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## Observational Study

# Clinical outcome of open ankle fractures in patients above 70 years of age

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## Abstract

### BACKGROUND

Open fractures of the ankle are complex injuries requiring multidisciplinary input and are associated with significant morbidity and mortality. However, data on the clinical outcomes of open ankle fracture management in patients older than 70 is minimal.

### AIM

To evaluate the clinical outcomes following open ankle fracture management in patients older than 70. Our secondary aim is to look at predictors of poor outcomes.

### METHODS

Following local research and audit department registration, 22 years of prospectively collated data from an electronic database in a district general hospital were assessed. All patients older than 70 years of age with an open ankle fracture requiring surgical intervention were identified. Demographic information, the nature, and the number of surgical interventions were collated. Complications, including surgical site infection (SSI), venous thromboembolic events (VTEs) during hospital stay, and mortality rate, were reviewed.

### RESULTS

A total of 37 patients were identified (median age: 84 years, range: 70-98);  $n = 30$  females median age: 84 years, range: 70-97);  $n = 7$  males median age: 74 years,

range: 71-98)) who underwent surgical intervention after an open ankle fracture. Sixteen patients developed SSIs (43%). Superficial SSIs ( $n = 8$ ) were managed without surgical intervention and treated with antibiotics and regular dressing changes. Deep SSIs ( $n = 8$ ; 20%) required a median of 3 (range: 2-9) surgical interventions, with four patients requiring multiple washouts and one patient having metalwork removed. VTE incidence was 5% during the hospital stay. Eight patients died within 30 d, and mortality at one year was 19%. The 10-year mortality rate was 57%. The presence of a history of stroke, cancer, or prolonged inpatient stay was found to be predictive of lower survivorship in this population (log-rank test: cancer  $P = 0.008$ , stroke  $P = 0.001$ , length of stay  $> 33$  d  $P = 0.015$ ). The presence of a cardiac history was predictive of wound complications (logistic regression,  $P = 0.045$ ). Age, number of operations, and diabetic history were found to be predictive of an increase in the length of stay (general linear model; age  $P < 0.001$ , number of operations  $P < 0.001$ , diabetes  $P = 0.041$ ).

## CONCLUSION

An open ankle fracture in a patient older than 70 years has at least a 20% chance of requiring repeated surgical intervention due to deep SSIs. The presence of a cardiac history appears to be the main predictor for wound complications.

**Key Words:** Fragility fracture; Open fracture; Clinical outcome; Mortality; Infection; Survival

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**Core Tip:** There is no standard consensus on management of open ankle fractures in patients above 70 years of age. Cardiac issues are the main predictors of poor outcome. 1 in 5 patients above 70 years of age develop deep infection requiring further surgical intervention. High infection increases length of stay in the hospital and mortality.

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## INTRODUCTION

Open fractures are complex injuries requiring multidisciplinary input[1] and are associated with significant morbidity and mortality[2]. Open ankle fractures account for about 2% of all ankle fractures[3]. About 187 per 100000 adults sustain ankle fractures every year[4]. Ankle fractures can be caused by various modes of trauma, e.g., twisting, impact, and crush injuries. The degree of bony comminution and soft tissue damage is directly related to the energy of trauma[5]. In older patients with unstable ankle fractures, surgical intervention *vs* application of a contact cast is reported to have an equivalent functional outcome at six months[6]. Surgical intervention is still the first line of management for the elderly with open fractures to minimize the risk of infection[7]. Among the elderly, an open ankle fracture can reduce quality of life by more than half, sharing a similar characteristic to a fragility fracture[8]. Typically, fractures of the hip, pelvis, spine, humerus, wrist, rib, clavicle, scapula, or sternum are described as osteoporotic fractures[9,10]. The incidence of ankle fractures does not increase with age, excluding them from the osteoporotic fracture class[11,12]. Minimal data on the clinical outcome of open ankle fracture management in patients older than 70 is available[13].

The primary aim of this study is to describe the clinical outcomes following an open ankle fracture in patients older than 70. Our secondary aim is to look at predictors of poor outcomes in this age group.

## MATERIALS AND METHODS

Following local research and audit department registration, 22 years of prospectively collated data from an electronic database in a district general hospital (DGH) were reviewed. All patients older than 70 years with an open ankle fracture requiring surgical intervention were identified. Demographic information, the nature, and the number of surgical interventions were collated. All open fractures were classified according to the Gustilo and Anderson classification[14] and the number of malleoli involved[15].

Complications, including surgical site infection (SSI), venous thromboembolic events (VTE) during hospital stay, and mortality rate at 30 d and one year, were reviewed. The presence of comorbidities, including diabetes mellitus, a history of cancer, and previous thromboembolic disease, and their relationship to poor outcomes, were evaluated.

Statistical analysis was performed using R 4.2.2 (R foundation). With patient factors as explanatory variables, logistic regression was used to predict any wound complication. A general linear model was chosen to identify variables that are predictive of an increased length of hospital stay. Survival analysis was performed with follow up time from admission

and death due to any cause as endpoint. The log-rank test was used to compare variables influencing survival. For all statistical analyses, a *P* value < 5% was considered significant.

## RESULTS

There were 37 patients older than 70 years who underwent surgical intervention after an open ankle fracture. The median age was 84 years (range: 70-98), with 30 females (median age: 84, range: 70-97 years) and seven males (median age: 74, range: 71-98 years).

Twenty-nine patients (78%) sustained bimalleolar ankle fractures; four patients had unimalleolar and another four had trimalleolar ankle fractures. An open wound over the medial malleolus was seen in 89% of the patients. Eight patients had a Gustilo-Anderson Type I fracture, and 24 patients had Type II, with the remaining five patients having Type III. The ankle joint was dislocated at initial assessment in 86% of cases (Table 1). There were no sex differences in the type of ankle fracture sustained or in the incidence of complications (Table 2).

Thirty-two patients (86%) had surgery within 24 h of injury, four underwent surgical intervention within 48 h, and one patient had surgery after six days due to a late presentation to the emergency department. Two patients were allowed to put partial weight on the surgical site following surgery.

The remaining 35 patients were advised to initially mobilize non-weight bearing on the operated site.

All 37 patients had wound washout and debridement at initial surgery. Twenty-one (57%) patients had primary closure, and 25 (68%) underwent definite fixation in the first sitting. Of the 37 patients, 16 wounds (43%) were left to heal by secondary intention. Of these, three patients later required a split skin graft, and seven required vacuum assisted closure (VAC) therapy application to achieve skin closure (Figures 1 and 2).

Out of 16 wound complications, eight were managed with regular dressing changes and antibiotics (superficial SSIs).

The other eight patients required further washout in the operating theatre (deep SSIs). Four patients with deep SSIs required multiple washouts. One of these patients needed to have the metalwork removed for the wound to heal. The maximum number of operations one patient had was nine (requiring washouts and VAC dressing changes). The median number of operations patients with deep SSIs had to undergo was three (range: 2-9). Table 3 describes the instances where either primary or secondary closure was chosen at the initial surgical intervention (Table 3).

The overall mortality rate in this study was 59%. Out of 37, seven (19%) patients died within one year of the open ankle injury. The 30-d mortality rate was 8%, with the 0-year mortality rate at 57%. The median length of stay in the hospital was 26 d (range: 3-84) (Table 4).

The overall mortality rate in this study was 59%. Out of 37, seven (19%) patients died within one year of the open ankle injury. The 30-d mortality rate was 8%, with the 0-year mortality rate at 57%. The median length of stay in the hospital was 26 d (range: 3-84) (Table 5).

## DISCUSSION

This is a retrospective study that evaluates the outcome of patients older than 70 who had surgical treatment for an open ankle fracture. Previously, Schermann *et al*[16] looked at predisposing factors and associated mortality in patients older than 65 years with open ankle fractures. Wijendra *et al*[8] reviewed outcomes in low-energy open ankle fractures in patients aged 27-100 (mean: 73). We assessed the clinical outcome in this group of patients based on the rate of complications and the number of operations undertaken. Patients requiring multiple operations had a longer hospital stay (median: 26 d, range: 5-84 d). All these patients were initially managed per the BOA Standards for Trauma guidelines[7] for open fractures.

In our study, four out of five Type III open fractures required multiple operations due to wound complications. These results are similar to the meta-analysis by Kortram *et al*[17] who described the Gustilo-Anderson classification Type III open fracture as a statistically significant risk factor for developing infectious complications. Thangarajah *et al*[18] showed SSI after fixation to be higher in patients with bimalleolar fractures. However, our study did not show any such relationship. We found that two out of four trimalleolar ankle fractures had a primary closure at the initial operation, while three unimalleolar ankle fractures required multiple operations due to wound complications.

Forty-five percent of patients presenting with an open bimalleolar fracture had definite fixation and primary closure.

The outcome and complication rates after an open ankle fracture dislocation are multifactorial. Factors include multiple comorbidities, the patient's age, and wound contamination. These findings are similar to Frank *et al*'s work on dislocated ankles[19].

Comparing the clinical outcomes of patients who had primary closure *vs* delayed closure, none of the 21 patients with primary closure and definite fixation required a second operation. Eight patients in this group developed superficial wound infections that could be managed with antibiotics. All patients with external fixation as primary fixation required a split skin graft at a later setting. These patients had the longest length of stay in the hospital. Patients requiring VAC dressing to achieve skin closure were at high risk for deep infections and required multiple washouts in the operating theatre. These findings align with the work done by Ovaska *et al*[15] and Wijendra *et al*[8]. We did not find any influence of the fracture pattern or fixation type on clinical outcomes.

Mortality among patients who are older than 65 with open ankle fractures has been reported at about 23%-27% during the first year postoperatively[16]. The mortality rate in our study was 19% at 12 mo and 57% at 10 years. Patients with multiple comorbidities had poor survival. Patients on anticoagulants or antiplatelets medication or patients with a cardiac

**Table 1** Description of clinical features of open ankle fractures in patients > 70 years old

Clinical feature	Number of patients, n (%)
1 Mechanism of injury	
Road traffic accident	4 (11)
Falls	33 (89)
2 Classification of ankle injuries[23]	
Unimalleolar	4 (11)
Bimalleolar	29 (78)
Trimalleolar	4 (11)
3 Site of open wound	
Medial	33 (89)
Lateral	1 (3)
Anterior	1 (5)
Medial + lateral + anterior	1 (3)
4 Gustilo-Anderson classification[24]	
Type I	8 (22)
Type II	24 (65)
Type III	5 (13)
5 Joint dislocation at initial assessment	
Yes	32 (86)
No	5 (13)

**Table 2** Male vs female characteristics, n (%)

Gender	Number of patients (n = 37)	Open fracture classification	Number of operations	Complications
Male	7 (19)	Type I = 3; Type II = 3; Type III = 1	Range - 1 to 7; Median - 2	Superficial SSI - 2; Deep SSI - 3
Female	30 (81)	Type I = 21; Type II = 5; Type III = 4	Range - 1 to 9; Median - 2	Superficial SSI - 5; Deep SSI - 6

SSI: Surgical site infections.

**Table 3** Type of wounds and joint congruency vs type of closure at initial surgical intervention

Type of wound	Total No. of patients (%)	Primary closure (%)	Secondary (%)	Closure
Gustilo-Anderson classification Type I	8 (22)	7 (87)	1 (13)	
Gustilo-Anderson classification Type II	24 (65)	13 (54)	11 (46)	
Gustilo-Anderson classification Type III	5 (13)	1 (20)	4 (80)	
Dislocated joint	32 (86)	20 (62)	12 (37)	
Congruent joint	5 (13)	1 (20)	4 (80)	
Medial wound	33 (89)	19 (57)	14 (42)	
Lateral wound	1 (3)	1 (100)	0	
Anterior wound	2 (5)	0	2 (100)	
Medial + lateral + anterior wound	1 (3)	1 (100)	0	

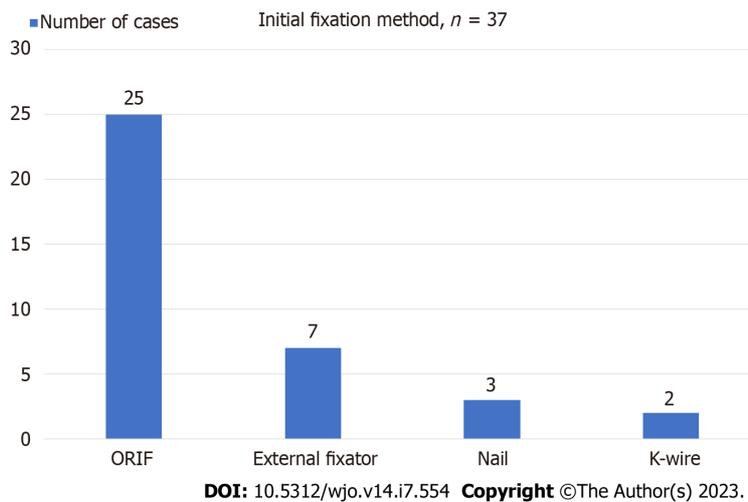
**Table 4 Predictors of poor outcome in patients with open ankle fractures > 70 years old**

No.	Predictors	Number of patients (%)	P value
1	Diabetes mellitus	9 (24)	0.041
2	Anticoagulants/Antiplatelets intake: Warfarin/ Apixaban; Aspirin/ Clopidogrel; Dual antiplatelet therapy	20 (54); 9 (45); 9 (45); 2 (10)	
3	Cardiac history (IHD, AF)	21 (57)	0.045
4	Chronic kidney disease	12 (32)	
5	Cancer history	8 (22)	0.008
6	History of thromboembolic disease	3 (8)	0.001
7	Steroids intake	9 (24)	0.75

IHD: Ischemic heart disease; AF: Atrial fibrillation.

**Table 5 Male vs Female predictors of poor outcome (%)**

Gender	Diabetes mellitus	Anticoagulants/Antiplatelets intake	Cardiac history	Chronic kidney disease	Cancer history	History of thromboembolic disease	Steroids intake
Male	2 (28)	3 (43)	3 (43)	1 (14)	4 (57)	0	0
Female	7 (23)	17 (57)	18 (60)	11 (37)	4 (13)	3 (10)	9 (30)

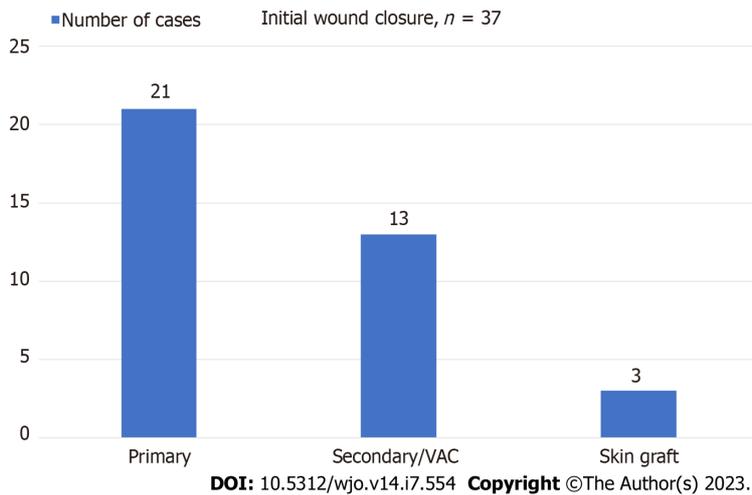


**Figure 1 Surgical Interventions performed in patients > 70 years old presenting with open ankle fractures.**

history had a worse outcome. This is likely due to the poor blood supply to the limb, which disrupts the wound-healing process. In our study, 20 patients were on anticoagulation due to a history of ischemic heart disease or atrial fibrillation. Three patients had a history of pulmonary embolism or deep venous thrombosis. These outcomes are similar to the work done by Schermann *et al*[16] and Toole *et al*[20], who also concluded that ischemic heart disease, chronic kidney disease, diabetes, and peripheral vascular disease are variables for mortality in the elderly population. Deep infection (8%) and skin necrosis (14%) were the most common complications after immediate internal fixation in open ankle fractures. Minimal literature is available on the outcomes of definitive treatment in patients with open ankle fractures[16]. In our study, two patients had a thromboembolic event.

Our results are compatible with other studies that suggest that definite fixation in the initial operation is safe, has fewer complications, and leads to a shorter hospital stay[8,21,22]. An external fixator is best employed in patients with inadequate soft tissue coverage.

There are limitations to this study. First, the total number of patients is relatively small. We operated on nearly 2500 ankle fractures over this 22 year period. This is mainly because this study is undertaken in a DGH, not an orthoplastic center. Second, this study has some selection bias. The data was collected from a database, and medical notes were reviewed retrospectively. The database was used logistically in generating theatre lists and acted as an accurate source of data. However, the surgery description may not always have included an open wound, which could have led to underre-



**Figure 2** Soft tissue procedures performed in patients > 70 years old presenting with open ankle fractures. VAC: Vacuum assisted closure.

porting.

## CONCLUSION

An open ankle fracture in a patient older than 70 years of age has at least a 20% chance of requiring repeated surgical intervention due to deep SSI. The presence of a cardiac history appears to be the main predictor for wound complications.

## ARTICLE HIGHLIGHTS

### Research background

There is no data on the clinical outcomes of patients older than 70 admitted with open ankle fractures. This study sets the foundation for future research trials in elderly population.

### Research motivation

This is the only study looking at patients older than 70 with open ankle fractures. This study highlights the multiple factors which can predict the poor outcome in this age group with open ankle fractures. There is no consensus on the best management strategy for these injuries in this population.

### Research objectives

The overall objective of this study is to look at the predictors of poor clinical outcome in patients older than 70 with open ankle fractures.

### Research methods

This is a retrospective observational study performed on 22 years of prospectively collated data from an electronic database in a district general hospital. We used R 4.2.2 (R foundation) to perform statistical analysis.

### Research results

We identified 37 patients above 70 years of age admitted over the period of 22 years with an open ankle fractures. Sixteen patients developed deep surgical site infections, with 4 requiring multiple wash outs. Eight patients developed superficial surgical site infections and were managed with antibiotics and regular dressing change. The 10 years mortality rate in this age group was 57%. The presence of a cardiac and stroke history, cancer, or prolonged inpatient stay were found to be the predictors of mortality.

### Research conclusions

We concluded that there is a 20% risk of patients above 70 years of age with open ankle fracture requiring repeated surgical intervention. The need for repeated surgical interventions is mainly due to deep Surgical Site Infections. We identified multiple predictors for worse outcome. However, the presence of a cardiac history appears to be the main predictor for wound complications.

## Research perspectives

This study sets the foundation for further research trials in patients above 70 years of age.

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## FOOTNOTES

**Author contributions:** Zahra W, Seifo M, and Cool P contributed to data collection; Zahra W and Cool P contributed to data analysis; Cool P and Ford D contributed to supervision; Ford D and Okoro T contributed to project idea; Zahra W contributed to writing the manuscript and literature review; Seifo M contributed to review the manuscript; Okoro T contributed to overall supervision.

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