

Surgical Site Infections Following Open Reduction and Internal Fixation of Ankle Fractures

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Abstract: *Background:* Ankle fracture fixation is one of the most commonly performed orthopaedic procedures. Although the results are generally favourable, complications are not uncommon, particularly in the case of surgical site infections. These have considerable impact on both postoperative morbidity and healthcare costs. Paradoxically, there is a paucity of literature studying patients who sustain them and therefore little is known about ways such occurrences can be minimised. The purpose of this study was to determine the infection rate following ankle fracture fixation and elucidate variables in their causation.

Methods: We retrospectively reviewed 50 consecutive patients who underwent open reduction and internal fixation of an ankle fracture. The study group consisted of 26 females and 24 males with an average age of 43 (Range 16-82) years.

Results: Problems with superficial infections were noted in seven patients and deep infections in five. Of the latter, four patients underwent further surgery including two that had their metal work removed. With use of the Fisher's exact test we determined that only smoking and a bimalleolar fracture pattern were significant variables, having p-values of 0.02 and 0.04 respectively.

Conclusion: We recommend that patients with ankle fractures who either have a history of smoking and/or bimalleolar injury be counselled about the potential risk of infection and its implications on their functional recovery. The ability to identify patients at risk of such problems highlights the need for caution during the perioperative period so that care strategies may be altered to facilitate recovery.

Keywords: Ankle fracture, open reduction internal fixation, infection, complication.

INTRODUCTION

Fractures of the ankle are amongst the most common injuries treated by an orthopaedic surgeon [1, 2]. With literature indicating that open reduction and internal fixation (ORIF) yields better results than conservative management, there has been an increasing trend towards operative intervention [3-6].

The aim of internal fixation is to stabilise bony fragments and permit early movement, but the onset of a surgical site infection (SSI) may lead to a poor outcome [4, 7]. Notwithstanding this, they have been proven to prolong the length of hospital stay by two weeks per patient and double re-hospitalization rates [8]. It is therefore imperative that such occurrences are minimised.

Whilst some authors have investigated the long-term results following fracture few have focussed on SSIs. The purpose of this study was to therefore retrospectively review the rate of infection following ankle ORIF and determine factors in their causation. We hypothesised that the infection rate would be relatively low other than in certain patient subgroups such as diabetics and the elderly. The

identification of patients susceptible to such problems is useful for evaluating operative indications and the need for further preventative measures.

MATERIAL AND METHODOLOGY

We undertook retrospective analysis of all patients who received ORIF for an ankle fracture between January and September 2005. The inclusion criteria were therefore all ankle fractures that underwent surgical fixation during the study period and for which complete medical charts, operative records and radiographs were available for. All cases were treated in a trauma unit within a large university teaching hospital.

A consecutive series of 50 skeletally mature patients were identified using the computerised theatre register at our institution. The cohort consisted of 26 females and 24 males with an average age of 43 (Range 16-82) years. Medical charts were then reviewed to identify preoperative details including patient age, gender, mechanism of injury, type of injury (open or closed), anatomical classification of the fracture, comorbidities, medication, smoking history, grade of operating surgeon and the delay to surgery. Initial recording of the data onto medical charts was performed by several members of different orthopaedic surgical teams, whereas the retrospective analysis was performed solely by the authors.

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A similar intraoperative protocol was used throughout the study group, with orthopaedic residents or attendees performing all procedures during a dedicated trauma list within the confines of a designated clean air trauma theatre. Surgical fixation was carried out when the overlying skin exhibited wrinkling. This was based on clinical assessment during a ward round on the morning of the proposed surgery, or a preoperative ward round the evening before surgery was carried out. Prophylactic intravenous cefuroxime, as specified in the hospital formulary, was used in all cases. All operations were performed under tourniquet control. Operations were carried out under the supervision of several orthopaedic attendees. As such, while the method of wound closure was uniform (layered closure, with vicryl and nylon/clips) the specific choice of material was at the discretion of the supervising surgeon. To evaluate the stability of the fixation, intraoperative image intensification was used in all cases. During the postoperative period the following parameters were assessed: onset of SSIs, need for readmission, need for further surgery and the final outcome.

For those cases where the clinical suspicion of a wound infection was high, the classification of superficial and deep SSIs was used. Confined to only the skin and subcutaneous tissue layers, the former was identified by an acutely inflamed superficial incision. Alternatively, a deep infection was characterised by involvement of the underlying muscle and fascia with the production of a purulent discharge and/or abscess. It was recognised clinically by a deep incision that spontaneously dehisced or necessitated exploration due to either pyrexia or localised pain [9]. In cases where wound discharge cultured micro-organisms the advice of the microbiology department was sought in order to institute appropriate antimicrobial therapy.

The Fisher's exact test was used for statistical evaluation of categorical data with the aim of finding factors associated with infection. A p-value of < 0.05 was considered to be significant.

RESULTS

The majority of patients presented to hospital within two (Range 0-19) days of injury and on average, were operated on within five (Range 0-19) days. The mean length of hospital stay was 12 (Range 2-60) days. A unimalleolar injury was found in 24 patients, bimalleolar in 16 and trimalleolar in 10. There were 48 closed and two open fractures. These were predominantly due to low energy falls, as was noted in 43 patients. The remaining cases were due to a sporting event in four patients and road traffic accident in three. 38 of 50 patients were followed up to 34 months following hospital discharge with the remaining 12 not seen again for problems pertaining to their operation.

Medical problems were frequently reported with 13 having one system disease, nine having two-system disease and four reporting three-system disease. The most common conditions were hypertension, asthma, diabetes and epilepsy. The remaining 24 patients were free from chronic disease. Eight of the ten patients with trimalleolar fractures had comorbidities in contrast to eight of the 24 with unimalleolar injuries (Table 1). Furthermore, the age of the trimalleolar group was higher than the unimalleolar subset. Residents performed many of the fixations under supervision as

necessary, with the attending surgeon being the primary surgeon in six cases.

Table 1. The Relationship Between the Presence of Comorbidities and Type of Fracture

Type of Fracture	Number of Cases	Number with Comorbidities	Mean Age (Range)
Unimalleolar	24	8	38 (17-56)
Bimalleolar	16	10	55 (30-79)
Trimalleolar	10	8	55 (34-77)

We noted 15 complications within the study group (Table 2). These comprised of seven superficial infections, five deep infections, two fixation failures and one case of chronic regional pain syndrome. Patients who were diagnosed to have superficial infections were all treated as an outpatient with oral antibiotics but without microbiological confirmation of an organism. Those with a diagnosis of a deep infection though were all readmitted to hospital and had micro organisms isolated. Within this group, four patients underwent further surgery including a washout and debridement in two cases and removal of metal work in a further two. The final patient received intravenous antibiotics. All patients that required further surgery healed satisfactorily.

In order to determine factors that could be implicated in the occurrence of infections the Fisher's exact test was used. A history of smoking and bimalleolar fracture were the only statistically significant variables with p-values of 0.02 and 0.04 respectively. The p-values for all other variables examined can be found in Table 3.

DISCUSSION

Internal fixation is the foremost treatment employed for ankle fractures [6]. Results are generally favourable with the majority of patients having a good functional outcome [3, 10]. There are instances though when complications occur, some of which necessitate in further surgery [11]. There is a paucity of literature investigating this however, and the studies that have been conducted vary considerably.

In a retrospective study by Beauchamp *et al.* [6] 71 patients who underwent ORIF of an ankle fracture were reviewed. Wound infections were noted in 11% but no causative factors could be identified. In a recent study by SooHoo *et al.* [12] the complication rate following ORIF for 57,183 ankle fractures was reviewed. Open injury, diabetes and peripheral vascular disease were recognised as being strong risk factors. Accordingly, the incidence of wound infections was 1.44% in the overall study population, yet in those with complicated diabetes was 7.71%. Admittedly though, the authors did not investigate the effect of smoking on such occurrences. Furthermore, unlike in the present study, the fracture pattern was not significant.

The elderly population have long been considered to have a greater risk of postoperative morbidity. To further investigate this, Srinivasan *et al.* [13] reviewed 74 elderly patients who had received ORIF for an ankle fracture in order to establish the rate of complications. Deep infection

Table 2. Demographic and Clinical Data of All Patients that Sustained Complications

Complication	Age	Gender	Classification of Fracture	History of Smoking	Comorbidities (Number of Body Systems Involved)	Grade of Operating Surgeon	Delay to Surgery (Days)	Need for Readmission	Treatment	Outcome
Superficial infection	37	Female	Unimalleolar	No	0	Resident	4	No	Oral antibiotics	Healed
Superficial infection	40	Female	Bimalleolar	Yes	1	Resident	9	No	Oral antibiotics	Healed
Superficial infection	60	Female	Bimalleolar	No	1	Resident	7	No	Oral antibiotics	Healed
Superficial infection	45	Male	Bimalleolar	No	2	Resident	0	No	Oral antibiotics	Healed
Superficial infection	56	Female	Bimalleolar	No	0	Resident	4	No	Oral antibiotics	On-going
Superficial infection	63	Female	Bimalleolar	No	0	Resident	10	No	Oral antibiotics	Healed
Superficial infection	39	Female	Trimalleolar	Yes	3	Resident	4	No	Oral antibiotics	On-going
Deep infection	21	Male	Unimalleolar	Yes	0	Resident	0	Yes	Debridement and washout	Healed
Deep infection	55	Male	Unimalleolar	Yes	1	Resident	3	Yes	Debridement and washout	Healed
Deep infection	80	Female	Bimalleolar	No	2	Resident	0	No	Intravenous antibiotics	Healed
Deep infection	51	Male	Bimalleolar	Yes	0	Resident	10	Yes	Removal of metal work	Healed
Deep infection	51	Female	Bimalleolar	Yes	2	Resident	12	Yes	Removal of metal work	On-going
Fixation failure	53	Female	Trimalleolar	Yes	2	Resident	9	Yes	Further corrective surgery	On-going
Fixation failure	25	Male	Unimalleolar	No	0	Resident	3	Yes	Redo fixation plus bone grafting	Healed
Chronic regional pain syndrome	34	Female	Unimalleolar	Yes	0	Resident	0	Yes	Removal of metal work	On-going

was noted in 1% and delayed wound healing in 9%. Conventionally regarded as a vulnerable subgroup of patients, elderly individuals were in actual fact noted to have a good outcome. Conversely, Anderson *et al.* [2] conducted a retrospective case control study of ankle fractures in the elderly and concluded that patients over the age of 65 years were at a significant risk ($p < 0.007$) of postoperative complications when compared to younger patients.

In the current study, SSIs formulated the majority of postoperative problems. Superficial lesions were found in seven patients whereas deep infections were diagnosed in five. The latter were also associated with further surgery in four cases, including removal of the fixation device in two patients and washout and debridement in the remaining two. Wound healing problems in this area are traditionally thought to be due to factors such as delay to surgery, degree of soft tissue damage, comorbidities such as diabetes,

tourniquet use and advanced age of the patient [8, 9, 14-17]. Our results however, only implicate smoking and a bimalleolar fracture.

We acknowledge that the rate of SSIs reported here are considerably higher than those quoted in the literature which range from 3-8% for superficial infections and 1-6% for deep ones [3, 13, 18, 19]. Since there is evidence to suggest that current and previous exposure to cigarette smoke is a potent risk factor for infection, it is plausible that the high proportion of current and former smokers within the study group may be responsible for this [20]. This is also a direct reflection of the high prevalence of smokers within the geographical location from which the sample was taken. Owing to the small sample size in the current study, little insight into the effect comorbidities such as diabetes have on infection rate could be evaluated. Whilst it is evident that the majority of cases were performed by residents, this was not a significant variable.

Table 3. Variables Examined and Corresponding P-Values

Variable	p-Value
Smoking	0.02
The presence of comorbidities	0.51
Grade of the operating surgeon	1.00
Unimalleolar fracture	0.33
Bimalleolar fracture	0.04
Trimalleolar fracture	0.42
Delay to surgery	0.51
Gender	0.33
Mechanism of Injury:	
Low energy fall	0.17
High energy fall	1.00
Sport	0.56
Open/Closed injury	0.15

Cigarette smoking is a well recognised risk factor for infection but there is little evidence to suggest it has a similar role in the incidence of SSIs following ankle ORIF [10, 20]. Egol *et al.* [10] prospectively followed 232 patients treated surgically for an ankle fracture in order to evaluate predictors of short-term functional outcome. A history of smoking was not deemed to be a significant variable. Conversely, Mangram *et al.* [21] conducted a randomised control trial comparing two groups of smokers undergoing elective hip and knee replacements. The intervention group received intense smoking cessation whereas the control group did not. There was an 83% reduction in wound complication risk in the intervention group when compared to the control (5 vs 31%). Furthermore, in a study by Bhandari *et al.* [22] poor functional outcomes were noted in those who smoke.

Considerable work has been carried out on the outcome following different patterns of ankle fracture. The majority of research concludes that bimalleolar fractures are associated with poor results, yet there has been no association to date with the development of SSIs. In a long-term study by Day *et al.* [23], 25 patients with bimalleolar fractures were followed up for 10-14 years after their initial injury. Poor outcomes were recorded in 24% of the group. Similarly, in a prospective study of 456 patients who had sustained an ankle fracture, Tejwani *et al.* [24] noted both a worse functional outcome and higher rate of elective hardware removal in patients with bimalleolar injuries. A comparable result was also found by Kennedy *et al.* [25]; however other predictors of poor outcome were also noted. These included the severity of the initial injury and advanced age of the patient.

The results presented in the current study are not applicable to all ORIF procedures and as such, the conclusions cannot be applied ubiquitously to orthopaedic practice. To overcome this, future studies should assess the incidence of SSIs related to ORIF of many different types of fractures and in doing so, ways in which they can be minimised on a larger scale may be determined. Other limitations of our study are predominantly due to the method

of data collection and study design. Sole reliance upon medical records may jeopardise the reliability of the results due to inaccurate recording of data. Details of pre and postoperative parameters such as soft tissue and bony abnormalities may not have been classified as attentively as they would have been done in a prospective study. We do not also have data on how many of the ankles were dislocated on presentation, and needed manipulation prior to surgery. Fractures associated with dislocations are likely to be associated with more soft tissue trauma. Moreover, outcomes measured retrospectively are subject to the bias of their surrogates. It is feasible that due to several observers recording details of the wounds, inconsistencies with the diagnosis of an infection may have occurred. It is therefore difficult for one to be certain that all positive cases were correctly identified.

CONCLUSIONS

Our small study showed a correlation between the development of SSIs and either smoking and/or bimalleolar fractures. SSIs have a profound effect on the outcome following surgery and as seen here, can lead to further procedures. Accordingly, we recommend that patients with ankle fractures who either have a history of smoking and/or bimalleolar injury be counselled about the potential risk of infection and its implications on their functional recovery. The ability to identify patients at risk of such problems highlights the need for caution during the perioperative period so that care strategies may be altered to facilitate recovery.

AUTHORS' CONTRIBUTIONS

TT: First author, initiation of project, data analysis and manuscript preparation.

BN and PSVP: Data analysis and manuscript preparation.

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