Early Definitive Care is as Effective as Staged Treatment Protocols for Open Ankle Fractures from Rotational Mechanisms: A Retrospective Cohort Study

[1]Daniel L. Peterson DPM, AACFAS; [2]Christopher J. Kennedy DPM; [3]Joseph M. Wilkinson DPM, AACFAS; [2]Meg Schuurman, BMSc; [2]Muhammad T. Padela, MD, MSc; [2]Rahul Vaidya, MD, FRCS; [2]Andreea Geamanu, PhD

[1]Fellow, North Jersey Reconstructive Foot and Ankle, Department of Podiatric Surgery, Lyndhurst, NJ
[2]Detroit Medical Center, Department of Orthopedics, Detroit, MI
[3]PeaceHealth Medical Group, Department of Orthopedics, Florence, OR

Statement of Purpose

- The purpose of this study was to compare immediate internal fixation with primary wound closure to temporary fixation/stabilization with delayed fixation and wound closure protocols for management of open ankle fractures from rotational mechanisms.

Methodology

- With IRB approval, a retrospective study of all open ankle fractures from the institutional trauma database from October 1999 to August 2017 at an inner-city Level I US trauma center were assessed.
- Only fractures caused by a primary rotational mechanism as described by Lauge-Hansen were included to compare similar osseous fracture types and soft tissue injuries.[1,2]
- Exclusion criteria were: open pilon fracture, ankle fracture from a blast or crush injury, ballistic injury, previously treated open ankle fracture, chronic open ankle fracture, open ankle dislocation without fracture, and less than six months follow-up.
- This left 88 patients with Gustilo-Anderson (GA) type I, II, and IIIA fractures who were included in the study.
- Cases were divided into two cohorts: immediate internal fixation with primary wound closure (EARLY) and temporary fixation/stabilization with delayed fixation and wound closure (STAGED) (Figure 1).
- The decision to perform EARLY versus STAGED treatment was attending dependent.

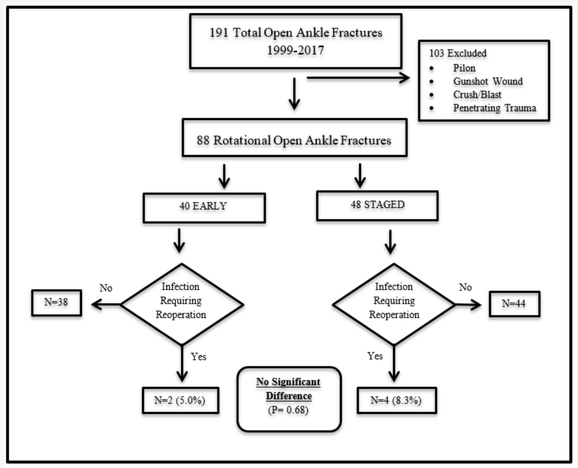

Figure 1. Flow diagram of patient selection and primary results

Literature Review

- Open ankle fractures are relatively uncommon injuries ranging from 1.5-4.5% of all ankle fractures.[3,4]
- The tenets of care for open ankle fractures include early antibiotics, expedient and adequate debridement, operative reduction and fixation, and wound closure.
- Many authors advocate a staged protocol for these injuries to allow for demarcation of nonviable soft tissue and to prevent sealing in contaminating organisms.[5,6]
- Treatment of open fractures has evolved over time due to regimented antibiotics, improvements in fixation, and an emphasis on soft tissue handling.[5]
- The incidence of infection in GA type III injuries has been reported to be as high as 50%.[7]
- Recent studies suggest that GA type IIIA injuries in tibia fractures may be comparable to GA type I and II injuries when performing immediate internal fixation with primary wound closure.[6,8]
- This may decrease the requirement for subsequent debridement and soft-tissue procedures, decrease joint stiffness, shorten hospital stay, reduce costs, reduce amputations, decrease time to union, expedite rehabilitation, and reduce infection.[6,9,10]

Table 1
Pre-Operative Bivariate Analysis of Open Ankle Fractures

	EARLY n=40	STAGED n=48	P-Value
Patient Demographics			
Age (mean)	43.8 (± 15.6; 22 to 82)	44.8 (± 15.7; 20 to 80)	0.72
Gender			0.09
Male	17 (42.5%)	30 (62.50%)	
Female	23 (57.5%)	18 (37.50%)	
Comorbidities			
Diabetes	7 (17.5%)	8 (16.7%)	0.92
Tobacco use	16 (40.0%)	20 (41.7%)	0.87
ASA Class			0.40
1	2 (5.0%)	7 (14.6%)	
2	24 (60.0%)	22 (45.8%)	
3	12 (30.0%)	16 (33.3%)	
4	2 (5.0%)	3 (6.3%)	
Mechanism of Injury			0.09
Motor vehicle collision	21 (52.5%)	31 (64.6%)	
Fall from stairs/ground	18 (45.0%)	14 (29.2%)	
Fall from height	0	3 (6.3%)	
Unknown	1 (2.5%)	0	
Polytrauma	9 (22.5%)	11 (22.9%)	0.96
Time to OR (Hours)	10.0 (± 5.5; 1 to 24)	10.7 (± 12.7; 0 to 62)	0.10
Fracture Characteristics			
Fracture type			0.68
Unimalleolar	15 (37.5%)	17 (35.4%)	
Bimalleolar	23 (57.5%)	26 (54.2%)	
Trimalleolar	2 (5.0%)	5 (10.4%)	
Weber Classification			0.17
A	4 (10.0%)	10 (20.8%)	
B	19 (47.5%)	26 (54.2%)	
C	17 (42.5%)	12 (25.0%)	
Lauge Hansen Classification			0.14
SER 1, 2, 3, 4	0, 1 (2.5%), 1 (2.5%), 9 (22.5%)	1 (2.1%), 0, 1 (2.1%), 10 (20.8%)	
PER 1, 2, 3, 4	0, 1 (2.5%), 2 (5.0%), 8 (20.0%)	1 (2.1%), 0, 1 (2.1%), 3 (6.3%)	
PAD 1, 2	0, 4 (10.0%)	6 (12.5%), 3 (6.3%)	
SAD 1, 2, 3	2 (5.0%), 4 (10.0%), 8 (20.0%)	3 (6.3%), 3 (6.3%), 16 (33.3%)	
Gustilo-Anderson Classification			0.0079
I	6 (15.0%)	1 (2.1%)	
II	14 (35.0%)	9 (18.8%)	
IIIA	20 (50.0%)	38 (79.2%)	

Results

- Pre-operative risk factors between EARLY versus STAGED cohorts were found to have similar distributions (Table 1).
- Overall, six patients were diagnosed with infection, corresponding to an incidence of 6.8% (6/88). No significant difference in infection requiring reoperation was found between EARLY versus STAGED cohorts ($p = 0.68$) (Table 2).
- The STAGED cohort had a statistically longer length of hospital stay versus the EARLY cohort ($p = 0.0003$) (Table 2).
- Number of reoperations was significantly greater in the STAGED cohort as compared to the EARLY cohort ($p < 0.0001$) (Table 3).
- Of the six patients with infection, the mean number of reoperations was significantly greater than patients without infection (6.33 vs 1.32 respectively; $p = 0.0016$).
- Clinical outcomes were compared for patients (52) with greater than 12 months of follow-up (Table 4). STAGED patients had more pain rated at ≥ 4/10 than EARLY patients at the latest follow-up ($p < 0.04$) (Table 4).

Table 2
Post-Operative Bivariate Analysis of Open Ankle Fractures

	EARLY n=40	STAGED n=48	P-Value
Infection requiring reoperation (n, %)	2 (5.0%)	4 (8.3%)	0.68
Reoperation (mean; SD; range)	0.6 (± 1.0; 0 to 4)	2.5 (± 2.9; 0 to 13)	< 0.0001
Follow-up (months, mean; SD, range)	14.0 (± 16.6; 2 to 78)	16.6 (± 22.9; 1 to 105)	0.57
Length of stay (days, mean; SD, range)	6.4 (± 4.7; 2 to 25)	10.6 (± 7.1; 3 to 35)	0.0003

Table 3
Type of Re-Operative Procedure

	EARLY	STAGED
I&D with wound vac	4	36
Hardware removal	13	24
Bone graft	1	4
Hardware revision	4	6
Skin graft	1	9
Local flap	0	1
I&D + delayed internal fixation	0	10
I&D + external fixation	0	16
I&D + delayed primary closure	0	15
I&D + primary closure	2	0
Total Reoperations	25	121

Table 4
Clinical Analysis of Patients with ≥1 Year Follow-up

	EARLY n=25	STAGED n=27	P-Value
Pain			0.04
≤ 3/10	23 (92%)	18 (66.7%)	
≥ 4/10	2 (8%)	9 (33.3%)	
Ambulation			0.40
Unlimited	12 (48%)	9 (33.3%)	
Limited	13 (52%)	18 (66.7%)	
Limp			0.96
No	15 (60%)	16 (59.3%)	
Yes	10 (40%)	11 (40.7%)	
Osteoarthritis			0.57
Mild/joint space narrowing	17 (68%)	16 (59.3%)	
Moderate/severe	8 (32%)	11 (40.7%)	

Analysis and Discussion

- Open ankle fractures occur from a wide array of injury types through multiple mechanisms with variable energy levels.[3,6,7,11] Published literature on this topic is inconsistent regarding pre- and postoperative measures. Even the very definition of what constitutes an open ankle fracture is not clearly defined.[5,6]
- To compare cohorts with similar osseous fractures and comparable soft tissue injuries, it was fundamental to include only open ankle fractures resulting from rotational mechanisms.
- To the authors knowledge, this is the first study to compare an EARLY versus a STAGED protocol for open ankle fractures from a single mechanism of action (rotational).
- The overall incidence of infection within our study was 6.8%. We found no significant difference in infection rates of patients treated with an EARLY versus a STAGED protocol
- Length of hospital stay was significantly less in patients in the EARLY cohort (6.38 vs 10.63; $p = 0.0003$). In addition, patients within the EARLY cohort had significantly fewer mean number of reoperations ($p < 0.0001$).
- The EARLY cohort reported less pain than the STAGED cohort ($p < 0.04$) in patients followed for > 12 months.
- In conclusion, our study showed that early definitive treatment as compared to a staged protocol for GA type I, II, and IIIA open ankle fractures from rotational mechanisms has similar rates of infection, leads to a shorter hospital stay, has fewer surgical interventions, and leads to less pain.

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