

Minimally Invasive Treatment Protocol for Closed Pilon Fractures

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Abstract

Introduction: high-energy injuries of distal tibia are usually associated with serious bony and soft tissues complications. Surgical options include biologic or open, internal or external fixation and primary arthrodesis with a lot of available fixation tools with no one treatment method has demonstrated superiority over others.

Material & Methods: from January 2007 to December 2010, 72 patients with closed pilon fractures managed by minimally invasive techniques according to a suggested protocol in the Al-Razi orthopedic hospital in Kuwait. Protocol is designed to choose minimally invasive treatment option depends on: 1) regional classification of soft tissue injuries, 2) grade of soft tissue injury & 3) degree of bony comminution.

Results: the mean follow up period was 34 months (range: 24–48 months). According to Tornetta clinical scoring system 35 (48.5%) patients were assessed as excellent, 29 patients with good results (40.5%), 5 patients (7%) assumed fair results and 3 patients (4%) had poor results. Using Teeny & Wiss radiologic scoring system, 43 patients (59.5%) achieved excellent results, 24 patients (33.5%) achieved good results, 4 patients (5.5%) with fair results and only one patient (1.5%) with poor result.

Conclusion: The designed protocol of minimally invasive treatment for closed pilon fractures provides the treating surgeon a variety of treatment options aiming to decrease the high rate of soft tissues and bony complications reported with these complex injuries. The unfavorable results will be decreased more if this protocol is combined with soft tissues stretching rehabilitation program and weight bearing is postponed until bony union become evident both clinically and radiologically.

Keywords: Pilon fracture; OTA/AO; Tscherne; Minimal invasive

Introduction

Pilon fractures are usually associated with significant soft tissue injury caused by high energy trauma, which may result in a series of complications such as fixation failure, skin flap necrosis or deep infection [1]. The most important predictors that influence the outcome of these injuries are soft-tissue management, the type of fracture, and quality of reduction [2].

Recognizing and managing soft tissue injury is the most important aspect of treating closed fractures. Simple skin contusion over a closed fracture can pose more complex therapeutic and prognostic problems than skin which has been broken by a fractured bone [3]. Tscherne has proposed a classification of soft tissue damage based on the presence or absence of five lesions (abrasion, contusion, laceration, dissolving injury & compartment syndrome). Table 1 Swelling & fracture blisters are additional two important soft-tissue lesions not include in Tscherne classification. Swelling can be assessed and graded clinically, as loss of skin wrinkles and palpable landmarks (wrinkle sign) suggests moderate to severe swelling. Loss or delay of capillary refill and intraoperative

blanching of the skin or loss of capillary refill with approximation of wound edges suggests severe swelling [4]. Fracture blisters are classified into: (1) Clear fluid-filled blisters which are probably not a reason to delay or alter surgical strategy and (2) Blood-filled blisters represent a deeper injury with a higher risk of poor healing and direct incision through them should be avoided. In the presence of blood-filled blisters and or severe swelling it is necessary to wait for the re-epithelialization of blisters and subsidence of skin swelling to avoid the significantly higher rate of complications. The disadvantage of delayed surgery is that a satisfactory reduction may become extremely difficult [4-10].

AO / OTA classified pilon fractures into three main subgroups: extra-articular, partial articular, and complete articular fractures (Figure 1) [11]. However, presence of small bone fragments without soft tissue attachment are responsible for the poor outcome with posttraumatic arthritis because of their insufficient reduction and high incidence of necrosis [12,13]. Fixation tool should be selected according to the degree and size of the fragments. Based on 3D CT, volumetric measurements of articular fragments categorized them into 3 sizes: major fragments (> 1000 mm³), minor fragments (500-1000 mm³) & small fragments (< 500 mm³) [14]. The treatment options include internal fixation, external fixation with or without limited internal

Grade 0	Minimal soft tissue damage Indirect injury to limb (torsion) Simple fracture pattern
Grade 1	Superficial abrasion or contusion Mild fracture pattern
Grade 2	Deep abrasion Skin or muscle contusion Severe fracture pattern Direct trauma to limb
Grade 3	Extensive skin contusion or crush injury Severe damage to underlying muscle Compartment syndrome Subcutaneous avulsion

Table 1: Tscherne classification system.

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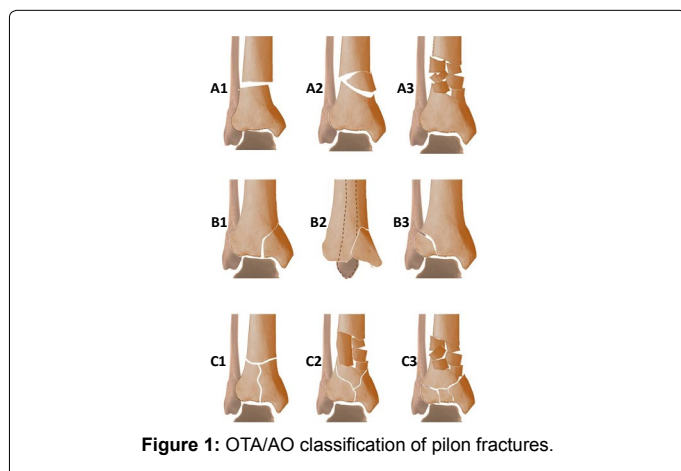


Figure 1: OTA/AO classification of pilon fractures.

fixation and primary arthrodesis which is reserved only for severe non-reconstructable articular comminution. To date, no one surgical treatment method has demonstrated superiority over others [15,16]. Open Reduction and Internal Fixation (ORIF) in high-energy distal tibia fractures, were associated with infection rates as high as 55%, wound sloughing rates as high as 36% and a few patients in multiple studies eventually required amputation [17]. Intramedullary Nailing (ILN) has the lowest infection rates but it is associated with other complications such as angular malunion, compartment syndrome and anterior knee pain [18,19]. For ILN, fractures should be > 2 cm from the articular surface with a minimum 2 and preferably 3 well distributed locking screws to provide sufficient stability [20]. External fixators (Ex. Fix) can be used in fractures with soft tissue damage that precludes plate and nail fixation. Its assembly should not jeopardize the attainment of an eventual coverage flap and avoid the course of a possible incision for future surgical treatment [12,21,22]. Hybrid fixator allows only a tibial assemblage with an inherent problem of cantilever bending which can be eliminated by the use of Ilizarov frame as cross-ankle circular Ex. Fix with the rate of fixation inefficiency is quite low [23-25]. Several authors combine an ankle-spanning Ex. Fix with percutaneous screws or wires fixation of articular fragments with good results and low complication rates [26-28]. Instead other authors suggested a staged treatment protocol consists of initial stage of fibular fixation and tibial Ex. Fix followed by a second stage of ORIF when soft tissue swelling has significantly diminished [29,30]. Recently, less invasive biological techniques were introduced in treatment of pilon fractures associated with expected fewer soft tissue complications and improve fracture healing. The emphasis lies on indirect reduction and stable fixation preserving most of the vascularisation and the osteogenic fracture haematoma which contains all growth factors necessary for bony healing [30].

Aim of work

Is to evaluate a protocol of minimally invasive treatment options for pilon fractures associated with soft tissues injuries. The protocol gives the surgeon a variety of appropriate treatment options based on the condition of soft tissue, type of bone fracture and the degree of comminution aiming to avoid soft tissue and bony union complications.

Material and Methods

From January 2007 to December 2010, 72 patients (29 females & 43 males) with closed pilon fractures managed by minimally invasive techniques according to the suggested protocol in the Al-Razi

orthopedic hospital in Kuwait. The mean age of the patients was 33 years (range, 19-66 years). The mechanism of injury was fall from height in 28 cases, motor vehicle accident in 25 cases, and simple fall 19 cases. Associated injuries were found in 17 patients. Our protocol depends on: 1) Regional classification of soft tissue injuries. 2) Grade of soft tissue injury. 3) Degree of bony affection. We classified the soft tissues around the ankle into three zones: zone one extends from anterior border of medial malleolus to anterior border of tendoachilles and covering the medial surface of tibia. Zone B is inter-malleolar covering the lateral surface of tibia. Zone C extends from anterior border of lateral malleolus to anterior border of tendoachilles covering the distal fibula. The aim of this classification is to use the appropriate fixation tool through healthy soft tissues decreasing its complications, e.g. using lateral distal tibia plate if blisters are present over the medial malleolus (Table 2 and Figure 2). We classified the soft tissue injuries into three grades including Tscherne criteria plus presence or absence of swelling and blisters. Grade I includes presence of one or more of superficial abrasion (Tscherne I), mild swelling or localized clear blisters. Grade II includes presence of one or more of deep contaminated abrasion (Tscherne II), moderate swelling or localized hemorrhagic blisters. Grade III includes presence of one or more of extensive skin contusion, muscle destruction, compartment syndrome (Tscherne III), extensive blisters or severe swelling (Table 3a & Figure 3b). Using 3D-CT we further classified type OTA/AO type C3 into three subtypes. Type C3a; large fragments > 1 cubic cm, type C3b; intermediate fragments 0.5- 1 cubic cm & type C3c; small fragments < 0.5 cubic cm (Figure 4). Screw hole involves more than 30 % of the bone diameter concentrates the stress and makes the bone weaker under bending and torsional loading [33]. So, to prevent further comminution of fragments we fixed large fragments with 3.5 or 4.5 screws and fixed intermediate fragments with K wires. Small fragments either reduced by spanning Ex. Fix through ligamentotaxis or not. Unreduced small fragments were considered as indication for primary arthrodesis. All patients were positioned in supine position without use of tourniquet and under C-arm fluoroscopic control.

Associated fractures	Number of cases
Long bone (femur, humerus, B.B forearm or B.B leg)	12
Pelvis	7
Spine	5
Head injury (fracture skull bones)	4
Others	2 cases fracture os calcis (one case bilateral) 2 cases fracture metatarsals 1 case patella + Bennett fractures

Table 2: Associated skeletal injuries.



Figure 2: Soft tissue zones.

Grade	Presence of one or more of the following:		
	Tscherne	Swelling	Blisters
0 Soft tissue injury grade 0	0	No	No
I: Soft tissue injury grade IA: localised to zone A IB: localised to zone B IC: localised to zone C	I: Superficial abrasion	Mild: Preservation of skin wrinkles and palpable landmarks	Clear localized to one zone
II: Soft tissue injury grade IIA: localised to zone A IIB: localised to zone B IIC: localised to zone C	II: Deep, contaminated abrasion with local contusion	Moderate: Loss of skin wrinkles & palpable landmarks (wrinkle sign)	Hemorrhagic localized to one zone
III: Soft tissue injury grade	III: Extensive skin contusion or crushing or muscle destruction	Severe: loss or delay of capillary refill, either preoperatively or intraoperatively, with approximation of the wound edges	Extensive Affecting two or more zone

Table 3a: Grades of Soft tissue injury.

Grade	Pain	Range of Motion	Angulation
Excellent	None	D > 5 P > 40	<3
Good	Intermittent, relieved by NSAID	D = 0–5 P = 30–40	3–5 valgus <3 varus
Fair	Pain activities of DLA relieved by narcotics	D = –5–0 P = 25–30	5–8 varus 3–5 varus
Poor	Intractable	D < –5 P < 25	>8 valgus >5 varus

Table 3b: Criteria for Clinical Results (Tornetta) [28].

Surgical techniques were one of the following:

Intra-medullary nail fixation (ILN)

The standard entry point was identified at the proximal tibia and a guide pin was inserted and bridged the fracture. Correct guide pin position was confirmed with anteroposterior and lateral image intensification. The intramedullary canal was then reamed incrementally over a beaded-tip guide wire and an appropriately sized nail was inserted over ordinary tip guide wire. The nail was then locked proximally and distally with at least two screws.

Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO)

Articular fragments were reduced percutaneously & fixed by 3.5 mm lag screws. According to soft tissue condition a medial or anterolateral distal tibial plate of appropriate length was inserted in a sub-muscular retrograde way through 3cm incision. The limb length, rotation and angulation were adjusted. Plate was temporary fixed with K wires then approximated to the bone using conventional screws and finally locked in its site using locking screws.

Spanning external fixator with CRPS

Closed Reduction and Percutaneous Screws or CRPP (Closed Reduction & Percutaneous Screws): simple articular fragments (C1,2) and (C3a) were reduced by traction, direct pressure or manipulation with K.wires as a joystick and holding the fragments temporary with K wire or pointed reduction forceps. Fragments were then fixed percutaneously with cannulated 3.5 cannulated screws. In cases with complex articular fragments (C3b), fragments were reduced by

ligament-taxis through calcanean traction and fixed with K. wires. Two Schanz screws were inserted through proximal tibial shaft and one transfixing pin through the calcaneus. Two tubular bars (one on each side of the leg) were connected to the tibial Schanz and calcanean pin. Fracture and limb rotation, length and angulation were adjusted before tightening the connectors.

Staged CRPP-CRPS Strategy (in cases with severe soft tissue injury)

Like spanning external fixator but the reduced articular fragments were fixed with K wires and after the soft tissue condition improved fragments were fixed with percutaneous cannulated screws.

Hybrid fixator

Articular fragments were manipulated and fixed as mentioned before. At least two transfix wires were applied with (60-90 ° angle in between) through the epiphyseal fragment. Then the wires were tensed and the ring was applied. Then two Schanz screws were inserted through proximal tibia and fixed to the ring using tubular bars and connectors after adjustment of limb and fracture alignment.

The method of treatment was selected according to the following protocol; in OTA types (A): in ST (I &II) ILN or medial or lateral MIPPO are preferred depending on the size of distal fragment and the zone of soft tissue injury. In ST (III) Hybrid fixator is preferred (Figure 5). In OTA types (B): ST (IB & IIB) in OTA type (B1) or ST (IA & IIA) in OTA type (B2) with large metaphyseal spike and/or involvement > 25% of articular surface of distal tibia is fixed by medial MIPPO type (B1) or lateral MIPPO in type (B2) fractures. Fractures with small metaphyseal spike and/or < 25% of articular surface of distal tibia are fixed by CRPS. ST (IA, IIA) in OTA type (B2) or ST (IB, IIB) in OTA type (B1) or ST (III) in OTA type (B1 and 2) are fixed by staged CRPP-CRPS strategy. OTA types (B3) are fixed anteroposterior CRPS if skin condition allowed otherwise are fixed by staged CRPP-CRPS strategy (Figure 6). In OTA types (C1 and C2): in ST (I) articular components are fixed first with CRPS & epiphyseal-diaphyseal components are fixed with MIPPO. While in ST (II & III) articular components are fixed first with CRPS or staged CRPP-CRPS strategy and epiphyseal-diaphyseal components are fixed with Ex Fix either hybrid or spanning tubular



Figure 3: Grades of Soft tissue injury.

(Figure 7). In OTA types (C3): spanning external fixator is the treatment of choice with reduction of articular fragments depends mainly on ligamentotaxis. The percutaneous fixation method of articular fragment varies according to degree of comminution and soft tissue condition. Types C3A and C3b with reduced fragments are fixed by CRPS in ST (I& II), and by staged CRPP-CRPS strategy in ST (III). Types C3c and irreducible fragments in type C3b are not suitable for minimal invasive treatment and need early or delayed open reduction, debridement or arthrodesis depending on soft tissue condition (Figure 8). Associated

fibular fractures: are fixed with 1/3 tubular plate using MIPO technique in ST (I) otherwise percutaneous intra-medullary K wires ST (CII & III), shifted later to plate fixation if reduction is not accepted when soft tissue condition is improved (Figure 9).

Postoperatively in comminuted articular or metaphyseal fractures AFO brace was worn fulltime during 4 weeks. Patients were seen at the outpatient clinic weekly for the first month, biweekly until the end of the 3rd month and then at 4 weeks intervals until clinical and radiological union occurred. Full weight bearing was allowed after radiological consolidation of fractures when mature bridging callus was identified on two views without pain on full weight bearing. At follow-up, clinical assessment was carried out using Tornetta scoring system [28] & radiologic assessment using Teeny and Wiss scoring system [21] Osteoarthritis of the ankle was graded on the basis of radiological evidence as grade 0 (no change), grade 1 (small spurs, cysts or osteophytes without narrowing of the joint space), grade 2 (plus mild narrowing of the joint space and irregularity of the subchondral bone with some sclerosis) or grade 3 (large osteophytes, severe narrowing of the joint space and subchondral collapse) [13] (Figures 10-13).

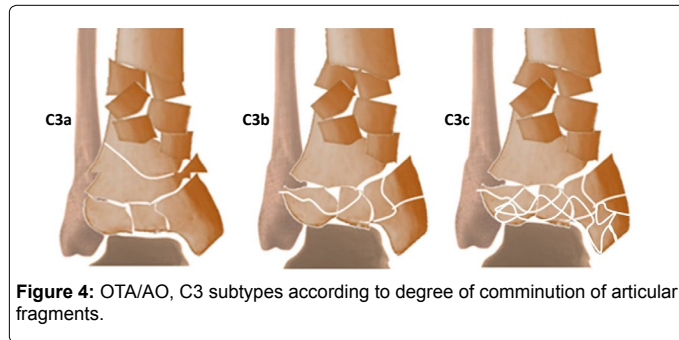


Figure 4: OTA/AO, C3 subtypes according to degree of comminution of articular fragments.

Results

After a mean follow up period of 34 months (range: 24-48 months),

AO/OTA (A)s	Soft tissue injury (ST)	Procedure
A1	Soft tissue injury I	<ol style="list-style-type: none"> 1. ILN: if distal fragment at least 2 cm from articular surface allowing a minimum of 3 well distributed locking screws. 2. MIPO (Anterolateral plating if zone A affected and medial plating if zone B affected).
	ST IA: localised to zone A ST IB: localised to zone B	
A2	Soft tissue injury II	<ol style="list-style-type: none"> 1. ILN: if distal fragment at least 2 cm from articular surface allowing a minimum of 3 well distributed locking screws. 2. MIPO (Anterolateral plating if zone A affected and medial plating if zone B affected). 3. Hybrid fixator
	ST IIA: localised to zone A ST IIB: localised to zone B	
A3	Soft tissue injury ST III	<ol style="list-style-type: none"> 1. Hybrid fixator 2. Staged strategy for (Spanning Ex Fix followed by ILN or MIPO when soft tissue condition improved)

Figure 5: protocol of treatment options for OTA/AO type A.

AO/OTA (B)s	Soft tissue injury (ST)	Procedure
B1	Soft tissue injury	<ul style="list-style-type: none"> • MIPO: Medial plating in B1 fractures With large metaphyseal spike and/or > 25% of articular surface of distal tibia. • CRPS : in fractures With small metaphyseal spike and/or < 25% of articular surface of distal tibia.
	ST (IB & IIB)	
B2	Soft tissue injury	<ul style="list-style-type: none"> • MIPO: Anterior plating in B2 fractures With large metaphyseal spike and/or > 25% of articular surface of distal tibia. • CRPS : in fractures With small metaphyseal spike and/or < 25% of articular surface of distal tibia.
	ST (IA & IIA)	
B3	Soft tissue injury	<ul style="list-style-type: none"> • CRPS (anteroposterior screws) • CRPP: shifted to more rigid fixation with plate or screws when the soft tissue condition improved
	ST (IA & IIA)	
B3	Soft tissue injury	<ul style="list-style-type: none"> • CRPP: shifted to more rigid fixation with screws when the soft tissue condition improved
	ST (IB, IIB & III)	

Figure 6: protocol of treatment options for OTA/AO type B.



AO/OTA (C)s	Soft tissue injury (ST)	Procedure
 C1	Soft tissue injury I ST IA: localised to zone A ST IB: localised to zone B	1. MIPO (Anterolateral plating if zone A affected and medial plating if zone B affected). 2. Spanning Ex Fix + CRPS for articular fragments
	Soft tissue injury II ST IIA: localised to zone A ST IIB: localised to zone B	1. MIPO plating (in C1) 2. Spanning Ex Fix + CRPS for articular fragments (in C2) 3. Hybrid fixator (in C2)
 C2	Soft tissue injury ST III	1. Hybrid fixator 2. Spanning Ex Fix + CRPP for articular fragments 3. Staged strategy: (Spanning Ex Fix followed by MIPO when soft tissue condition improved)

Figure 7: protocol of treatment options for OTA/AO type C1&2.




AO/OTA (C3a)	Soft tissue injury (ST)	Procedure
 C3a	Soft tissue injury ST (I & II)	• Spanning Ex Fix + CRPS for articular fragments
	Soft tissue injury ST III	• Spanning Ex Fix + CRPS for articular fragments followed by CRPS when soft tissue condition improved.
 C3b	Soft tissue injury ST (I, II & II)	• Spanning Ex Fix + CRPS for articular fragments Irreducible fragments by ligamentotaxis not suitable for minimal invasive treatment and need delayed open reduction or debridement.
 C3c	Soft tissue injury ST (I, II & II)	• Spanning Ex Fix → reducible articular fragments → continue or irreducible articular fragments Irreducible fragments → early or delayed primary arthrodesis according to soft tissue condition.

Figure 8: protocol of treatment options for OTA/AO type C3.


Fibula	Soft tissue injury (ST)	Procedure
	Soft tissue injury: ST I: localised to zone A, B ST II: localised to zone A, B	• MIPO with 1/2 tubular plate
	Soft tissue injury: ST (I,II): localised to zone C ST III: extensive	• Percutaneous intra-medullary K wires if region C affected

Figure 9: protocol of treatment options for fibular fracture.

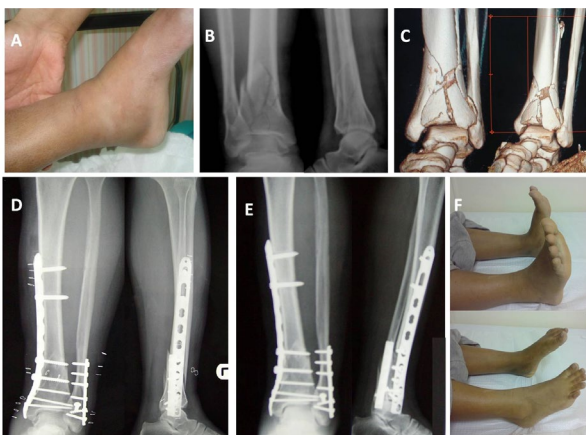


Figure 10: case No 8. A) ST (I). B) OTA/AO (C1). C) 3D CT shows large articular fragments. D) X-ray views show medial MIPO fixation. E) X-ray views show united fracture. F) Photos show full R.O.M operated ankle.



Figure 11: case No 19. A) ST (IIA). B) OTA/AO (C1). C) 3D CT shows large articular fragments. D) X-ray views show lateral tibial + fibular MIPO fixation. E) X-ray views show united fractures. F) Photos show nearly full R.O.M operated ankle.

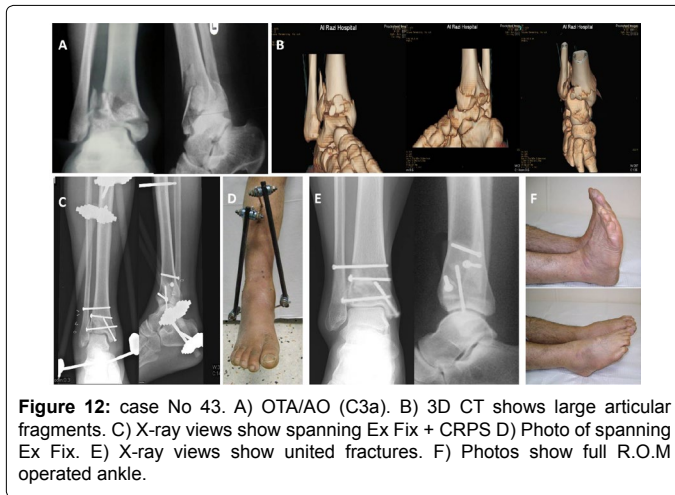


Figure 12: case No 43. A) OTA/AO (C3a). B) 3D CT shows large articular fragments. C) X-ray views show spanning Ex Fix + CRPS D) Photo of spanning Ex Fix. E) X-ray views show united fractures. F) Photos show full R.O.M operated ankle.

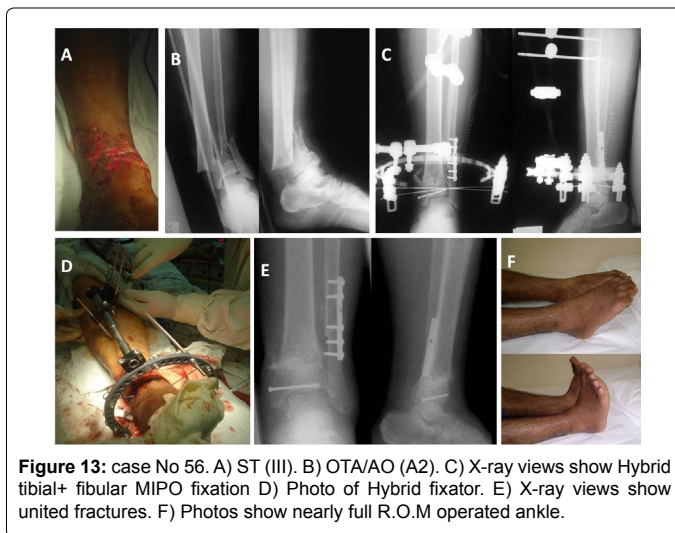


Figure 13: case No 56. A) ST (III). B) OTA/AO (A2). C) X-ray views show Hybrid tibial+ fibular MIPO fixation D) Photo of Hybrid fixator. E) X-ray views show united fractures. F) Photos show nearly full R.O.M operated ankle.

89 % of the patients were satisfied with the treatment and resumed their preoperative activities. According to Tornetta clinical scoring system 35 (48.5%) patients were assessed as excellent, 29 patients with good results (40.5%), 5 patients (7%) assumed fair results and 3 patients (4%) had poor results. Table 3b using Teeny and Wiss radiologic scoring system, 43 patients (59.5%) achieved anatomical reduction, 24 patients (33.5%) achieved good results, 4 patients (5.5%) with fair results and only one patient (1.5%) with poor result. Two patients showed wound dehiscence necessitated skin grafting. One case showed Ex. Fix and screws loosening. No patient suffered from deep infection, nerve entrapment or reflex sympathetic dystrophy. Three patients although their radiologic score were good, their clinical score were fair with pain during their daily living activities. These patients are heavy workers (laborers) and had grade III soft tissue injuries. Postoperatively they suffered painful swelling at the end of their working days. The two cases with fair clinical and radiologic scores had painful limited R.O.M of injured ankle with radiologic ankle and syndesmosis incongruities. One of these two cases, was 68 yrs old female severely osteoporotic and diabetic sustained C1 fracture pattern and grade III soft tissue injury treated by closed reduction + spanning Ex. Fix + CRPS for articular fragments. Due to osteoporosis loosening of the fixator & screws was occurred with resultant joint incongruities. The second case was drug addicted patient sustained C3b fracture with grade II soft tissue injury treated by spanning Ex. Fix + CRPP. He put early weight bearing

and refused postoperative physiotherapy. Two of the three cases with poor clinical results, their radiologic results were fair and one case showed poor both radiologic and clinical scores. All of cases with poor clinical results gained these scores due to joint incongruities, painful limitations of ankle movements and angular deformity of the heel. The three cases sustained type C fractures (C2, C3a and C3b) respectively and soft tissue injury grade III plus concomitant fractures. The first case had bilateral fracture os calcis, the 2nd case was obese patient had contralateral fracture femur and the 3rd case had contralateral fractures femur and tibial plateau. All of these patients put early weight on the pilon side.

Discussion

High-energy injuries of distal tibia can cause serious damage to both soft tissues and bone in this area with an insufficient vascular structure. Failing to appreciate the soft tissue condition will invariably complicate the injury with infection, wound dehiscence or non union. Minor complications in the soft tissues increase the rate of major complications therefore delicate handling of the soft tissues by using minimally invasive techniques has been advocated for this type of fracture [33,34].

Relying on available treatment options we suggest a treatment protocol of minimally invasive techniques for closed pilon fractures aiming to decrease soft tissues and bony complications. The protocol depends on soft tissue condition, type & degree of comminution of bone. We extend Tscherns soft tissues injury classification to include two important criteria (swelling & blisters) due to their role in changing the type and time of treatment and altering the clinical results. Also we introduced regional classification of the soft tissues around the ankle as localized soft tissue injury to one zone can interfere with certain treatment options but not with others. We further classified the comminuted intraarticular fractures (OTA/AO type C3) according to the size of fragments on 3D CT evident based. The aim of this classification is to give a guide for treating surgeon for the suitable fixation method e.g. K.wire or screw fixation, or primary arthrodesis.

Our results highlights certain points: 1) Respecting the soft tissues in management of distal tibial fractures decrease the devastating complications since there were only two cases with wound dehiscence (<3%) and there was no cases with superficial or deep infections. 2) Increasing severity of soft tissues injury is proportional to increased bad prognosis; 0% in ST grade I, 8% in ST grade II & 20.5% in ST grade III. 3) Treatment journey does not ends with union of anatomical or accepted fractures but should extends to use physiotherapy to stretch the contracted soft tissues included in affected the zone(s). 4) Quality of bone (osteoporosis) is added problem in treatment of these cases and enhancement of bone quality by using adjuvant therapy like bone graft, bone healing enhancers and antiosteoprotic drugs should be incorporated in such treatment. 5) Spanning external fixator can be used as permanent treatment option without fair of postoperative stiffness (used in 36 patients of our study with only 6 cases16.5% developed mild to moderate permanent stiffness). This is matched with what was reported by Borelli et al in 2002. They found that early movement is only one of many major factors influence the final range of movement and determine the clinical results with intra-articular fractures [35]. 6) Weight bearing should be avoided until bony union become evident both clinically and radiologically. Patient susceptible to inevitable early weight bearing like those with concomitant contralateral lower limb fractures, the pilon fractured limb, should be protected in weight bearing brace.

Conclusion

The suggested protocol of minimally invasive treatment for closed pilon fractures associated with soft tissue injury provides the treating surgeon a variety of treatment options according to the soft tissue condition and the degree of articular comminution. The protocol is being designed to decrease the unwanted high rate of soft tissues and bony complications reported with these complex injuries. To optimize the clinical and radiologic results, the protocol should be combined with postoperative soft tissue stretching program prevents contracture of injured tissues and weight bearing should be started only when radiologic and clinical union was achieved.

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