

### Open Ankle Fractures: What Predicts Infection?

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**Purpose:** Data on the complication rates of open ankle fractures are from small data sets or aggregate data that lack precision and detail. The purpose of this study was to identify the patient, injury, and treatment factors associated with infection of open ankle fractures in a large data set generated from individual chart reviews.

**Methods:** We reviewed the records of a consecutive series of patients presenting to 13 trauma centers with open indirect ankle fractures. Patients with plafond injuries were excluded. We gathered demographic information including: age, gender, BMI (body mass index), smoking history, diabetes, immunosuppressive medications, neuropathy, and OTA fracture type; and treatment variables including: timing and duration of antibiotics, timing of debridement, and method of closure. Infection was defined two ways: first as the combination of superficial or deep purulence, and second with the addition of wound dehiscence. Statistical comparisons were made using Fisher exact and Student t tests for categorical and continuous data.

**Results:** We reviewed 613 patients, (312 male, 301 female) aged 18-96 years (average 52) with an average BMI of 32 who sustained OTA types 44A (11%), 44B (60%), and 44C (29%) open ankle fractures; 433 (72%) were dislocated upon presentation. Average follow-up was 392 days. There were 95 patients with diabetes, of whom 31 were insulin dependent and 37 had documented neuropathy. 22 patients were on immunosuppressive medications. 226 patients (41%) were smokers. Increased BMI, OTA type, immunosuppressive medications, or presence of dislocation were not significantly associated with infection ( $P > 0.05$ ). The overall infection rate in the series was 12% and rose to 17% when including wound dehiscence. Diabetes was associated with an increased risk of infection (24%;  $P = 0.0006$ ) and was 32% when including wound dehiscence ( $P = 0.0002$ ). Smoking ( $P = 0.04$ ) and increasing Gustilo

type ( $P = 0.005$ ) also correlated with infection. The table details the rates of infection by open fracture type. Initial antibiotics were given within 6 hours in 86% and 12 hours in 94% and neither cutoff was associated with infection. There was no difference in the average time to antibiotic administration for those who developed infection versus those who did not (3.8 hours vs 3.7 hours;  $P = 0.95$ ). The time to initial debridement tended to be longer for those who developed purulence ( $P = 0.15$ ). Debridement at >6 hours (17% vs 9%;  $P = 0.03$ ) and >12 hours (21% vs 11%;  $P = 0.003$ ) after injury was associated with infection. Cases that developed infection were closed at an average of 14.2 days versus 3.3 days for those that did not become infected ( $P = 0.004$ ). Primary and delayed primary closure was achieved in 93% of cases. Primary closure resulted in a lower rate of infection ( $P = 0.006$ ). Overall there were 51 cases of malunion, nonunion, and loss of reduction. Infection resulted in a higher rate of these complications ( $P = 0.02$ ).

**Conclusion:** In this large series of open ankle fractures, several patient and injury factors were found to be associated with infection and wound breakdown including diabetes, smoking, and increasing severity of open fracture. We found no association between the timing of initial antibiotics, but all centers were efficient and 86% were given antibiotics within 6 hours of injury, limiting our ability to evaluate this as a factor. However, debridement after 6 hours and 12 hours demonstrated incremental increases in infection rates. Finally, a shorter time to wound coverage and the ability to close the wound primarily were associated with a lower risk of infection.

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**Table: Infection including wound dehiscence by Gustilo type**

Gustilo Type	1	2	3A	3B,C
% Infection	6%	15%	18%	36%

Risk Factors vs. Infection			
NOT Associated with Infection		Associated with Infection	
Factor	P Value	Factor	P Value
BMI	0.22	Diabetes	0.0002
OTA Classification	0.81	Smoking	0.04
Dislocation	0.07	Gustilo Type	0.005
Immunosuppressive Meds	0.18	Time to Debridement	0.02
Time to Antibiotics	0.88	Time to Closure	0.004

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.