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Research Article

Incidence and Outcome of Open Ankle Fractures Treated with Internal and External Stabilization Techniques

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Abstract: Open ankle fractures are challenging injuries due to the fact of frequent infections, non-unions and potential limb loss. Although the traditional management of these injuries is external fixation, a trend towards definitive stabilization techniques has evolved in the current literature. Is there adistinction in different forms of stabilization for open ankle fractures influencing overall outcome. The objective of this prospective collected and retrospective evaluated data study was intended to analyse the outcome of different forms of stabilisation in open ankle fractures. All open ankle fractures (OTA 43 and 44) presenting to our urban Level I trauma centre during a ten-year period were reviewed. Fifty patients were initially treated at our institution within six hours of injury. All patients underwent emergent wound irrigation, debridement and antibiotic therapy. Study population (44 patients) can be subdivided according to Gustilo classification for open fractures: 12 (27%) GI, 19 (43%) GII and 13 (30%) GIII. Initially fracture management was performed with plating (PL) 17 (39%), external fixation (EF) 10 (23%), with nail and plate five (12%), with EF and K-wire 2 (5%), with EF and PL 2 (5%), K-wire and screw 2 (5%), EF and screw 1 (3%), K-wire 1 (3%), cast 1 (3%), and amputation 1 (3%). In two cases (6%) no treatment was performed because of imminent death after admittance. Complications occurred in our study population in a total of twelve (27%) cases. Using internal fixation techniques in acute fracture treatment for open ankle fractures is a safe and effective surgical technique, when it comes to evaluating complications in our study group. We had 84% in GI, 47% in G II and 46% in G III for internal fixation procedures. Level of evidence: Level III. Prospective clinical study.
Keywords: open fracture, distal tibia, ankle, incidence, outcome

INTRODUCTION

Trauma ranks within the top ten causes of disability, and open fractures account for 3 to 4% of all fractures [2,11,14,18]. Infection rate for severe open fractures is reported as high as 50% [4,15,16,25,37]. Open ankle fractures are challenging injuries related to frequent infections, non-unions and potential limb loss [15,16]. Fractures of the ankle joint have a major impact on functionality outcome in the ankle joint due to the fact of stability in the malleolar arch. They are increasingly common, trailing only hip fractures and wrist fractures in frequency among adult patients, with a larger proportion of injuries in the younger population [29,37,39]. Those fractures represent the most common intraarticularfratures of a weight-bearing joint [5,35]. Overall, most ankle fractures are isolated malleolar fractures, andbimalleolar fractures occur in 25% [3,10,28].

Open ankle fractures, account for up to 2% of all ankle fractures, are often associated with severe injuries to other organ systems [29,40]. Very view papers are dealing with the rare issue of open ankle fractures [5,9,27,33,40]. Those fractures are resulting more often from high energy trauma, than closed fractures and motor vehicle accidents (MVA) and falls from height account for more than 60% of all open ankle fractures [19,40].

For open fracture management various classification systems have been proposed, but the classification by Gustilo*et al.* [22] and his modified version [23] can be considered to be the gold standard, even if the clinical benefit of the revised version is discussed controversial [7,23,26]. Initial evaluation of a patient with an open fracture of a limb should follow the guidelines according to the Advanced Trauma Life Support System (ATLS) and the British Orthopedic Association (BOA) [1,6,12,21]. First operative procedure should be performed within 6 hours of the original accident, despite the fact that its benefit was only significant in one study [29,34].

Open fractures of the lower limb remain still a challenge because of the need of simultaneous management of both, skeletal and soft tissue injury [21]. In severe injured patients primary goal is to achieve a stable cardio respiratory condition to avoid the "triad of death" [8,17,37]. The principle goals in treating open fractures are to promptly restore function and bony union, to avoid complications such as infections, and to minimize both operative and anesthetic risks [13].

Well-designed, prospective studies related to this topic are lacking [5]. Thereforethe purpose of our study was to assess the influence of initial stabilization techniques in open distal tibia fractures on overall outcome.

MATERIALS AND METHODS

The present retrospective study was performed by standards of International Conference of Harmonisation (ICH) and Good Clinical Practice (GCP). Between 2000 to 2011, 50 patients (50 fractures) were admitted to our emergency room (ER) with an acute open distal tibia fracture. Fractures caused by motor vehicle accidents, falls, and direct impact were included, pathologic fractures were not included into the present study. Six patients were excluded because of missing data or incomplete follow up.

The groups of patients comprised a total of 44 patients. Included were twenty-six (59%) men and eighteen (41%) women with a total mean age of 50.3 (range, 14.8 to 93.4) years (Table 1). Of the fractures twenty-one (48%) were motor vehicle accidents, fifteen (34%) falls from height, four (9%) were caused by jumps in suicidal intention, two (4%) were work related and two (4%) were result of a fight.

In accordance with the Orthopedic Trauma Association (OTA) classification33 the fracture types were: Five 43.A1, one 43.A3, one 43.B1, one 43.B2, one 43.B3, one 43.C1, two 43.C2, three 43.C3, four 44.A1, three 44.B1, seven 44.B2, nine 44.B3, five 44.C1 and one 44.C2. Open fractures were categorized by the Gustilo classification: twelve (27%) GI, nineteen (43%) GII and thirteen (30%) GIII fractures [22] (Table 2).

Sixteen open wounds were located medial, twelve lateral, eight anterior, three posterior, and five almost circular. We could observe a difference in gender related distribution when correlating GIII fractures. For the GIII group ratio male : female was 2.8:1.

All patients admitted to our emergency room who were in unstable condition were stabilized before fracture treatment. If associated injuries like intracranial bleeding or life threatening pelvic fractures occurred, they were treated first for the benefit of the patient. All fractures were treated within 6 hours from the injury. OTA classification was performed by reviewing initial x-rays from day of admission. Careful wash-out, debridement and antibiotic therapy were performed in all open fractures. All patients had anatomic reposition after initial surgery. All other information was collected by critically screening the electronic patient documentation system. Double cross check of the gained data was performed by an independent person not involved in the current project.

For statistical analyses we used the SPSS software package (SPSS, Chicago, Ill., USA). Discrete variables were presented as counts and percentages, continuous variables as median and range unless otherwise stated.

RESULTS

Initially fracture management was performed with plating (PL) 17 (39%), external fixation (EF) 10 (23%), with nail and plate five (12%), with EF and K-wire 2 (5%), with EF and PL 2 (5%), K-wire and screw 2 (5%), EF and screw 1 (3%), K-wire 1 (3%), cast 1 (3%), and amputation 1 (3%). In two cases (5%) no treatment was performed because of imminent death after admittance.

GI fractures were treated in seven (58%) cases by plating, two (17%) case with a combination of an intramedullary nail, plate and a screw fixation, in one (8%) case by a combination of EF and screw, in one (8%) case by a combination of K-wire and screw, and in one (8%) case by EF. GII fractures were treated in six (32%) cases with external fixation, four (21%) cases by plating, three (16%) case with a combination of an intramedullary nail, plate and a screw fixation, and one (5%) case each with cast, K-wire, a combination of K-wire and screw, a combination of EF and PL, amputation. The patient who underwent amputation died three months after initial surgery due to MOF. One patient underwent no treatment for his open fracture because of imminent death. GIII fractures were treated in six (46%) cases by plating, three (23%) cases with external fixation, two (15%) cases with a combination of EF and K-wiretransfixation, and one (8%) case with EF and PL. One patient underwent no treatment for his open fracture because of imminent death.

Four patients in the study population where young adults, treated with EF in three cases and EF and screw in one case. Five (12%) patients had additional fractures of the femur, five (12%) of the talus and three (7%) of the calcaneus. Twenty-two (51%) patients had additional injuries in the lower extremity, ten (23%) in the upper extremity, seven (16%) in the head and thorax, six (14%) in the spine, five (12%) in the pelvic, and three (7%) in the abdominal region.

Median follow up was 15.5 (range, 0 to 94.2) months. Bone-union occurred in fourty-three patients with a median time of 172 (range 24-766) days. One patient initially treated with EF developed a non-union. Three patients one in the EF/ K-wire group and two in

the PL group developed arthrosis in the ankle joint. Skin graft was necessary in five (12%) cases, three in the GIII, one on the GII and one in the GI group, 41 (range, 0 to 176) days after initial surgery. Duration of external fixation application was 77 (range, 22 to 223) days.

In six (14%) cases primary fracture immobilization technique had to be changed. A total of four (9%) patients treated initially with EF, one with EF and PL and one with EF and K-wire had to undergo a change in treatment strategy. (Table 3)

Complications (n=12, 27%) that occurred in our study population can be described as following: Four (9%) wound healing complications, two (5%) pin infections, one (2%) implant infection and one implant failure. In one patient (2%), fasciotomy was performed because of dooming compartment syndrome, in one patient (2%) a subluxation of the talus was noticed during follow up and in one case (2%) an arthrodesis was performed due to arthritis and pain.One (2%) patient with a GIII / 43.C3 developed a non-union. (Table 4)

Range of motion (ROM) for the ankle joint was between 0-0-0 and 30-0-60. Pain as reported by the patients at the last follow up visit was graded non-in twenty-nine cases (67%) and mild in eight cases (18%) and severe in four case (9%).

Table 1
Characteristics of study population

	n	%
Total	44	*100*
Male	26	*59*
Female	18	*41*
Age (*y*)	50.3 (14.8-93.4)	
Follow up (m)	15.5 (0-94.2)	
Subdividing*		
G I	12	*27*
G II	19	*43*
G III	13	*30*
Treatment according to GI-III		
G I		100
External	1	*8*
Internal	10	*84*
Combination	1	*8*
G II		100
External	6	*32*
Internal	9	*47*
Combination	1	*5*
Amputation	1	*5*
Other	2	11
G III		100
External	3	*23*
Internal	6	*46*
Combination	3	*23*
Non	1	*8*

* according to Gustilo classification for open fractures

Table 2
Classification according to OTA and Gustilo

OTA	GI	GII	GIII	Total
43.A1		3	2	5
A3		1		1
B1		1		1
B2		1		1
B3	1			1
C1			1	1
C2	1	1		2
C3		1	2	3
44.A1	2	2		4
B1		2	1	3
B2	3	2	2	7
B3	2	4	3	9
C1	2	1	2	5
C2	1			1

Table 3
Change of treatment

OTA	G	Initial treatment	Secondary treatment
43.A3	II	EF	Nail
43.B2	II	EF	PL
44.B3	II	EF/PL	Reposition / K-wire
44.B2	I	EF	Reposition / K-wire
43.A1	III	EF/K-wire	Nail / spongiosa plasty
44.B3	II	EF	Nail

EF= external fixator
PL= plate

Table 4
Complications in detail*

OTA	G	Initial treatment	Complication
44.A1	II	EF	Pin infection
44.B3	I	PL	Wound infection
44.B3	II	EF/PL	Wound infection
44.B2	II	PL	Implant infection
43.C1	III	EF/PL	Pin infection
44.C2	I	Nail/PL/ Screw	Bolt break
44.C1	III	EF/K-wire	Wound infection
44.B1	II	PL	Wound complication
43.C3	III	EF	Non-union
44.B3	I	PL	Fasciotomy
44.B2	I	PL	Talus subluxation
44.B2	II	EF	Arthrodesis

*each case representing one patient
EF= external fixator
PL= plate

DISCUSSION

Despite the fact that a number of authors have described results after fracture treatment with several techniques, still information about optimal treatment in open ankle fractures can be seen as limited.

The use of internal fixation for open fractures of the ankle remains still controversial [20]. New developments in the field of implants and operative techniques enabled the use of internal fixation for open ankle fractures, but this technique is associated with high complication rate, compared to external fixation [40]. Early anatomic reduction and secure internal fixation leads to a satisfactory outcome in closed displaced ankle fractures [30,35,40]. In open fractures however, soft tissue coverage and implants as foreign bodies, lead to controversial opinion for initial treatment [9,31,36]. Immediate open reduction and internal stabilization of open ankle fractures is the treatment of choice by some authors [5,40]. In our study population we observed a total of twenty-five internal stabilization procedures, compared to ten external and five combined (internal and external) procedures. EF was involved in all six patients that needed change of initial treatment strategy, and in five out of twelve complications.

Wound infection is reported in the literature up to 4.57% for all open ankle fractures [38], compared to 6.9% (n=3) in our study population. Those complications did not occurred only in the GIII group, like most would suggest, but had also one case each in GI and in the GII group. PL was involved in one case (GI), PL and EF in one case (GII), and EF and K-wire in one case (GIII). Analyzing those results, we are unable to give a clear statement for one or the other technique related to wound healing problems. Due to the fact of two additional cases with pin infections and one case of non-union, all associated to the EF group, internal stabilization might be superior to EF.

Correlation between OTA andGustilo classification did not reached significance and distribution of Gustilo GI-III lesions can be seen as equal. According to the literature, we observed additional injuries of the head, spine, thorax, abdomen, upper and lower extremity in several patients, but only three patients died during follow up period [11,25,10,40]. Gender related differences as reported by Tejwani*et al*. and Ho et al. could not be observed in our study population [24,40]. We could only detect a difference in gender related distribution when correlating to GIII fractures, with a male: female ratio 2.8:1. Results for range of motion and pain can be summarized as acceptable, due to the fact of including also polytraumatized patients. Only four patients had severe pain at the end of follow up, two in the PL, one in the EF and one in the EF/K-wire group. Reason for severe pain was arthrosis in the ankle joint with support of orthopedic shoes in two cases, non-union in one case, and an implant infection leading to an arthrodesis. Only three patients had less ROM than 10-0-10 at last follow up.

There are several limitations of the current study we have to mention in relation to our results. The first and most gravid is the long inclusion duration of 11 years and the heterogeneity of our study population. We also want to mention the special patient population when it comes to suicidal jumps and MVA´s, with people of challenging social background that might have an influence on the outcome, compliance and follow up. Inclusion of extreme fracture cases with severe soft tissuetrauma, also may have a negative influence. Finally the results are based on out-comes during the first fifteen months after injury, a period in which patients have not yet completely recovered. Despite those limitations we believe that the results justify our conclusion.

CONCLUSION

Using internal fixation techniques in acute fracture treatment for open distal tibia fractures is a safe and effective surgical technique, when it comes to evaluating complications in our patient group. In our study population we had 84% in GI, 47% in G II and 46% in G III for internal fixation procedures. The decision which of the compared techniques should be used in a patient is depending on the surgeons experience and the individual case.

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