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Open Calcaneus Fractures and Associated Injuries

Jacob R. Worsham, MD [1], Mark R. Elliott, MD [1], Anthony M. Harris, MD [2]

[1] Orthopaedic Surgery Resident, Department of Orthopaedic Surgery and Rehabilitation, University of Florida College of Medicine–Jacksonville, Jacksonville, FL
[2] Orthopaedic Trauma Surgery Attending Physician, Department of Orthopaedic Surgery and Rehabilitation, University of Florida College of Medicine–Jacksonville, Jacksonville, FL

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ABSTRACT

Open calcaneus fractures are usually the result of high-energy mechanisms and are associated with other orthopedic and whole body system injures. Understanding the difference between open versus closed fractures is essential for the provider, and they must be vigilant for the associated injuries that present with this condition. We performed a retrospective medical record review of 62 patients (64 calcaneus fractures) with open calcaneus fractures from January 2003 to January 2013 presenting at a level 1 trauma center. Sex, age, laterality, mechanism of injury, wound appearance, initial management, and associated injures were recorded. The most common mechanisms were motor vehicle accidents (35 [56.4%]) and falls from >6 ft (15 [24.1%]). Four (6.4%) patients had a posterior tibial artery transection. Eight (12.9%) patients had a femoral shaft fracture, 14 (22.5%) an ipsilateral ankle fracture, 16 (25.8%) a metatarsal fracture, and 11 (17.7%) had associated midfoot fractures. Of the midfoot fractures, 12 (19.3%) patients had a talus fracture and 5 (8.0%) a cuboid fracture. Spinal fractures were present in 9 (14.5%) of the patients, with lumbar fractures occurring in 6 (9.6%) patients. Fifteen (24.1%) patients had associated upper extremity fractures. Thirteen (20.9%) patients had an associated pulmonary injury, including 8 pneumothoraces. Ten (16.1%) patients had a closed head injury and 6 (9.6%) had an abdominal injury. Fifteen (23.4%) patients were treated with percutaneous wire fixation and 7 (10.9%) with open reduction internal fixation. A total of 44 (68.7%) fractures were treated without internal fixation. Overall, 5 (8.0%) patients with an open calcaneus fracture eventually underwent a below-the-knee amputation. Open calcaneus fractures are severe, high-energy injuries with the potential for considerable morbidity to the patient, given the high rate of concomitant orthopedic and whole body system injuries. Type III open injuries have an increased risk of requiring subsequent amputation. The management of these injuries should include intravenous antibiotics, tetanus prophylaxis, and urgent debridement and irrigation.

Open calcaneus fractures are relatively rare injuries and are typically caused by high-energy axial loading mechanisms, with resultant disruption of the medial hindfoot and soft tissue envelope (1). Despite the severity of this injury and the potential complications, published data describing the associated injuries with open fractures of the calcaneus are lacking. The present study reports on the associated injuries, demographic distribution, and the initial treatment of patients sustaining open calcaneus fractures presenting at a single, level 1 trauma center.

Patients and Methods

From January 2003 through January 2013, all patients sustaining an open calcaneus fracture were identified from a prospectively designed orthopedic trauma database documenting all traumatic injuries. A search of our trauma database using the calcaneus fracture "International Classification of Disease, Ninth Revision" codes (825.0 and 825.1) yielded 742 consecutive calcaneus fractures. A total of 69 (9.2%) were open fractures. Open fractures caused by gunshot wounds were excluded, leaving 64 (8.6%) fractures in 62 patients for investigation. The medical records and radiographs of patients with open calcaneus fractures were retrospectively reviewed after institutional review board approval. Patient sex and age, laterality, mechanism of injury, wound appearance, initial management, associated injures, and complications were recorded. All patients aged 6 to 70 years old who presented to the trauma center at our institution with an acute, open calcaneus fracture were included in the present review.

All patients included in the present review had undergone a full trauma evaluation and initial assessment by traumatologists. Standard radiographs and computed tomography scans of the affected extremities were obtained according to our institution's trauma protocol, including, but not limited to, computed tomography of the head, chest, abdomen, pelvis, and spine. The remaining data were obtained from the medical records of 62 patients who had sustained 64 open calcaneus fractures by reviewing the physical examination and radiographic findings, operative notes, clinic progress notes, hospital progress notes, and other ancillary studies.

Results

The most common mechanisms were motor vehicle accidents (35 [56.4%]) and falls from >6 ft. (15 [24.1%]). Other mechanisms of

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Address correspondence to: Jacob R. Worsham, MD, Department of Orthopaedic Surgery and Rehabilitation, University of Florida College of Medicine–Jacksonville, 655 West 8th Street, ACC Building, 2nd Floor, Jacksonville, FL 32209.
E-mail address: Jacob.Worsham@jax.ufl.edu (J.R. Worsham).

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Table 1
Mechanism of injury and demographics

Mechanism of Injury	No. of Patients (%)	Mean Age (y)	Sex		Male/Female Ratio
			Male	Female	
MVA	34 (54.8)	47.3	14	20	0.7:1
Fall	15 (24.2)	43.8	12	3	4:1
MCC	6 (9.7)	35.0	4	2	2:1
Crush	6 (9.7)	38.7	4	2	2:1
Pedestrian versus automobile	1 (1.6)	30.0	1	0	1:0
Total fractures	64				
Total patients	62				

Abbreviations: MCC, motorcycle accident; MVA, motor vehicle accident.

injury included motorcycle crashes, crush injuries, and pedestrian versus automotive accidents (Table 1). With respect to demographics, 36 of the 62 (58.0%) patients were male and 26 (41.9%) were female. The mean age was 44.1 years (41.3 years in males and 47.7 years in females). The location of the injury was the right lower extremity in 44 (68.7%) open calcaneus fractures and the left lower extremity in 20 (31.2%). A total of 55 (88.7%) patients had a Gustillo type II or type III open calcaneus fracture with a medial-based wound. Bilateral, open calcaneus fractures were present in 2 (3.2%) patients.

A total of 57 (91.9%) patients had $\geq$1 additional orthopedic injuries. Pelvic fractures occurred in 3 (4.8%) patients and acetabular fractures were present in 6 (9.6%) patients. Three (4.8%) patients presented with an associated hip dislocation. Eleven (17.7%) patients had an associated fracture of the femur, including 2 (3.2%) femoral neck fractures, 1 (1.6%) intertrochanteric femur fracture, and 8 (12.9%) femoral shaft fractures. Tibial fractures occurred in 12 (19.3%) patients, including 5 (8.0%) open tibial plafond fractures. Fourteen (22.5%) patients had ipsilateral ankle fractures. Twelve (19.3%) patients had fractures involving the talus. Midfoot fractures occurred in 11 (17.7%) patients, including 5 (8.0%) cuboid, 4 (6.4%) navicular, and 2 (3.2%) cuneiform fractures. Two (3.2%) Lisfranc fractures were present, both involving the contralateral lower extremity. There were 16 (25.8%) metatarsal fractures, 11 (17.7%) of which were on the contralateral lower extremity. Five (8.0%) patients had ipsilateral subtalar dislocation. Also, 4 (6.4%) posterior tibialis arterial injuries and 3 (4.8%) posterior tibialis tendon injuries were present. Spinal fractures were present in 9 of the 62 (14.5%) patients, including 3 (4.8%) cervical fractures, 1 (1.6%) thoracic spine fracture, and 6 (9.6%) lumbar fractures. Upper extremity orthopedic injuries were seen 18 (29%) patients. These included 1 (1.6%) humerus fracture, 1 (1.6%) olecranon fracture, 4 (6.4%) bilateral bone forearm fractures, 4 (6.4%) isolated ulna fractures, 2 (3.2%) distal radius fractures, 1 (1.6%) perilunate dislocation, and 4 (6.4%) metacarpal fractures. A complete list of associated musculoskeletal injuries is given in Table 2.

Of the 62 patients, 36 (58.0%) had an additional nonorthopedic injury. Head injuries occurred in 10 (16.1%) patients. Six (9.6%) patients had abdominal trauma, including 2 (3.2%) patients with liver lacerations, 2 (3.2%) with splenic injuries, and 2 (3.2%) with adrenal hematomas. Thirteen (20.9%) patients sustained chest trauma, with the most common injury a pneumothorax, which occurred in 8 (61.5%) of these patients. Major facial trauma occurred in 7 (11.2%) patients. A complete list of associated nonorthopedic injuries is given in Table 3.

Fifteen (23.4%) fractures were treated with percutaneous wire fixation and 7 (10.9%) with open reduction internal fixation. Of the 64 fractures, 44 (68.7%) were treated without fixation or hardware after initial debridement and irrigation. Eight (12.5%) required soft tissue coverage by plastic surgery. Overall, 5 (8.0%) patients with an open calcaneal fracture eventually required a below-the-knee amputation.

Table 2
Associated orthopedic injuries (N = 64 fractures in 62 patients)

Bone	Laterality	No. of Injuries (%)
Upper extremity		
Humerus	—	1 (1.6)
Olecranon	—	1 (1.6)
Ulna	—	4 (6.5)
Radius and ulna	—	4 (6.5)
Distal radius	—	2 (3.2)
Perilunate dislocation	—	1 (1.6)
Metacarpal	—	4 (6.5)
Spine		
Cervical	—	3 (4.8)
Thoracic	—	1 (1.6)
Lumbar	—	6 (9.7)
Lower extremity		
Pelvic ring	—	3 (4.8)
Hip dislocation		3 (4.8)
	Ipsilateral	1 (1.6)
	Contralateral	2 (3.2)
Acetabulum		6 (9.7)
	Ipsilateral	2 (3.2)
	Contralateral	4 (6.5)
Femoral neck		2 (3.2)
	Ipsilateral	1 (1.6)
	Contralateral	1 (1.6)
Intertrochanteric		1 (1.6)
	Ipsilateral	1 (1.6)
Femoral shaft		8 (12.9)
	Ipsilateral	4 (6.5)
	Contralateral	4 (6.5)
	Open	2 (3.2)
Patella		4 (6.5)
	Ipsilateral	2 (3.2)
	Contralateral	2 (3.2)
Tibial plateau		4 (6.5)
	Ipsilateral	2 (3.2)
	Contralateral	1 (1.6)
	Open	2 (3.2)
Tibial shaft		3 (4.8)
	Ipsilateral	2 (3.2)
	Contralateral	1 (1.6)
	Open	2 (3.2)
Pilon		5 (8.1)
	Ipsilateral	1 (1.6)
	Contralateral	4 (6.5)
	Open	2 (3.2)
Ankle		14 (22.6)
	Ipsilateral	14 (22.6)
Talus		12 (19.4)
	Ipsilateral	9 (14.5)
	Contralateral	3 (4.8)
Subtalar dislocation		5 (8.1)
	Ipsilateral	5 (8.1)
Cuboid		5 (8.1)
	Ipsilateral	4 (6.5)
	Contralateral	1 (1.6)
Navicular		4 (6.5)
	Ipsilateral	2 (3.2)
	Contralateral	2 (3.2)
Cuneiform		2 (3.2)
	Ipsilateral	2 (3.2)
Lisfranc		2 (3.2)
	Ipsilateral	2 (3.2)
Metatarsal		16 (25.8)
	Ipsilateral	5 (8.1)
	Contralateral	11 (17.7)
Post tibial artery laceration	—	4 (6.5)
Post tibial tendon laceration	—	3 (4.8)

Discussion

Open fractures of the calcaneus are relatively rare injuries, representing only 0.8% to 10% of all calcaneal fractures (1). The data in the present study were in the upper end of that range at 8.6%. The