Can One Treat Pilon Fracture In Conjunction With Accurate Osseous Reduction And Rigid Fixation By Ilizarov And Assisted Arthroscopic Reduction?

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Abstract: Introduction: Anatomic restoration of the joint is the goal of management in fractures about the ankle. Open surgical treatment of comminuted tibialPilon fractures is associated with substantial complications in many patients. Indirect reduction and stabilization of fractures by means of distraction using a circular external fixator and anatomic repositioning of the joint surface assisted by arthroscopy can be a useful method of achieving satisfactory joint restoration. The potential benefits are less extensive exposure, preservation of blood supply, and improved visualization of the pathology. **Patient and methods**: This was a prospective study conducted between October 2010 and, September 2013 on twelve patients were presented to the emergency department of Zagazig university hospitals with high energy distal tibial fractures of closed and Gustilo Types I&II open fractures. All cases were treated using Ilizarov fixators with or without limited internal fixation and assessment of intra-articular reduction of tibial plafond by arthroscopy. All had been allowed to bear partial weight on the limb in the early postoperative period. A follow up review ranged from12 to 18 months(mean 15 months). **Results:** All cases had united with a mean time of 13.75 weeks (range from 8 to 19), good range of motion was achieved in most at the end of the follow up period. According to the adopted score for evaluation of this series, four cases were excellent, five cases were good, and threecases were faire. **Conclusions:** Application of the principles of capsuloligamentotaxis by means of circular external fixation combined with Anatomical repositioning of the joint surface assisted by Arthroscopy is a wonderful tool in the management of intra-articular fractures of tibial plafond. It assists in attaining anatomical reduction while minimizing disruption of the soft tissue envelopeand early mobilization of the joint.
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1. Introduction

The treatment goal of Pilon fractures should be to obtain the best possible articular reduction and alignment while respecting the soft tissues. After high-energy Pilon fractures, the patient is at risk of infection in the early stage and arthritis at a later stage. To minimize these complications when treatingthese fractures, minimally invasive surgical treatment, stable osteosynthesis, restoration of the joint surface, and early mobilization should all beperformed[(1)].

With certain fracture types and patterns, accurate anatomic reduction can be difficult to obtain without significant soft tissue disruption. Accomplishing this anatomic reduction by the least invasive yet still effective means is a matter of increasing concern. This is especially true given complications that can ensue, especially in the geriatric and diabetic patient population[(2)]. Reduction and restoration of length can be achieved through ligamentotaxis by bridging external fixation[(3)].

The use of circular external fixators alone or combined with limited internal fixation offers solutions for the problems encountered with open reduction and internal fixation. They minimize soft tissue problems and provide rigid fixation that allow early mobilization[(4)]. But, the basic principle for treatment remains anatomic reduction until bony union is achieved[(3)].

Arthroscopic assisted fracture reduction can provide a less invasive operative reduction of the fracture and respects the soft tissue envelope.It provides the surgeon the ability to anatomically reduce a fracture under direct visualization with minimal intervention. It also enables the surgeon to address any articular injury primarily[(2)].

2.Patients and methods:

This was a prospective study conducted between October 2010 and September 2013, on 12 patients presented to the emergency unite at Zagazig university hospital with Pilon fractures were treated with circular external fixator with or without limited internal fixation and assessment of reduction of distal tibial articular surface using arthroscope (TableI).The average of the patients` ages was 33.25 years with range from 18to 49 years. Ten patients (83.33%) were males and 2 patients (16.67%) were females. In 6 cases (50%), there was history of fall from height, four cases (33.33 %) were encountered in motor-vehicle accidents and twisting injury in two patients(16.67 %). Eightpatients (66.67

%) had right sided fractures, while 4 patients (33.33 %) had left sided fractures. Preoperative assessment includedboth clinical and radiological evaluation. Clinical evaluation included skin condition, neurovascular state of the limb and systemic review of other skeletal and visceral injuries.

Skin condition:

Closed fractures in seven patients (58.33 %),while five cases were open. Open fractures are classified according to Gustilo and Anderson[5]. Gustilo type I in three patients(25%), Gustilo type II in two patients (16.67%). Patients with Gustilo Type III injuries were excluded where a local flap rotation or plastic surgery was required and the circular fixator was expected to interfere with soft tissue reconstruction procedures. Closed soft tissue injuries were classified according to Tscherene and Oestern[6](TableII). Four cases were grade 0 while three cases were grade I.

Table I. Data sheet of patients with Pilon fractures.

No	Age (yrs)	sex	Fracture Type (Rudi & Algowar)	Wound grading (Gustilo)	Other skeletal injuries	Healing time	Ankle movement dorsiflexion / plantar flexion	Complications	Score
1	32	M	III	I		10	12\20	Pin tract infection	Good
2	26	M	II	closed		12	13\30	Pin tract infection	excellent
3	18	M	III	closed	2nd lumbar vertebra	9	10\25	Pin tract infection malunion	Faire
4	44	F	II	I		18	11\21	delayed union& deep infection	Good
5	23	M	III	II	tibial plateau	16	12\26		excellent
6	27	M	II	closed		11	15\35	Pin tract infection	excellent
7	49	M	III	closed	10thdorsal vertebra	18	9\31	Pin tract infection	Good
8	47	M	III	closed	1st lumbar vertebra	13	5\22		Good
9	19	F	III	II		8	16\30	Pin tract infection & deep infection	excellent
10	25	M	III	closed		16	0\15	Delayed arthritis	Faire
11	48	M	II	closed		15	7\20	Pin tract infection	Faire
12	41	M	III	I	Oscalcis	19	10\13	delayed union	Good

Table II: Grading of closed soft tissue injuries

Grade 0	Minimal or no soft tissue damage
Grade 1	Superficial abrasions or contusions
Grade 2	Deep abrasions, skin or muscle contusion
Grade 3	Extensive skin contusion or crush injury, severe damage to underlying muscle, subcutaneous avulsion or compartment syndrome.

Radiological evaluation:

AP, lateral, and mortice plain radiographs were obtained for all cases from these radiographs, the type of fracture was determined. Fractures were classified according to Rüedi and Allgöwer[7](Table III). 8 fractures were type III while 4 fractures were type II.

Table III. Rüedi and Allgöwer classification of Pilon fracture

Type I	Intra articular fractures without displacement
Type II	Displaced intra articular fractures without comminution
Type III	Fractures with articular and metaphyseal comminution

Neurovascular evaluation:

All patients had no neurovascular insult.

Other skeletal injuries:

Seven cases (58.33%) had no associated injuries while 5 cases (41.67%) had associated orthopedic injuries as the following case no (3) had wedge fracture of the 2nd lumbar vertebra, Case no (5) had right tibial plateau (split type 1) fracture which was managedby percutaneous cannulated 6.5 partially serrated cancellous screws, case no (7) had fracture of 10th dorsal vertebra and case no (8) had wedge fracture of the 1st lumbar vertebra. All these spinal fractures were stable and managed conservatively by thoraco-lumbar brace with support and bed rest. The last patient is case no(12) had oscalcis fractures of the contralateral foot which managed by below knee cast. Patients with open fractures were operated upon immediately, while other patients were put in splint and elevated till edema subsided, ranging from 3 to 10 days (average 7 days). Limited internal fixation wasdoneinfourcases.

Operative technique

The Ilizarov frame for each case was preassembled. It consisted of three rings and calcaneal 5/8 ring. The proximal 2 rings were stable as one block and connected to the calcaneal 5/8 ring by three long threaded rods. The third ring which is the floating ring was sliding on these three rods. Under general or spinal anesthesia, patients lie supine on a radiolucent table,

appropriate draping was done and the preassembled frame was applied to the patient. The proximal two rings were fixed to the proximal tibial segment by crossing wires and half pins. The distal 5/8 ring was fixed to the calcaneus by two crossing olive wires and half pin. Gradual distraction was done between the proximal two rings and the distal 5/8 calcaneal ring, so the fracture were reduced by ligamentotaxis. The fracture reduction was checked using C arm. We used diagnostic arthroscopy to check the articular surface by anterolateral and anteromedial portals.The anteromedial portal is made first. Saline is injected at the level of the anteromedialportal to distend the joint. The skin incision is created just medial to the tibialis anterior tendon, and the joint is approached bluntly, aiming toward the tip of the lateral malleolus. With the foot in full dorsiflexion, a4.0-mm 30°-angle arthroscope is introduced into the joint. Typically, an arthroscopic pump is used to distend the joint and improve intra-articular visualization. However, use of a pump is associated with an increased risk of soft-tissue swelling and compartment syndrome. In traumatic cases with severe soft-tissue damage, gravity inflow is preferred. Under arthroscopic control, the anterolateral portal is made lateral to the peroneus tertius tendon, with care taken to avoid injury to the superficial peroneal nerve. The fracture haematoma, synovial tissues, and loose bodies were debrided arthroscopically. Steps on the articular surface were flattened using a curette and probe (Figs I&II). In impacted fractures involving the tibial plafond, the articular surface should be restored. A cortical window is created 5 cm above the joint line on the anteromedial tibia. Under fluoroscopic visualization, a bone tamp is inserted in the window and placed 2 cm above the fracture. The depressed fragment is elevated by impacting the cancellous bone. When we became sure that the articular fragments were well reduced, the floating ring was slide over the rods till it became opposite the reduced fractured tibial plafond and fixed with nuts in its place. Multiple olive wires were introduced in various opposite directions according to the anatomical planes of distal leg.[8]

The distal end of the fibula can be used as buttress by compressing it with an olive wire from lateral to medial. Additional Ilizarov wires and half pins were added according the fracture geometry. All wires were tensioned over the prefixed floating ring.

Autogenous bone graft was applied in 3 cases when there were large bone defect. When there was large bone fragment it was fixed using interfragmentary compression screw through a limited incision as in cases (2,4,7,12). The fibula sometimes was fixed using rush nail as in case (5) or plate and screws as in case (11).

Fig 1: Split fracture

Fig II: manipulation of fracture fragments

Postoperative Care

Postoperative analgesia and anti-inflammatory medications were used for a short period. Limb elevation was instructed most of the time for all patients. Active range of motion of the knee and toes was encouraged from the second postoperative day. Foot support plate is connected to the distal tibial ring during sleep to provide comfort and prevent dropping of the foot. Care of wires and pins to decrease the incidence of pin tract infection was routinely and daily done. weight bearing is permitted as tolerated 4 weeks postoperatively. The minor adjustments in alignments of the fractures were under intravenous sedation in the ward if needed using the threaded rods attached to the rings.

Follow up

In the outpatient clinic had continued at monthly intervals. If a sticky callus was formed, the calcaneal 5/8 ring was removed after 3 to 4 weeks to allow early ankle and subtalar movement. When the fractures

healed radiologically, the fixator was removed on outpatient's basis or under light anesthesia. However a protective below knee cast was applied if needed. Bone graft was added to the fracture site in the follow up period if there was a gap in the bone that was not expected to bridge by itself. Patients were followed up afterwards at monthly intervals in the beginning and after each three months. At the end of follow up period each was asked to come for an evaluation which included fresh biplane X-rays, measurement of ankle range of motion, questionnaire regarding pain, stiffness ext.

We evaluated our results clinically according to the scoring system of Olerud and Molander[9] (Table IV).

Table (IV): Olerud and Molander: Scoring system After Ankle Fracture

Parameter	Degree	Score
Pain	None While walking on uneven surfaces While walking on even surfaces While walking indoors Constant	25 20 10 5 0
Stiffness	None Present	10 0
Swelling	None Only evening Constant	10 5 0
Stair climbing	No problems Impaired Impossible	10 5 0
Running	Possible Impossible	5 0
Jumping	Possible Impossible	5 0
Squatting	Possible Impossible	5 0
Supports	None Taping Crutches	10 5 0
Working activities of daily life	The same before injury The same but with some restrictions Change into simpler job Severely impaired working capacities	20 15 10 0

Patients were divided into 4 groups according to their score
Group I: Poor: 0 -30
Group II: Fair: 31 – 6
Group III: Good: 61 - 90
Group IV: Excellent: 91 -100

All cases are followed monthly for a period ranged from 12 to 18months (average 13.5 months), each time evaluation of knee range of motion, toes range of motion, state of the wound, care of the pins were done. Serial x- rays were done just postoperative, one month, 2 months, 3 months, 6 months and one year postoperative. Ankle range of motion was measured using a hand held goniometer at the time of last evaluation.

3. Results

A total of twelve patients were available for evaluation. All cases are followed monthly for a period ranged from 12 to 18 months, The mean time of healing was 13.75 weeks, (Range 8– 19 weeks). Removal of external fixator was carried out when serial x –rays show adequate callus formation at an average of 10 weeks (range 8 -12 weeks). A below knee cast was applied for a mean of another 6 weeks (range 4-8 weeks), during this period gradual weight bearing with the aid of crutches is allowed. We evaluated our cases according to the scoring system of Olerud and Molander [9].At final follow-up the range of ankle motion averaged 10° of dorsiflexion (range 0 to 16) and 24° of plantarflexion (range 13° – 35°). Four patients (33.3%) complained of pain while walking over uneven surfaces. Nine patients (75%) had no stiffness. Seven patients had returned to working activities of daily life as before injury (58.3%) (Table III). No loss of reduction was observed at the regular follow-up after fixator removal. The complications encountered in our series were few and dealt with,

including two cases (16.7%) showed delayed union due to presence of metaphyseal comminution required bone graft. Post traumatic arthritis occurred in one case (8.3%) which required later ankle arthrodesis. There were two cases (16.7%) associated with infection these two deep infections were low grade and occurred in open fractures. They were treated with debridement and intravenous antibiotic. Pin tract infection in seven cases (58.3%). This complication did not need more than repeated dressing and with the use of oral antibiotics. Lateral ankle instability occurred in one case (8.3%) which was put on active physiotherapy to continue the follow up. There is only one case (8.3%) with malunion in varus position of the ankle joint. In our series 3 cases were classified as group II (25%)[fair], 5 cases were classified as group III (41.7 %)[good] and 4 cases were classified as group IV (33.3 %)[excellent] (TablesV&VI).

TableV:Results according to the fracture type and pain

	none			While walking on uneven surfaces			While walking on even surfaces		
	Excellent	Good	Fair	Excellent	Good	Fair	Excellent	Good	Fair
Type II		**1**		**1**	**1**				**1**
Type III	**1**	**1**			**4**				**2**

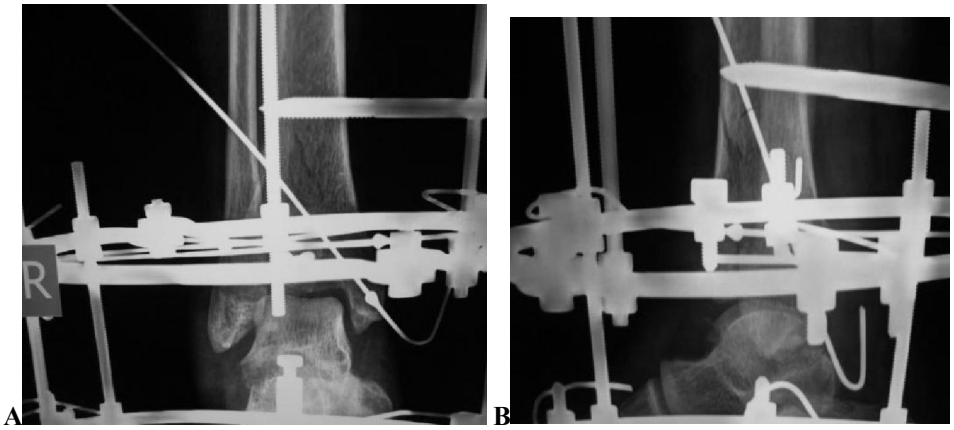
Table VI: Results according to fracture type and working activities of daily life

	The same before injury			The same but with some restrictions			Change into simpler job		
	Excellent	Good	Fair	Excellent	Good	Fair	Excellent	Good	Fair
Type II	**1**				**2**				**1**
Type III	**1**	**1**						**1**	**2**

Case report
Case no (2)

A **B**

Preoperative X ray of type II fracture
A: AP view B: Lateral view



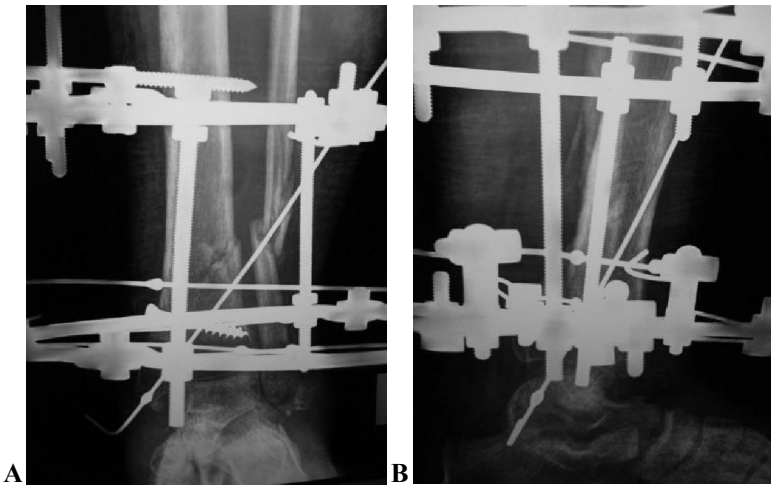
A **B**

Postoperative X ray
A: AP view B: Lateral view

After frame removal X ray showing solid union and limited fixation by inter- fragmentary screw
A: AP view B: Lateral view

Case no (7)

Preoperative X ray of type III fracture
A: AP view B: Lateral view

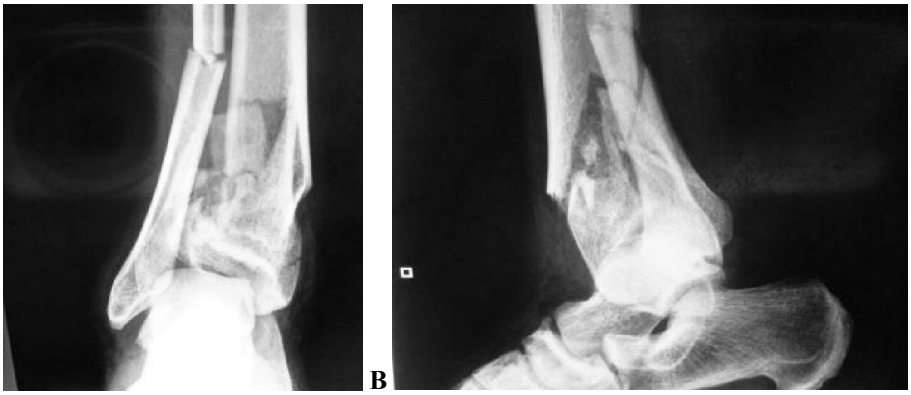


Postoperative X ray
A: AP view B: Lateral view

A B

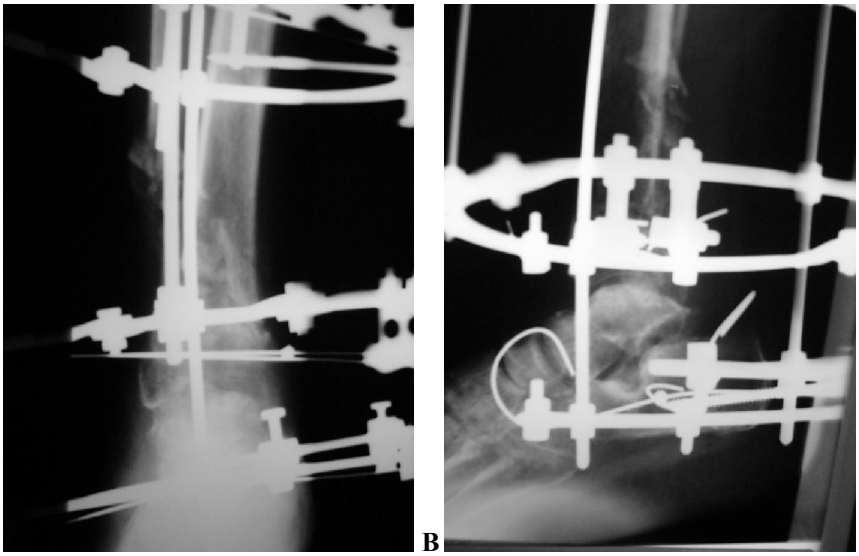
After frame removal X ray showing solid union and limited fixation by inter- fragmentary screw
A: AP view B: Lateral view

Case no (10)



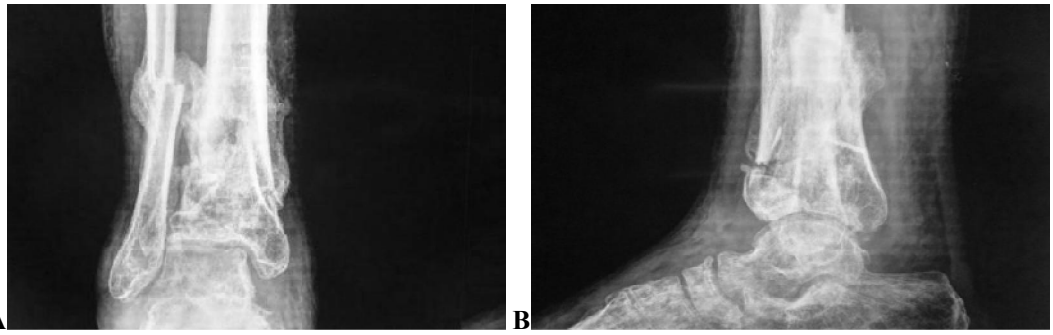
A B

Preoperative X ray of type III fracture
A: AP view
B: Lateral view



A B

Postoperative X ray
A: AP view B: Lateral view



After frame removal X ray showing solid union
A: AP view B: Lateral view

4. Discussion:

The treatment of intra-articular fractures of the distal tibia and ankle is challenging. Despite reports of satisfactory outcomes following open reduction and internal fixation (ORIF) of comminuted tibial Pilon fractures, posttraumatic arthrosis of the ankle is common following this type of intervention for this particular injury. Poor outcomes following ORIF of comminuted tibial Pilon fractures may be the result of inability to realign and stabilize small fracture fragments, thereby failing to restore articular alignment, as well as damaging the soft tissue envelope that surrounds the Pilon. Loss of vital soft tissue coverage about the tibial Pilon is generally known to be associated with an increased risk of bone infection and nonunion. Indirect reduction, without disruption of the soft tissue envelope (essentially closed reduction), by means of capsuloligamentotaxis provides an alternative method of treatment for repair of these inherently unstable and difficult to restore articular fractures of the distal tibia[(10)].

We believe that treatment with Ilizarov external fixator provides multiple advantages in regard to fragment manipulation, stabilization, and maintenance of capsular and ligamentous traction required to adequately promote proteoglycan synthesis and normal cartilage metabolism[(11)].

It is difficult for an external fixator to reduce the tibial articular surface alone, so we used arthroscopy to improve reduction of the fracture with the external fixator. Arthroscopy is an expedient tool in the management of intra-articular fractures of the ankle and post-fracture articular defects. It provides the surgeon the ability to anatomically reduce a fracture under direct visualization with minimal intervention. It also enables the surgeon to address any articular injury primarily. With certain fracture types and patterns, accurate anatomic reduction can be difficult to obtain without significant soft tissue disruption. Arthroscopic assisted fracture reduction can provide a less invasive operative reduction of the fracture and respects the soft tissue envelope[(2)].

Late complications, such as stiffness andposttraumatic arthritis, correlate with the severity of theinitial injury and the accuracy of reduction. Some authorshave shown that the rate of complications islower when external fixation is used instead of open reduction and internal fixation, but others found that Pilon fracturestreated with external fixation had a higher rate of malunion than fractures treated with open reduction and internal fixation[(3)].

In our series we have only one case with malunion and one case with post traumatic arthritis.

The results have been quite acceptable when compared with other published series[(1,2)] that used the arthroscopy to assist in fracture reduction of Pilon fracture.

Our results were better when compared with other published series that depends only fracture reduction by capsuloligamentotaxis using circular external fixator under Carm control without arthroscopic assistance. This enhance the opinion that arthroscopy provides better articular surface reduction that minimize the incidence of later arthritis and pain[(12-17)].

Conclusions

Application of the principles of capsulo-ligamentotaxis by means of circular external fixation combined with Anatomical repositioning of the joint surface assisted by Arthroscopy is a wonderful tool in the management of certain intra-articular fractures of tibialplafond. It assists in attaining anatomical reduction while minimizing disruption of the soft tissue envelope, application of minimally invasive surgical methods, and early mobilization of the joint. Arthroscopy also enables the surgeon to debride the joint and address any articular defects primarily. Circular external fixation provides persistent joint distraction that promotes normalization of articular cartilage.

References

1. Cetik O, Çift H, Ari M and Comert B: Arthroscopyassisted combined external and internal fixation of a Pilon fracture of the tibia Hong Kong Med J *2007 Oct*; *13*(*5*):403-*5*.
2. Graham A. Hamilton, DPM, and Travis L. Sautter, DPM: A Closer Look At Arthroscopy For Ankle Fractures And Post-Fracture Defects: www.podiatrytoday.com. 2009, 26 -32
3. Nehme A, Tannous Z, Joseph Wehbe J, Mecharrafieh R and Maalouf Gh: Arthroscopically Assisted Reconstruction and Percutaneous Screw Fixation of a Pilon Tibial Malunion: J. of Foot & Ankle Surgery 2007, 46(6): 502–507.
4. B, Kontovazenitis P, Evangelopoulos DS, Tsailas P, Nikolopoulos K and Soucacos PN. Distal tibial fractures treated with hybrid externalfixation. J. Injury 2010, 41(3), 253-258.
5. Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: Retrospective and prospective analyses. J Bone Joint Surg. Am. 1976, 58:453–8.
6. Tscherne H, Oestern HJ A new classification of soft-tissue damage in open and closed fractures. Unfallheilkunde; 1982, 85(3):111–115.
7. Rüedi TP, Allgöwer M: The operative treatment of intra-articular fractures of the lower end of the tibia. J. ClinOrthop1979; 138:105-110.
8. Catagni MA: The anatomic location for insertion of wires and half pins In Maiocchi AB (ed). Advances in Ilizarov apparatus assembly 1st ed. Milan medicaplastic srt.1994.
9. Olerud 1 and Molander H:A Scoring Scale for Symptom Evaluation After Ankle Fracture. J Arch Orthop. Trauma Surg. 1984, 103:190-194.
10. Bozkurt M, Ocguder D A, Ugurlu M, and Kalkan T: Tibial Pilon Fracture Repair Using Ilizarov External Fixation, Capsuloligamentotaxis, and Early Rehabilitation of the Ankle. J of Foot & Ankle Surgery.2008, 47(4):302–306.
11. Salter RB, Simmonds DF and Malcom BW: The biological effect of continuous passive motion on the healing of full thickness defect in articular cartilage. An experimental investigations in the rabbit. J. Bone and Joint Surg. Am.1980, 26:1232-1251.
12. Kapoor S, Kataria H, Patra S and Boruah T: Capsuloligamentotaxis and definitive fixation by an ankle-spanning Ilizarov fixator in high-energy Pilon fractures. J Bone Joint Surg. Br. 2010, 92:1100-6.
13. Tornetta P, Weiner L, Bergman M, Watnik N, Steuer J, Kelley M, and Yang E: Pilon Fractures: Treatment With Combined Internal and External Fixation. J Orthop Trauma 1993; 7: 489-496.
14. Barbieri R, Schenk R, Koval K, Aurori K and Aurori B: Hybrid external fixation in the treatment of tibial plafond fracture. J. Clin. Orthop. 1996, 332:16, 22.
15. Bone LB, Stegemann P., Mc Namara K And Sieble R: External fixation of severely comminuted and open tibial plafond fractures.J. Clin. Orthop.1993, 292: 101- 107.
16. Hussain FN: A one-year follow up of Pilon fractures of Tibia treated with Ilizarov external fixator without image intensifier guidance. J. Orthopedics 2007;4(1)e16.
17. Abdelsamie A, Elmogazy N: Treatment of high energy tibial plafond fractures using Ilizarov external fixator with floating ring. Egyptian orthopedic journal, 2011, 46 (2), 227-233.

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