Injury, Int. J. Care Injured 46 (2015) 1650–1655

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Contemporary demographics and complications of patients treated for open ankle fractures

Mikko T. Ovaska [a,*], Rami Madanat [b], Maija Honkamaa [a], Tatu J. Mäkinen [c]

[a] Department of Orthopaedics and Traumatology, Helsinki University Central Hospital, Topeliuksenkatu 5, 00260 Helsinki, Finland
[b] Massachusetts General Hospital and Harvard Medical School, Boston, MA, USA
[c] Mount Sinai Hospital and University of Toronto Toronto, ON, Canada

ARTICLE INFO

Article history:
Accepted 10 April 2015

Keywords:
Open ankle fracture
Demographic
Complication
Deep infection
Wound necrosis

ABSTRACT

Open ankle fractures are rare injuries with a high likelihood of wound complications and subsequent infections. There is limited information about the complications and outcomes of these injuries in different age groups. The aim of this study was to assess the contemporary demographics and complications related to this injury. We performed a chart review of all the 3030 patients treated for ankle fractures at a Level 1 trauma centre from 2006 to 2011. 137 (4.5%) patients had an open ankle fracture. The demographic data, injury mechanism, comorbidities, and fracture type were collected. Treatment, complications, length of stay and number of outpatient visits were also recorded. The mean age of the patients was 60 years and 56% were women. Most fractures were Weber type B with a medial sided wound (93%). Only 20% of the fractures were the result of high-energy trauma, and 31% were Gustilo grade III injuries. Immediate internal fixation was performed in 82% of patients, and the wound was primarily closed in most cases (80%). The incidence of postoperative wound necrosis and deep infection was 18% and 17%, respectively. There were more deep infections if pulsatile lavage was used during the wound debridement ($p = 0.029$). About 14 (10%) patients required a flap reconstruction to cover the soft-tissue defect. Every other patient (54%) had a complication, and 21 patients (15%) suffered a long-term disability related to the injury. The number complications did not differ for nighttime and daytime operations ($p = 0.083$). High-energy injuries were more common in younger patients ($p < 0.001$) and these patients also had more lateral sided open wounds than older patients ($p = 0.002$). Interestingly, younger patients also had significantly more complications ($p = 0.024$), suffered more often from chronic pain ($p = 0.003$), and required more flap reconstructions ($p = 0.026$), reoperations ($p = 0.026$), and outpatient clinic visits ($p = 0.006$). Open ankle fractures have a high complication rate and often require multiple surgical procedures. In young patients these injuries are more likely to be the consequence of high-energy trauma leading to more complications and subsequently increased healthcare resource utilisation.

Introduction

Open ankle fractures are rare injuries with a reported incidence of only 3% of all ankle fractures [1]. It was recently shown that the incidence of more complex ankle fracture patterns in elderly people is increasing [1]. With an ageing population and an increasing number of active octogenerians, the number of open ankle fractures is expected to increase [2].

An open fracture is a known risk factor for wound complications [3–5]. Furthermore, the rate of postoperative infections increases with higher Gustilo grades reflecting the more severe insult to soft-tissues [6–10]. In the limited literature on open ankle fractures, most studies have focused on high-energy injuries in young male patients [7,11,12]. Additionally, the main focus of these studies has been the timing of the internal fixation [7,11,13,14]. There is scant information about open ankle fractures in the elderly, and limited data regarding the complications and outcomes of these severe injuries in different age groups.

The present study aimed to assess the contemporary demographics and complications of patients treated for open ankle fractures. Additionally, the study aimed to determine if the age of the patient influences the degree of associated soft-tissue injury and the rate of postoperative complications. We hypothesised that open ankle fractures in elderly patients are more commonly due to

* Corresponding author. Tel.: +358 50 427 4509; fax: +358 9 471 87481.
E-mail address: mikko.ovaska@hus.fi (M.T. Ovaska).

http://dx.doi.org/10.1016/j.injury.2015.04.015
0020–1383/

low-energy trauma when compared to younger patients. Our second hypothesis was that younger patients are more likely to suffer from complications related to their fractures since these are more likely to be the consequence of high-energy trauma.

Materials and methods

We performed a chart review of all ankle fractures that were surgically treated at a Level 1 trauma centre from January 2006 through December 2011. Our Level 1 trauma centre is located in an urban area with a catchment population of 1.9 million persons, population density of 170 per km^2 and surface area of 9568 km^2. The current life expectancy for females and males living in the catchment area is 84 years and 78 years, respectively. All patients who had undergone operative treatment for an ankle fracture were identified by querying the hospital surgical procedure database for diagnoses coded using the International Classification of Diseases, Tenth Revision (ICD-10) as fibular fracture (S82.4), medial malleolar fracture (S82.5), lateral malleolar fracture (S82.6), bimalleolar or trimalleolar fracture (S82.8), and with the procedure code for internal or external fixation of an ankle fracture. Approval from our institutional review board was obtained prior to the beginning of the study. Eligible operations were restricted to those performed primarily at our institution and in patients 16 years of age or older. We identified 3041 ankle fracture operations in 3030 patients. The charts of all 3030 patients were scrutinised, and eventually 137 patients with open ankle fractures were identified. Altogether, 57 surgeons performed the 137 open ankle fracture operations during the 10-year study period.

A standardised treatment protocol was used during the study period. In the emergency department, the open fracture wound was copiously irrigated with saline and covered with sterile dressings. Intravenous antibiotics (second-generation cephalosporin) were administered as soon as possible to all patients. Aminoglycoside was added for cases with Gustilo grade III open injuries. The selection of antibiotics was based on the prevailing national guidelines. The antibiotics were continued for three days after primary wound closure or until secondary wound closure was performed with the aim of preventing overt bacterial colonisation of the open wound. The ankle was immobilised in a well-padded splint. Wound debridement and fracture reduction with internal or external fixation were performed as emergency, and standard AO-principles were applied in skeletal stabilisation. Minimally invasive techniques such as fibular nailing or percutaneous screws were not utilised during the study period. The open fracture wound was primarily closed after debridement, if the wound bed was considered clean and the skin closure could be done without significant tension on the wound edges. If the wound was not amenable to primary closure, it was left open and covered with moist sterile dressings and adhesive drape. Thereafter, secondary wound closure was planned by a reconstructive plastic surgeon. According to our protocol, if there was an extension of the injury zone after the first debridement indicated by developing wound edge necrosis, a second-look debridement was conducted for further tissue excision. If there were clinical signs of an infection (e.g. increasing drainage and redness), a new bacterial culture was taken and the antibiotic regimen was modified based on the sensitivity report. A secondary wound closure was performed when the signs of infection were absent in the wound. The secondary wound closure consisted of delayed primary closure, split-thickness skin grafting or flap reconstruction depending the complexity of the soft-tissue defect. All patients with adequate vascular status regardless of patient age were offered a flap reconstruction based on the need for soft tissue coverage.

Medical, operative, and radiological records of all 137 patients were reviewed in order to identify various characteristics of the patients and their injuries. Records from other medical specialties were also assessed. We collected the demographic data and information about the possible comorbidities of the patients (diabetes, peripheral vascular disease, alcohol abuse, tobacco use, the presence of a neurologic or psychiatric disease). The injury mechanism (high-energy or low-energy), fracture type (Danis–Weber classification; uni-, bi-, or trimalleolar fracture), Gustilo classification of the open injury (I–III), and size as well as location (medial or lateral) of the wound were recorded. The delay from injury to antibiotic administration and from admission to surgery was obtained. The time of day of surgery (08–16, 16–24, or 24–08 h), use of a tourniquet, and use of high-pressure lavage were collected. The number of patients treated with immediate internal fixation was recorded. The treatment of the open injury at the primary operation (wound closure, wound left open, flap reconstruction) was also collected. In cases with delayed wound closure, the time the wound remained open (defined as time from injury to definitive wound closure) was recorded. It was noted, how many of these patients eventually required flap reconstruction. The number of reoperations, the duration of in-hospital stay, the number of outpatient clinic visits, and the number and type of complications (compartment syndrome, wound necrosis, deep infection, thromboembolism, chronic pain, severe post-traumatic arthritis, amputation, death) were collected. Long-term disability was defined as severe chronic pain leading to permanent disability, severe talocrural osteoarthritis (Kellgren–Lawrence grades III–IV), persistent infection requiring amputation, or death related to treatment of an open ankle fracture. Three patients were lost to follow-up following hospital discharge. For the remaining 134 patients the mean follow-up time was 62 months (range 31–101 months).

The data was analysed by an independent biostatistician. Normally distributed continuous variables are described using mean and standard deviation (SD) and non-normally distributed variables using median and interquartile range (IQR). Categorical variables are presented with frequencies and percentages. Chi-square test was used to assess the effect of pulsatile lavage on infectious complications, the association of timing of antibiotics divided into lowest and highest tertiles to the development of deep infection, as well as the number of complications in patients operated during daytime or nighttime stratified according to Gustilo grades. Mann–Whitney *U*-test for used to assess the delay from injury to antibiotic administration and from admission to surgery. A two-sample *t*-test was used to compare mean ages between various characteristic groups. The correlation between age and continuous characteristic variables was calculated using Spearman rank-order correlation coefficient. *p*-Values lower than 0.05 were considered statistically significant. Statistical analyses were done using SAS System for Windows, version 9.4 (SAS Institute Inc., Cary, NC, USA).

Results

The incidence of open ankle fractures was 4.5% (137 of 3047 ankle fractures), and the incidence increased during the study period (Fig. 1). Of the 137 patients, 124 (91%) were scene transports and 13 patients were transferred from a Level 2 centre following initial evaluation. The mean age of the patients was 60 years (range 16–97 years), and 54 patients (39%) were over 65 years of age. 56% (77 of 137) of the patients were women (Fig. 1). The right ankle was affected in 57% of patients. The characteristics of the patients are presented in Table 1. Most of the fractures were Weber type B, and the majority of patients (93%) had a medial sided wound with mean size of 5 cm (SD 3 cm). Only 20% (28 of 137) of the fractures were the result of high-energy trauma, and Gustilo grade III soft-tissue injury was present in 31% of the