

Predictors of Amputation in High-Energy Forefoot and Midfoot Injuries

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Purpose: High-energy forefoot and midfoot injuries are known to be high morbidity events but are poorly described in the literature. Patients with these injuries are challenging clinically as many will ultimately require a decision of limb salvage or amputation. The purpose of this study was to identify risk factors predictive of amputation in high-energy forefoot and midfoot injuries.

Methods: All patients presenting to our Level I trauma facility between January 2005 and December 2014 with a minimum of two foot fractures were reviewed, yielding 1970 unique patients. This cohort was then filtered for patients who sustained multiple fractures of the midfoot and forefoot with high-energy mechanisms, yielding 144 patients with 151 qualifying injured feet. Patient characteristics (age, comorbidities, tobacco use, body mass index [BMI]), fracture and dislocation patterns, and soft-tissue injury severity (open vs closed, Gustilo classification, location of wound, vascular injury, sensory loss) data were collected. Patients were grouped by mechanism into one of 5 categories: (1) falls from height, (2) restrained motorized collisions, (3) unrestrained motorized collisions, (4) direct-contact blunt trauma, and (5) industrial injuries. Operative reports were reviewed for the timing and levels of amputation (transmetatarsal through below-knee amputation [BKA]) at any time in their postoperative course. Cumulative incidence rate of amputation versus days since injury was estimated using a Kaplan-Meier survival analysis. Association between each variable and amputation was evaluated using a univariate Cox proportional hazard model. Statistical significance was set at a P value of <0.05.

Results: The 30-day amputation rate in this cohort was 14.2% (95% confidence interval [CI]: 8.4-19.7) and rose to 20.9% (95% CI: 13.1-28.1) at 1 year post injury (Fig. 1) after which the rate stabilized at that level. Of the 27 amputations, 23 (85.2%) ultimately proceeded to BKA. Variables predictive of amputation were the total number of fractures ($P = 0.01$), open injury ($P < 0.001$) to either the plantar ($P < 0.001$) or dorsal ($P < 0.001$) surface of the foot, Gustilo grade ($P < 0.001$), vascular injury ($P < 0.001$), loss of sensation to any surface of the foot ($P < 0.001$), and injury mechanism ($P = 0.04$). Specific fracture patterns that were predictive of amputation were fracture of all 5 metatarsals ($P < 0.001$) and independently, fracture of the first metatarsal ($P = 0.002$). Variables of interest that were not statistically significant predictors of amputation included the presence of associated fractures of the distal tibia and plafond ($P = 0.35$), the presence of midfoot dislocations ($P = 0.045$), tobacco use ($P = 0.19$), and all patient comorbidities. Hazard ratios (HR; 95% CI) showed that open fractures were 17.3 (5.96–50.05) times more likely to progress to amputation. Each additional fracture of the foot increased the probability of amputation by 25% (1.05–1.49). Fracture of the first metatarsal specifically increased the probability of amputation by a factor of 3.4 (1.57-7.17) while fractures of all five metatarsals increased the probability of amputation by a factor of 9.8 (4.18-22.77). Patients who sustained direct blunt trauma (HR 11.39; 95% CI

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.

1.49-87.17) and industrial (HR 11.73; 95% CI 1.22-112.83) mechanisms of injury were most likely to receive an amputation.

Conclusion: High-energy forefoot and midfoot injuries are associated with a high degree of morbidity; 20% of patients sustaining these injuries proceeded to amputation within 1 year. Using the findings of this hazard model, providers will be able to utilize the presenting characteristics of the injury to counsel patients regarding the severity of their injury and the possible need for subsequent amputation.

Cumulative incidence rate with 95% confidence limits

