8.0 (6.0 – 15.0)	7.0 (5.50 – 8.0)	13.50 (9.0 –15.0)	11.0 (3.0 –15.0)		

IQR: Inter Quartile Range SD: Standard deviation F: for ANOVA test*: Statistically significant at p ≤ 0.05

This table shows that there wasn't a statistically significant difference in time to operation between the two groups that were looked at (the total group and the method group).

Table (8): Comparison between the studied groups according to time to weight bearing

Time to weight bearing	Total (n = 30)	Method			F	P
		MIPO (n =15)	External fixation (n =10)	Cannulated screws (n =5)		
Min. – Max.	60.0 – 105.0	60.0 – 95.0	67.0 – 105.0	65.0 – 85.0	3.989*	0.030*
Mean ± SD.	79.63 ± 12.84	76.27 ± 11.73	88.0 ± 12.85	73.0 ± 8.34		
Median (IQR)	80.0 (67.0 – 89.0)	75.0 (66.0 –85.0)	90.0 (80.0 – 97.0)	70.0 (67.0 – 78.0)		
Sig. bet. grops		p_1=0.052,p_2=0.852,p_3=0.067				

IQR: Inter Quartile Range SD: Standard deviation
F: F for ANOVA test, Pairwise comparison bet. each 2 groups was done using Post Hoc Test (Tukey)

p_1: p value for comparison between MIPO and External fixation
p_2: p value for comparison between MIPO and Cannulated screws
p_3: p value for comparison between External fixation and Cannulated screws
*: Significant from a statistical standpoint when p is less than or equal to 0.05

This table shows that there was a statistically significant difference between the groups that were studied (both the total group and the method group) when it came to the time it took to start bearing weight.

Table (9): Comparison between the studied groups according to time to union

Time to union	Total (n = 30)	Method			F	P
		MIPO (n =15)	External fixation (n =10)	Cannulated screws (n =5)		
Min. – Max.	60.0 – 150.0	75.0 – 150.0	60.0 – 115.0	67.0 – 100.0	3.028	0.065
Mean ± SD.	93.67 ± 19.32	100.67 ± 20.57	90.80 ± 15.80	78.40 ± 12.93		
Median (IQR)	90.0 (84.0– 102.0)	93.0 (87.50– 110.0)	88.50 (85.0 – 95.0)	77.0 (70.0 – 78.0)		

IQR: Inter Quartile Range SD: Standard deviation
F: F for ANOVA test

This table shows that there was statistically insignificant difference between the studied groups as (total and the method) as regard time to union.

Table (10): Comparison between the studied groups according to follow up

Follow up	Total (n = 30)	Method			F	P
		MIPO (n =15)	External fixation (n =10)	Cannulated screws (n =5)		
Min. – Max.	6.0 – 9.0	6.0 – 9.0	8.0 – 9.0	6.0 – 8.0	11.253*	<0.001*
Mean ± SD.	7.37 ± 1.22	6.87 ± 1.13	8.50 ± 0.53	6.60 ± 0.89		
Median (IQR)	7.50 (6.0 – 8.0)	6.0 (6.0 –7.50)	8.50 (8.0 – 9.0)	6.0 (6.0 – 7.0)		
Sig. bet. grops		p_1=0.001*,p_2=0.845,p_3=0.003*				

IQR: Inter Quartile Range SD: Standard deviation
F: F for ANOVA test, Pairwise comparison bet. each 2 groups was done using Post Hoc Test (Tukey)

p_1: p value for comparison between MIPO and External fixation
p_2: p value for comparison between MIPO and Cannulated screws
p_3: p value for comparison between External fixation and Cannulated screws
*: Significant from a statistical standpoint when p is less than or equal to 0.05

This table demonstrates that there was a highly statistically significant difference between the groups that were evaluated in terms of follow up (both the total group and the technique group are represented).

Table (11): Comparison between the studied groups according to mazur

Mazur	Total (n = 30)	Method			F	P
		MIPO (n =15)	External fixation (n =10)	Cannulated screws (n =5)		
Min. – Max.	70.0 – 95.0	70.0 – 95.0	70.0 – 85.0	80.0 – 95.0	9.000*	0.001*
Mean ± SD.	84.17 ± 7.67	87.0 ± 7.02	77.50 ± 4.25	89.0 ± 6.52		
Median (IQR)	85.0 (80.0 –90.0)	90.0 (85.0 – 90.0)	77.50 (75.0 –80.0)	90.0 (85.0 – 95.0)		
Sig. bet. grops		p_1=0.002*,p_2=0.805,p_3=0.006*				

IQR: Inter Quartile Range SD: Standard deviation
F: F for ANOVA test, Pairwise comparison bet. each 2 groups was done using Post Hoc Test (Tukey)
p_1: p value for comparison between MIPO and External fixation
p_2: p value for comparison between MIPO and Cannulated screws
p_3: p value for comparison between External fixation and Cannulated screws
*: Significant from a statistical standpoint when p is less than or equal to 0.05

This table shows that there was highly statistically significant difference between the studied groups as (total and the method) as regard mazur.

Table (12): Comparison between the studied groups according to complications

Complications	Total (n = 30)		Method						χ^2	^{MC}p
			MIPO (n =15)		External fixation (n =10)		Cannulated screws (n =5)			
	No.	%	No.	%	No.	%	No.	%		
No	22	73.3	14	93.3	4	40.0	4	80.0	10.866*	0.022*
Malunion	3	10.0	0	0.0	3	30.0	0	0.0		
Artheralgia	3	10.0	1	6.7	2	20.0	0	0.0		
Infection	2	6.7	0	0.0	1	10.0	1	20.0		

χ2: Chi square test MC: Monte Carlo
*: Significant from a statistical standpoint when p is less than or equal to 0.05

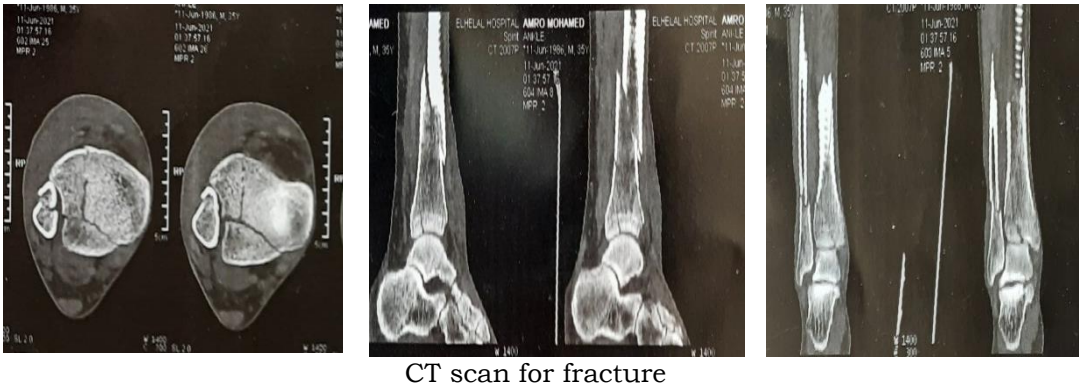
According to the data shown in this table, there was a statistically significant difference in the occurrence of complications between the two groups that were evaluated (total and technique).

Case presentation

Case 1

Preoperative data: Male, 37 years, Advertiser, smoker, type B according to A O classification.

Plain X ray



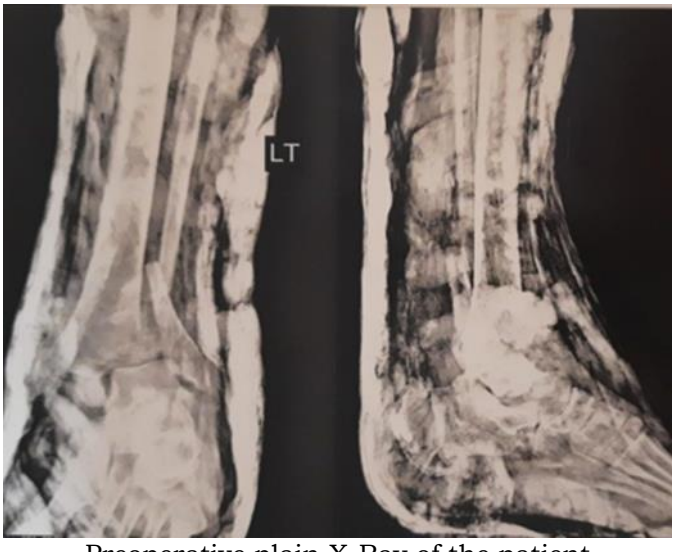
CT scan for fracture

Post operative plain x ray

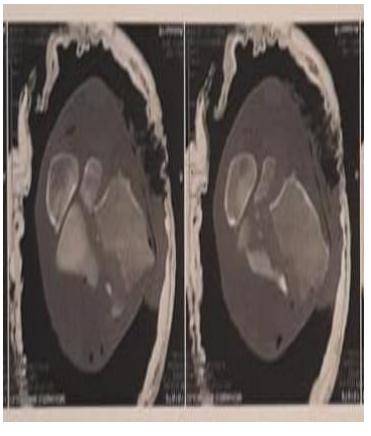
X ray after fracture union (150 days)

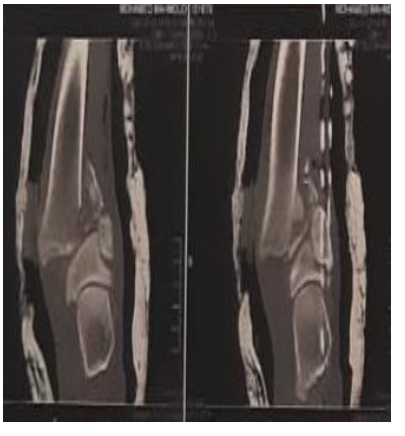
Case 2

Preoperative data: Male patient 41 years old, Worker, smoker, type C according to A O classification.

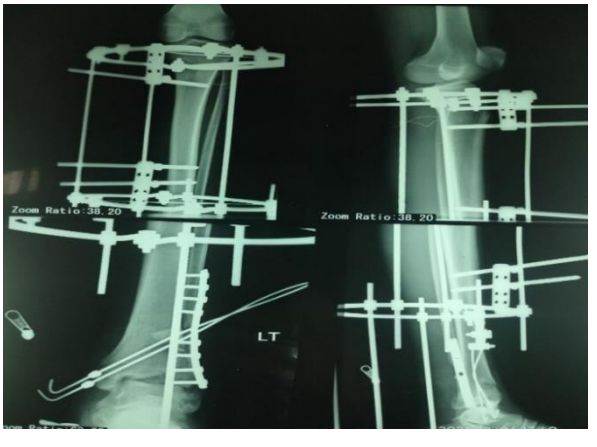


Preoperative plain X-Ray of the patient





Preoperative CT scan



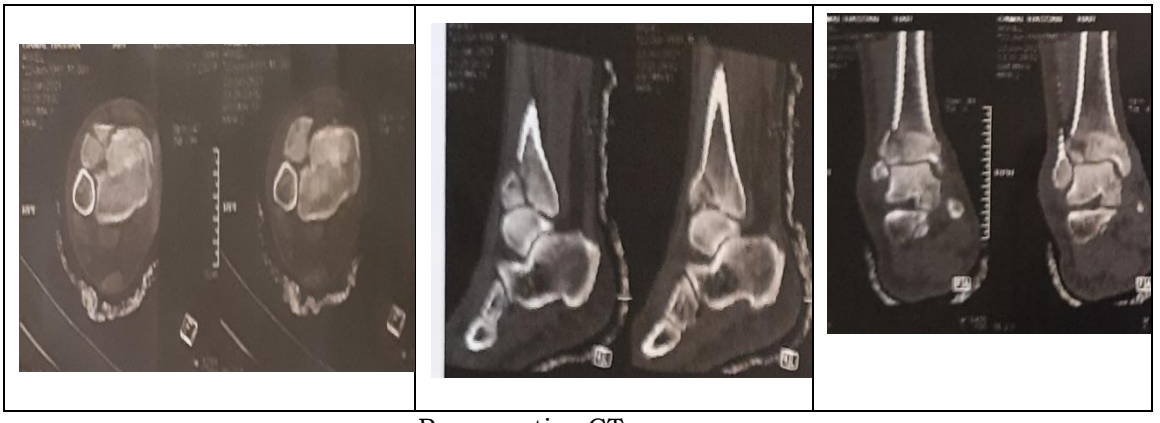
Postoperative x ray

X-ray after complete union (85 days)

Case 3

Preoperative data: Male patient 60 years old, House guard, smoker,type B according to A O classification.

Preoperative plain X-Ray of the patient



Preoperative CT scan

postoperative X-Ray

X-ray after complete union (67 days)

Discussion

Treatment for tibial pilon fractures has many main goals, but the most important ones are to keep the leg's length, fix the joint surfaces, and put the leg back in the right place. Open reduction is the safest way to reduce a fracture and get the joint back to where it should be. When thinking about whether or not external fixation can fix severe articular comminution, it's important to remember that open reduction is the only way to do this. [6] On the other hand, this type of treatment option shouldn't hurt the soft tissues. Even the most anatomically accurate reconstructions could fail if there was a serious injury to the soft tissues. This could cause the surgical wound to break down, which could expose the hardware and lead to an infection. [7]

When it comes to fractures caused by high-energy forces, the single most essential thing to keep in mind is that early open surgery (performed less than a week after the accident) has a much greater risk of complications compared to later surgery. It is essential to monitor the status of the skin and wait to conduct a checkup until the so-called wrinkle sign of the skin is positive. It is also crucial to wait for the local reepithelialization of each blister. [8] The surgical procedure should be postponed if there is even the tiniest indication of harm to the soft tissue. It is feasible to do internal fixation in a very short amount of time in some scenarios, such as low-energy fractures of the AO or OTA type A or B that do not cause a significant amount of damage to the soft tissues. It is not entirely clear what the optimal course of treatment is for type C fractures. It would seem that everyone has reached a consensus on how to prevent frequent difficulties, particularly those involving soft tissues. [9]

High-energy injuries to the end of the tibia can do a lot of damage to both soft tissues and bone in this area if the blood supply isn't good enough. If the condition of the soft tissues isn't taken into account, the injury will always be made worse by an infection, a wound that doesn't heal, or both. Small problems in the soft tissues make it more likely that big problems will happen. For this type of fracture, doctors have recommended being careful with the soft tissues and using minimally invasive techniques. [10,11] Our very low rates of complications are probably attributable to the fact that we postponed final surgery in cases where soft tissue damage occurred.

At the Al-Razi orthopaedic hospital in Kuwait, 72 patients with closed pilon fractures were treated with minimally invasive procedures in accordance with a protocol. *Abdelgaid et al.* [12] wrote about the long-term follow-up of these patients. The patients were given treatment at the Al-Razi orthopaedic hospital. The fractured bones of these individuals were all treated at the same time by the surgeon. The objective of the protocol is to identify the method of treatment that calls for the least amount of time spent in the operating room.

1) Regional classification of soft tissue injuries,
2) Grade of soft tissue injury &
3) Degree of bony comminution.

The duration of the follow-up period, on average, was 34 months. According to the Tornetta clinical rating method, 35 patients had outstanding outcomes, 29 patients had good results, 5 patients had acceptable results, and 3 patients had bad results. The percentage of patients with poor results was 4 percent. According to the Mazur scoring system, 5 patients (16.7 percent) in this research were evaluated as having exceptional outcomes, 6 patients (20 percent) were rated as having good results, 19 patients (63.3 percent) were believed to have acceptable results, and no patients (0 percent) had bad results.

MIPO was used to treat 18 patients who had fresh pilon fractures of class I, II, or III according to the classification system developed by Ruedi Allgower. Three patients had exceptional inference, nine patients had good inference, five patients had fair inference, and one patient had bad inference according to the rating standards developed by Mazur. Two patients had a disease known as scar dehiscence as a direct consequence of the operation, and one patient developed a RuediAllgower class III fixed equines deformity of the ankle as a direct result of the procedure. [13] *Mitkovic et al.* [14] successfully treated type B and type C fractures by using the technique of dynamic external fixation. In spite of the high incidence of infections, they discovered that 71% of patients were pleased with the outcomes of their treatment (11 percent). In spite of the fact that 11% of the individuals developed osteoarthritis, this was nevertheless the case (15 percent). The rates of amputation, arthritis, chronic osteomyelitis, and dehiscence of the surgical site were all around 2 percent with open reduction and internal fixation, whereas the risk of skin necrosis was 13 percent.

It is generally believed that using external fixation, with or without minimal internal fixation, lowers the amount of damage that is caused to soft tissues as a result of surgical procedures. As a result, the risk of having difficulties with soft tissue after surgery is decreased as a direct result of this. Our research, on the other hand, showed a 26.7 percent rate of complications, which included three cases of osteoarthritis, three cases of malunion, and two cases of a superficial infection.

Seven people who had closed pilon fractures were treated with closed reduction and internal fixation with percutaneous cannulated screws. Mujahid Ali and Vinod Kumar cared for the people. The average length of time for following up was 30.6 months. The way they were graded was completely based on the grader's own opinion. Most of the people who took the test got a score of 90.8 out of 100. This method of fixing something doesn't require a lot of cutting into the soft tissue and gets great results. This method of closed reduction and stabilisation of pilon fractures using only cannulated screws that are put in through a small hole in the skin does not appear to have been written about anywhere else in the medical literature. [15] In this particular research, the typical score was 89 percent, and there was only one instance of a superficial infection.

Conclusion

Comminuted intra-articular tibial plafond fractures are still hard to treat. To reduce the risk of complications and improve the effectiveness of treatment, it is important to postpone the surgery until the soft tissue has healed and to avoid excessive soft tissue dissection and periosteal stripping. Because of how well the

soft tissue damage from these fractures was treated, it seemed like complications were kept to a minimum. Larger, prospective, and randomised studies are needed to find out if these results are true and what kind of long-term functional results can be achieved by using different treatment methods.

References

(1) Calori GM, Tagliabue L, Mazza E, de Bellis U, Pierannunzii L, Marelli BM, et al. Tibial pilon fractures: which method of treatment?Injury. 2010;41(11):83–90. [PubMed] [Google Scholar]

(2) Mauffrey C, Vasario G, Battiston B, Lewis C, Beazley J, Seligson D. Tibial pilon fractures: a review of incidence, diagnosis, treatment, and complications. Acta Orthop Belg. 2011 Aug;77(4):432-40. [PubMed] [Reference list]

(3) Wyrsch B, McFerran MA, McAndrew M, Limbird TJ, Harper MC, Johnson KD, Schwartz HS. Operative treatment of fractures of the tibial plafond. A randomized, prospective study. J Bone Joint Surg Am. 1996 Nov;78(11):1646-57. [PubMed] [Reference list]

(4) Mauffrey C, Vasario G, Battiston B, Lewis C, Beazley J, Seligson D. Tibial pilon fractures: a review of incidence, diagnosis, treatment, and complications. Acta Orthop Belg. 2011 Aug;77(4):432-40. [PubMed] [Reference list]

(5) *Chan R, Taylor BC, Gentile J Orthopedics.* Optimal Management of High-Energy Pilon Fractures. *2015 Aug; 38(8):e708-14.* [PubMed] [Ref list]

(6) Mazur JM, Schwartz E, Simon SR. Ankle arthrodesis. Long-term follow-up with gait analysis. J Bone Joint Surg Am. 1979;61:964–975. doi: 10.2106/00004623-197961070-00002. **[**PubMed**] [**CrossRef]

(7) Helfet DL, Koval K, Pappas J, Sanders RW, DiPasquale T (1994): Intraarticular ―pilon‖ fracture of the tibia. *Clin Orthop Relat Res*; 298: 221-228.

(8) Kline AJ, Gruen GS, Pape HC *et al.* (2009): Early complications following the operative treatment of pilon fractures with and without diabetes. *Foot Ankle Int*; 30: 1042- 1047.

(9) Pollak AN, McCarthy ML, Bess RS, Agel J, Swiontkowski MF (2003): Outcomes after treatment of highenergy tibial plafond fractures. *J Bone Joint Surg*: 85-A: 1893-1900.

(10) Mehta S, Reilly MC, Rhorer AS, Liporace FA (2011): Current plating techniques and definitive treatment options for fractures of the tibial plafond and treatment of the late and failed pilon. In: *AAOS 2011 Annual Meeting Instructional Course* Edited, San Diego Convention Center.

(11) Mast JW, Spiegel PG, Pappas JN (1988) Fractures of the tibial pilon. Clin Orthop Relat Res: 68-82.

(12) Rammelt S, Endres T, Grass R, Zwipp H (2004) The role of external fixation in acute ankle trauma. Foot Ankle Clin 9: 455-474, vii-viii.

(13) Abdelgaid SM, Ahmed MA, Abdel-Mageed EG (2013) Minimally Invasive Treatment Protocol for Closed Pilon Fractures. Clin Res Foot Ankle 1: 108. doi:10.4172/2329-910X.1000108

(14) J Clin Diagn Res. 2016 Jan; 10(1): RC01–RC04. Published online 2016.

(15) Mitkovic MB, Bumbasirevic MZ, Lesic A, Golubovic Z (2002): Dynamic external fixation of comminuted intra-articular fractures of the distal tibia (type C pilon fractures). *Acta Orthop Belg*; 68: 508-514.
(16) Syed, MA., & Panchbhavi, VK. (2004). Fixation of tibial pilon fractures with percutaneous cannulated screws. *Injury*, *35*(3), 284-289.
(17) Widana, I.K., Sumetri, N.W., Sutapa, I.K., Suryasa, W. (2021). Anthropometric measures for better cardiovascular and musculoskeletal health. *Computer Applications in Engineering Education*, *29*(3), 550–561. https://doi.org/10.1002/cae.22202
(18) Suryasa, I. W., Rodríguez-Gámez, M., & Koldoris, T. (2021). Health and treatment of diabetes mellitus. *International Journal of Health Sciences*, *5*(1), i-v. https://doi.org/10.53730/ijhs.v5n1.2864