

## Original Research Article

# Functional outcome of JESS fixation and bone grafting in distal tibial plafond-pilon fracture: a prospective study

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### ABSTRACT

**Background:** The Pilon fractures are one of the most difficult to treat. Fracture known as “orthopedicians nightmare”. The incidence of complications following ORIF of pilon ranges from 10-55% and other complication are infection, loss of reduction, secondary arthrosis. In these circumstances JESS and Bone grafting is cost effective and less hospitalization. Our aim was to evaluate in the functional outcome of JESS fixation and bone grafting in distal tibial plafond- pilon fracture using Olerud and Molander score.

**Methods:** The JESS fixation and bone grafting was used for pilon fracture in 30 patients, 24 male and 6 female. Mean age 44 years range (18-60 years). Fractures caused by fall and RTA. All were treated with JESS fixation and bone grafting. the patients were assessed clinically and radiographically at regular interval of 1 month and later 2 months interval. Outcome was assessed using Olerud and Molander score. Complications were recorded.

**Results:** 12 patients had Ruedi and Allgower type II fracture and 18 patients had type III fracture. After 9 month of follow up midterm OMAS score- 11.766 was achieved. Outcomes were good in 71.25% and fair results in 50.83% respectively. The complication seen was residual ankle pain in 6.66% patients and implant failure in 13.33%.

**Conclusions:** Fixation of pilon fracture with JESS and bone grafting is associated with good functional outcome in type II and fair in type III pilon fracture. The incidence of complications high in type III pilon fracture.

**Keywords:** JESS fixation, Olerud and Molandar score, Reudi allgower

### INTRODUCTION

The pilon fractures are one of the most difficult fractures to treat. This is known as “an orthopaedicians night mare. “The incidence of severe complications following ORIF of tibial plafond ranges from 10% to 55%. These complications typically involve the soft tissues and range from superficial skin necrosis at the suture line to full thickness skin loss and deep infection. Full thickness wound complications can progress to deep infection including osteomyelitis. Teeny et al reported that the development of superficial wound problem increased the risk for deep infection six fold.<sup>1</sup> Nonunion of distal tibia are believed to be the result of traumatic

devascularization of the fragments, excessive soft tissue stripping at the time of surgery. Bourne et al reported a 25% nonunion rate in Ruedi and Allgower classification type C fractures.<sup>2</sup> In 2 stage open reduction and internal fixation- disadvantages are large soft tissue dissection and difficulty of reduction techniques and are associated with complications such as skin necrosis, chronic draining sinus and deep infection. Complications associated with combined external and limited internal fixation are infection, loss of reduction, secondary arthrosis. In these circumstances, JESS fixation is a minimally invasive procedure, it is cost effective and less hospitalization. Because of these reasons functional outcome of JESS fixation and bone grafting in pilon

fracture is likely to be better than conventional or plate and screw fixation.

**Rationale**

- JESS fixation is cost effective
- It is a minimally invasive procedure.
- Less hospitalization.
- Early mobilization of patient

Distal tibial fractures including pilon are prone for non union, as the vascularity of this area is poor because of less musculature and also the bone is subcutaneous in most area. Hence any open reduction and internal fixation will cause wound healing delay/sloughing/skin necrosis which is least likely in this case with JESS fixation. The chance of failure rate is more with plate and screw fixation.

In this study we applied ‘JESS fixation and bone grafting ‘for Ruedi and Allgower type II and type III pilon fracture.

The distractive effect of JESS will help in realign the articular surface. JESS help in preservation of hematoma, avoid ankle stiffness and results in early mobilization. Because of these reasons the functional outcome of JESS fixation and bone grafting in pilon fracture is likely to be better than conventional or ORIF with plate and screw fixation or JESS will greatly improve the functional outcome.

**Objectives**

Prospective study to evaluate the functional outcome of JESS fixation and bone grafting in distal tibial plafond – pilon fracture.

**METHODS**

**Study design**

This was a hospital based prospective study over a period of 18 months from April 2011 to September 2012.

**Study subjects**

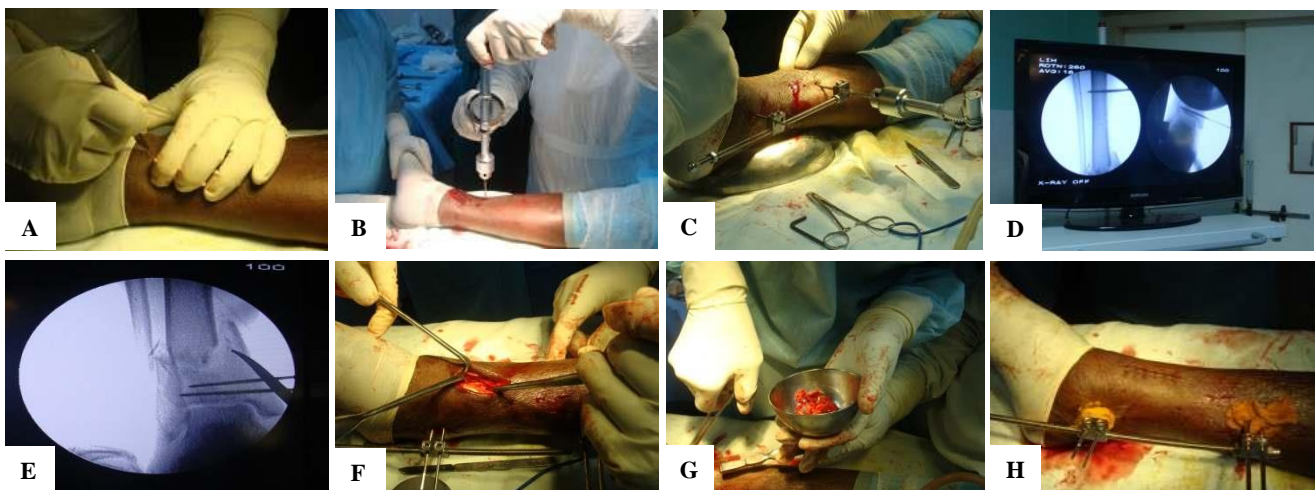
Patients coming to orthopaedic op or casualty who were diagnosed to have distal tibial plafond fracture satisfying inclusion criteria.

**Inclusion criteria**

Inclusion criteria were patients with distal tibial plafond fracture coming to op/ casualty from April 2011 to march 2012 aged between 18-60 years; all closed distal tibial plafond pilon fracture- Ruedi and Allgower type 2 and type 3; fracture less than one week old.

**Exclusion criteria**

Exclusion criteria were age less than 18 and more than 60 years; all open fractures; disoriented patients; paraplegic/ quadriplegic patients; injury coming after one week.



**Figure 1 (A-H): Procedure.**

**Study procedure**

All patients coming to ortho OP/casualty between 18-60 yrs with distal tibial plafond fracture will be assessed by clinical and radiological examination. X-ray findings of all cases will be recorded, will be requested for all cases. Patient will be subjected to minimal invasive procedure after taking informed written consent. JESS fixation and

bone grafting done under C-arm control. JESS is removed after 3 weeks and below knee pop cast applied for 4 weeks. In the first follow up- removal of pop cast done and check x-ray is taken for evaluation of fracture healing. Patient is advised to mobilize the ankle for 4 weeks. In the second follow up patient is clinically and radiologically evaluated. Partial weight bearing is advised for next 4 weeks if good callus formation is present. In

the third follow up –patient is evaluated clinically and radiologically if union progresses advise gradual full weight bearing. In each follow up active and passive movements, and radiological findings are recorded. Monthly follow up and in each visiting any complications if developed will be documented. Patient will be further followed up at least for 6months and clinically and radiologically assessed and final assessment done by clinical, radiological and subjective scoring using Olerud and Molander score.

### Procedure

After making a puncture wound 4.5 mm Shanz pin is introduced into the distal fragment under fluoroscopic guidance 5 mm just above the articular surface.

Another Shanz pin introduced into the proximal fragment 5 cm from the fracture site. The distal and proximal pins are connected by a JESS rod and fracture distraction and reduction is done under control of c-arm machine.

A small stab incision is put on the anterior or anteromedial aspect of fracture site. Through the rent in the fracture site Bone graft is put and gap filled with bone graft.

### Statistical analysis

Data collected was subjected to paired t- test, p-chart, bar chart, frequency table and percentage analysis and correlation value and P value were calculated using SPSS and MATLAB software.

### Study subjects

30 patients satisfying eligibility criteria were selected for the study after obtaining informed consent. Of these 24 patients were male and 6 were female patients.

### Evaluation of the result

Consisted of both subjective and objective assessment considering union or non union, deformity, shortening, movements of joint, stiffness, residual pain etc.

Along with this any complications if present were noted. The results were noted according to the Olerud and Molander scoring.

- Excellent- 91-100
- Good- 61-90
- Fair result- 31-60
- Poor result- 0-30

**Table 1: Showing Olerud and Molander score.**

Parameter	Finding	Points
<b>Pain</b>	None	25
	While walking on uneven surface	20
	While walking even surface outdoor	10
	While walking indoors	5
	Constant severe	0
<b>Stiffness</b>	None	10
	Only in evening	5
	Constant	0
<b>Stair climbing</b>	No problem	10
	Impaire	5
	Impossible	0
<b>Running</b>	Possible	5
	Impossible	0
<b>Jumping</b>	Possible	5
	Impossible	0
<b>Scatting</b>	No problem	5
	Impossible	0
<b>Support</b>	None	10
	Tapping, wrapping	5
	Stick/crutch required	0
<b>Work and activities of daily living</b>	Same as before injury	20
	Loss of tempo	15
	Change to simple job	10
	Severely impaired work capacity	0

Score= Sum (points for all 9 parameters); Interpretation: Minimum score: 0; Maximum score: 100; The higher the score, the better the functional ability; clinical and radiological profile of one patient under study.



**Figure 2: Clinical and radiological profile of one patient under study. (A and B) preoperative x-ray; (C) Immediate post-operative photo; (D) At 2 months; (E) At 4 months; (F) At 7 months; (G) At 10 months; (H) At 18 months; (I) Movemnts of ankle- planter flexion; (J) Dorsiflexion.**

## RESULTS

Mechanism of injury was fall in 86.67% (26 patients) and RTA in 13.33% (4 patients). Of the 30 patients 40% ( 12 patients) had Ruedi and Allgower type- 2 pilon and 60 patients (18 patients) had Ruedi and Allgower type- 3 pilon.13.33% (4 patients) had associated fibula fracture.

Even though all patients had stiffness at first month of follow up, but it disappeared by 5th month and none had stiffness of ankle joint 5 months after the procedure. In the study population callus appeared in 93.33% (28 patients) by 3rd month in the follow up. Fracture was united by 7th month in 73.33% (22 patients) of study population and in rest of the patients (6 patients), fracture

union occurred by 8th month of follow up. None developed malunion or non union.

Minimum dorsiflexion required for walking (weight bearing) is 100 which is attained by 53.33% (16 patients) by 5th month and 33.33% (10 patients) by 7th month after procedure. 53.33% patients (16 patients) attained 200 dorsiflexion by 12 month post procedure. 13.33% (4 patients) of study population attained maximum range of dorsiflexion by 16 months following the surgery.

Assessment of maximum range of dorsiflexion was not possible because of variation in the duration of follow up.

Minimum range of plantar flexion required for walking (200) was attained by 40% (12 patients) of study



population by 5th month of follow up. Another 33.33% (10 patients) attained 200 plantar flexion by 7 months following surgery. 66.66% (20 patients) attained 300

plantar flexion by 9 months post procedure. By 18months following the surgery, 60% (18 patients).

**Table 2: Showing age and sex profile of study population.**

Age group	Age	18-30	31-40	41-50	51-60
	No. of patients	2	6	16	6
%	6.6	20	53.3	20	
Sex	Sex	Male		Female	
	No. of patients	24		6	
%	80		20		

**Table 3: Showing follow up – clinical and complication profile of study population.**

Clinical	Complication				
	Pain	Swelling	Refracture	Implant failure	Stiffness
Follow up in months					
1 <sup>st</sup> (2 <sup>nd</sup> month)	30	28	0	2	30
2 <sup>nd</sup> (3 <sup>rd</sup> month)	30	28	0	0	28
3 <sup>rd</sup> (4 <sup>th</sup> month)	30	22	0	0	2
4 <sup>th</sup> (5 <sup>th</sup> month)	28	24	0	0	0
5 <sup>th</sup> (6 <sup>th</sup> month)	20	26	0	0	0
6 <sup>th</sup> (7 <sup>th</sup> month)	18	21	0	0	0
7 <sup>th</sup> (8 <sup>th</sup> month)	16	8	0	0	0
8 <sup>th</sup> (9 <sup>th</sup> month)	17	4	0	0	0
9 <sup>th</sup> (10 month)	7	4	0	0	0
10 <sup>th</sup> (12 month)	8	4	2	0	0
11 <sup>th</sup> (14 month)	2	2	0	0	0
12 <sup>th</sup> (16 month)	2	0	0	0	0
13 <sup>th</sup> (18 month)	2	0	0	0	0

**Table 4: Showing Olerud and Molander score (OMAS score) of study population.**

Score	0-30 Poor result	31-60 Fair result	61-90 Good result	91-100 Excellent
Number of patients	6	6	16	2
%	20%	20%	53.33%	6.66%

**Table 5: Showing statistical difference for the predictor of outcome.**

Predictors OMAS	P value
Female	72.5±5.222 0.0035**
Male	56.25±7.977 0.03*
Ruedi and Allgower type 2	71.25±6.0086 0.0043**
Type 3	50.83±5.1143 0.471
Age <40 yrs	63.75±4.989 0.0087**
>40 yrs	57.5±3.117 0.027*

\*\*OMAS score significant at 0.01 i.e. highly Significant; \*OMAS score significant at 0.05 i.e. significant; unmarked not significant.

Out of 30 patients (study population), 13.33% (4 patients) developed complications (implant failure and refracture), 40% (12 patients) started weight bearing in 4- 6 months and 46.66% (14 patients) started weight bearing in 7- 9 months.

patients developed complications and 4 had not started weight bearing). 60% (18 patients) return to normal activity of daily living in. 7–9 months and 13.33% (4 patients) return to normal activity of daily living in 10–12 months.

Among the study population 26.66% (8 patients) didn't return to normal activity of daily living (of these, 4

In the study population 13.33% (4 patients) had less than 6 months follow up, 46.67% (14 patients) had follow up

between 6-12 months and 40% (12 patients) had follow up between 13-18 months.

Type 2 pilon fracture had good result (OMAS score 71.25) and Type 3 pilon fracture had fair result (OMAS score 50.83).

OMAS score is a very good predictor of outcome in females with pilon fracture, p value is <0.01 (0.0035), i.e. statistically highly significant. OMAS score is a good predictor of outcome in males with pilon fracture, p value is <0.05 (0.03), i.e. statistically significant.

OMAS score is a very good predictor of outcome in patients with Type- II pilon fracture, p value is <0.01 (0.0043), i.e. statistically highly significant.

OMAS score is a very good predictor of outcome in patients with age <40 yrs, p value is <0.01 (0.0087), i.e. statistically highly significant. OMAS score is a good predictor of outcome in patients with age >40 yrs, p value is <0.05 (0.027), i.e. statistically significant.

**T-test**

Here the significance value is less than 0.01; hence the correlation is highly significant.

Here the significance value is less than 0.01, hence it is highly significant, i.e. there is significant difference between Midterm OMAS SCORE and final OMAS score. Our treatment has significant effect.

**Table 6: Showing paired statistics.**

		Mean	N	Std. Deviation	Std. Error Mean
<b>Pair 1</b>	Midterm OMAS score	26.6667	30	12.95439	2.36514
	Final OMAS score	59.1667	30	27.76389	5.06897

**Table 7: Showing paired correlation.**

		N	Correlation	Significance
<b>Pair 1</b>	Midterm OMAS score and final OMAS score	30	.987	0.0000034

Here the significance value is less than 0.01; hence the correlation is highly significant.

**Table 8: Showing paired samples test.**

		t	df	Sig (2-tailed)
<b>Pair 1</b>	Midterm OMAS score - final OMAS score	-11.766	29	0.000

**DISCUSSION**

Success in the treatment of pilon fracture means that union of fracture is achieved with minimum restriction of motion in the ankle and with restoration of good muscle strength without pain. The merits of any treatment regimen should be judged on these criteria because failure to achieve any one of them will compromise the functional result. Which method to be selected is depending on the discretion of surgeon. In this small group study an attempt is made to assess the Functional out of JESS fixation and bone grafting in pilon fracture.

Although multiple treatment approaches and protocols have been described, there is no consensus regarding the optimal treatment of these challenging injuries. Similarly, long-term outcome data from randomized comparative treatment methods remains lacking. What does appear to be clear, however, is that the surgeon must balance the extent of osseous reduction and stability, particularly that of the articular surface, within the tolerances of the soft tissue envelope.

The last decade has noted resurgence in the treatment of tibial plafond fractures with open reduction and internal

fixation techniques, but to the critical appreciation and handling of the traumatized soft tissue envelope. This has led to the popularization of the staged management of tibial pilon fractures, championed in 1999 by two separate reports by Sirkin and colleagues, and Patterson and Cole.<sup>3,4</sup>

These studies concluded that the historically high rates of infection associated with open reduction and internal fixation of pilon fractures may have been caused by attempts at immediate fixation through swollen and compromised soft tissues. Although staged treatment remains the current foundation for the management of these injuries, the application of minimally invasive plating techniques, use of alternate exposures, the development of low profile and anatomically contoured plates, and a greater understanding of the osseous fracture anatomy has, in part, also been a response to the difficult soft tissue injury that accompanies these fractures.<sup>5-8</sup>

Treatment options- AO plating, external fixation, tibiotalar spanning external fixation, trans articular external fixation, articular reduction and external fixation, hybrid external fixation, minimally invasive plating, primary arthrodesis.<sup>9-14</sup>

ORIF with plate and screw device can be used effectively to treat tibial pilon fracture if strict attention is paid to fracture reduction and soft tissue management.<sup>15</sup> This technique suitable for low-energy fractures with large displaced fragments, little comminution, and no diaphyseal extension.<sup>16,17</sup> An extremity with minimal swelling and a good soft-tissue envelope is of paramount importance if complications are to be prevented. Plate and screw fixation has been associated with more frequent wound breakdown and infection. Minimally invasive plating is suited in the treatment of those pilon fractures that have less comminution and reduce ligamentotaxis.

The most significant complications after operative management of tibial plafond fractures involves those of the soft tissue envelope.<sup>18-21</sup> The vast majority of distal tibial nonunion after a fracture of the tibial plafond occur within the metaphysis or the metadiaphyseal junction.<sup>22</sup> Rates of nonunion range from 0% to 16%.

The pilon fractures are one of the most difficult fractures to treat. Severely comminuted pilon fracture (Ruedi and Allgower type III) leads to poor results. Most common complication of pilon fracture is the residual pain and ankle stiffness, and persistent swelling.

In this study the following were specifically noted:- patients treated with JESS fixation and bone grafting in Ruedi and Allgower type II fracture has got 71.25% (Good result) which is highly significant and type III got fair result, ie functional outcome in type II pilon fractures are good. This study shows that JESS fixation and bone grafting resulted in good functional outcome in female population in the study group and resulted good functional outcome in patients less than 40 years of age. Implant failure (6.66%) and refracture (6.66%) were the complications noted and which resulted in poor results in this study population.

Previous studies have documented conflicting results regarding clinical and functional outcomes after pilon fracture. Ruedi and Allgower reported that 71% of their patients treated with open reduction and internal fixation had a good-to-excellent result four years after injury.<sup>23</sup> 92% of their study population had returned to work at the time of follow-up.

Ovadia and Beals documented a 65% rate of good-to-excellent results after the treatment of 145 pilon fractures.<sup>24</sup> Only 20% of the fractures were open. Many other authors have reported poorer overall results. Teeny and Wiss reported that 50% of their 55 patients had a poor clinical result after treatment of a pilon fracture with open reduction and internal fixation and a 37% rate of good-to-excellent results after the treatment of Ruedi type II compared with a rate of only 13% after treatment of type III fractures.<sup>25</sup>

Wyrsh et al found that patients treated with open reduction and internal fixation tended to have worse clinical scores.<sup>26</sup> However, it is difficult to directly compare their study with ours because of the difference in the severity of the pilon fractures between the two groups in their study group and because we assessed outcome differently.

Pollak et al observed cohort analysis of pilon fractures treated at 2 centers between 1994-1995. They assessed the functional outcome.<sup>27</sup> The primary outcome was measured with health status, walking ability, limitation of range of movements, pain and stair climbing ability and secondary outcome was measured with employment status. 35% patients reported ankle stiffness; 29% persistent swelling and 33% had on-going pain.

In this study 6.66% patients had residual pain ankle. No patients reported ankle stiffness and persistent swelling. Our treatment has significant effect. So this study is comparable or better to other studies in closed pilon fracture treatment.

## CONCLUSION

Successful treatment of intra articular distal tibial plafond –pilon fracture requires a full understanding of the fracture. This begins with correct identification of fracture components and areas of comminution and with an understanding of which type of implant is biomechanically good. Significant time (upto 30 months) is required before these patients can realize their maximal gain in activity and functionality.

The incidence of pilon fracture is common between 41-50 years of age. More common in males. Fall from height is the major causative factor in 87% of patients and RTA in 13.33% of patients. 60% of patients in study group was type III pilon fracture (Ruedi and Allgower) and 40% was type II. 40% patients started weight bearing in 4-6 months and 46.66% in 7-9 months of post procedure. 60% patients returned to normal daily activity in 7-9 months and 13.33% in 10-12 months.

## Complications

6.66% patients had residual ankle pain and 13.33% patients developed implant failure and refracture. This study (procedure) has high significance in functional outcome of type II pilon fracture and in patients less than 40 years of age.

In patients with type II pilon fracture and patients less than 40 years of age; JESS fixation and bone grafting is the suitable procedure which can be proposed with good prognosis and favourable outcome.

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## REFERENCES

1. Teeny SM, Wiss DA. Open reduction and internal fixation of tibial plafond fracture. Variables contributing to poor results and complication. *Clin Ortho Relat Res.* 1993;292:108-17.
2. Bourne RB, Rerabeck CH, Mac Nab J. Intraarticular fracture of distal tibia: the pilon fracture. *J Trauma.* 1983;23(7):591-6.
3. Patterson MJ, Cole JD. Two-staged delayed open reduction and internal fixation of severe pilon fractures. *J Orthop Trauma.* 1999;13(2):85-91.
4. Sirkin M, Sanders R, DiPasquale T, Herscovici D Jr. A staged protocol for soft tissue management in the treatment of complex pilon fractures. *J Orthop Trauma.* 1999;13(2):78-84
5. Bahari S, Lenehan B, Khan H, McElwain JP. Minimally invasive percutaneous plate fixation of distal tibia fractures. *Acta Orthop Belg.* 2007;73(5):635-40.
6. Collinge C, Kuper M, Larson K, Protzman R. Minimally invasive plating of high-energy metaphyseal distal tibia fractures. *J Orthop Trauma.* 2007;21(6):355-61.
7. Collinge CA, Sanders RW. Percutaneous plating in the lower extremity. *J Am Acad Orthop Surg.* 2000;8(4):211-6.
8. Assal M, Ray A, Stern R. The extensile approach for the operative treatment of high-energy pilon fractures: surgical technique and soft-tissue healing. *J Orthop Trauma.* 2007;21(3):198-206.
9. Blauth M, Bastian L, Krettek C, Knop C, Evans S. Surgical options for the treatment of severe tibial pilon fractures: a study of three techniques. *J Orthop Trauma.* 2001;15:153.
10. Bonar SK, Marsh JL. Unilateral external fixation for severe pilon fractures. *Foot Ankle.* 1993;14:57.
11. Borens O, Kloen P, Richmond J, Roederer G, Levine DS, Helfet DL. Minimally invasive treatment of pilon fractures with a low profile plate: preliminary results in 17 cases. *Arch Orthop Trauma Surg.* 2009;129(5):649-59.
12. Cole PA, Benirschke SK. Minimally invasive surgery for the pilon fracture: the percutaneous-submuscular plating technique. *Tech Orthop.* 1999;14:201.
13. Court-Brown CM, Walker C, Garg A, McQueen MM. Half-ring external fixation in the management of tibial plafond fractures. *J Orthop Trauma.* 1999;13:200.
14. Dickson KF, Montgomery S, Field J. High energy plafond fractures treated by a spanning external fixator initially and followed by a second stage open reduction internal fixation of the articular surface—preliminary report. *Injury.* 2001;32:92.
15. Egol KA, Wolinsky P, Koval KJ. Open reduction and internal fixation of tibial pilon fractures. *Foot Ankle Clin.* 2000;5:873.
16. Grose A, Gardner MJ, Hettrich C, Fishman F, Lorich DG, Asprinio DE, et al. Open reduction and internal fixation of tibial pilon fractures using a lateral approach. *J Orthop Trauma.* 2007;21(8):530-7.
17. Heim U, Naser M. Operative treatment of distal tibial fractures. Technique of osteosynthesis and results in 128 patients (author's transl). *Arch Orthop Unfallchir.* 1976;86(3):341-56.
18. Giordano CP, Koval KJ, Zuckerman JD, Desai P. Fracture blisters. *Clin Orthop Relat Res.* 1994(307):214-21.
19. Giordano CP, Scott D, Koval KJ. Fracture blister formation: a laboratory study. *J Trauma.* 1995;38(6):907-9.
20. McFerran MA, Smith SW, Boulas HJ, Schwartz HS. Complications encountered in the treatment of pilon fractures. *J Orthop Trauma.* 1992;6(2):195-200.
21. Strauss EJ, Petrucelli G, Bong M, Koval KJ, Egol KA. Blisters associated with lower-extremity fracture: results of a prospective treatment protocol. *J Orthop Trauma.* 2006;20(9):618-22.
22. Dillin L, Slabaugh P. Delayed wound healing, infection, and nonunion following open reduction and internal fixation of tibial plafond fractures. *J Trauma.* 1986;26(12):1116-9.
23. Rüedi TP, Allgöwer M. The operative treatment of intraarticular fractures of the lower end of the tibia. *Clin Orthop Relat Res.* 1979;138:105.
24. Ovadia DN, Beals RK. Fracture of the tibial plafond. *J Bone Joint Surg Am.* 1986;(4):543-51.
25. Teeny SM, Wiss DA. Open reduction and internal fixation of tibial plafond fractures. Variables contributing to poor results and complications. *Clin Orthop Relat Res.* 1993(292):108-17.
26. Wyrsh B, McFerran MA, McAndrew M, Limbird TJ, Harper MC, Johnson KD, et al. Operative treatment of fractures of the tibial plafond. A randomized, prospective study. *J Bone Joint Surg Am.* 1996;78(11):1646-57.
27. Pollak AN, McCarthy ML, Bess RS, Agel J, Swiontkowski MF. Outcomes after treatment of high-energy tibial plafond fractures. *J Bone Joint Surg Am.* 2003;85(10):1893-900.

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