

# Operative Management of Ankle Fractures in Patients with Diabetes Mellitus

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## ABSTRACT

**Background:** Multiple studies have documented increased risks associated with treatment of ankle fractures in patients with diabetes mellitus. We reviewed our results in the largest series to date of this complex patient group to determine the frequency of complications. **Methods:** Eighty-four patients with diabetes had open reduction and internal fixation using standard fixation techniques for acute, closed ankle fractures. The 51 men and 33 women had an average age was 49.3 (22 to 77) years. The average followup was 4.1 years (11 to 97 months). Seventy-five fractures were closed and nine were open. Thirty-nine patients used insulin and 45 used oral hypoglycemics or diet for control of their diabetes. Diabetic complications, including nephropathy, hypertension, peripheral vascular disease, and neuropathy were evaluated. The management of diabetes, fracture classification, and presence of diabetic complications were assessed with chi-square, ANOVA, and univariate logistic regression to determine the presence of statistical significance for these factors. **Results:** Twelve of the 84 patients developed postoperative complications. Ten patients developed infections (eight deep and two superficial). Four of 12 patients with preoperative evidence of peripheral neuropathy developed Charcot arthropathy. Ten of 12 patients who had absent pedal pulses preoperatively developed complications ( $p < 0.0001$ ) and 11 of 12 patients with peripheral neuropathy had complications ( $p < 0.0001$ ). A trend towards complications was noted with nephropathy (two of five patients) and hypertension (nine of 12 patients). Open fractures, insulin dependence, patient age, and fracture classification had no significant effect on outcome. **Conclusions:** Most patients with diabetes can undergo open reduction and internal fixation of acute ankle fractures without complications. Patients with absent pedal pulses or peripheral neuropathy are at increased risk for complications.

**Key Words:** Ankle Fracture; Charcot; Complications; Diabetes

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## INTRODUCTION

The treatment of ankle fractures in patients with diabetes mellitus poses a challenging clinical dilemma. Surgical wounds and soft-tissue injuries in patients with diabetes have been shown to have an increased rate of complications.<sup>1,2,12,14</sup> Multiple studies have documented an increased risk of complications in diabetic patients who sustain ankle fractures.<sup>1-15</sup> Older reports<sup>9,10,12,14</sup> revealed very high rates of complications and frequent transtibial amputations after operative treatment of ankle fractures. More recent publications still report frequent complications after operative treatment of ankle fractures in diabetic patients,<sup>1,2,8,13</sup> and even after nonoperative treatment.<sup>5</sup> Additionally, a high rate of Charcot arthropathy has been reported in diabetic patients with fractures of the foot or ankle treated nonoperatively.<sup>7</sup> Therefore, we have routinely treated medically stable diabetic patients with displaced ankle fractures with open reduction and internal fixation. This study is the largest series to date reporting the operative management of ankle fractures in this complex patient population.

## MATERIALS AND METHODS

Eighty-four patients (51 men and 33 women) who had operative management of displaced ankle fractures and a concomitant diagnosis of diabetes were identified in our hospital database over an 8-year period. The average age was 49.3 (range 22 to 77) years. The average followup was 4.1 years (11 to 97 months). Seventy-five fractures were closed and nine were open. Thirty-nine patients used insulin to manage their diabetes and 45 used oral hypoglycemics or diet for control of their diabetes. Due to the retrospective nature of the study, glycosylated hemoglobin tests were available for fewer than half of the patients.

In all closed fractures, a preoperative closed reduction failed to achieve an anatomic reduction. Before surgery, all patients with closed fractures received a dose of first generation cephalosporin and those with open fractures received cephalosporin with aminoglycoside. Standard fixation techniques with small fragment internal fixation hardware were

used in all patients. Postoperatively, all patients were placed in a short-leg nonwalking cast and antibiotics were continued for 24 hours for closed fractures and 72 to 96 hours for open fractures. Weightbearing in a short-leg cast with a walker or, less commonly, crutches was begun 4 to 8 weeks after surgery. Patients were kept in a walking cast for 2 to 6 additional weeks.

Medical records were reviewed to determine demographic data and surgical complications. Complications included wound healing problems, infection (superficial and deep), Charcot arthropathy, nonunion, and malunion. The type of diabetic management (insulin, oral hypoglycemics, or diet-control) was noted. Sequelae of diabetes, including nephropathy, hypertension, peripheral vascular disease, and neuropathy were noted. Neuropathy was present if noted on the admission history and evaluated with qualitative testing. Nephropathy was defined as albuminuria for more than 6 months. Hypertension was defined as systolic pressures exceeding 160 mm Hg or diastolic pressures exceeding 90 mm Hg on two observations before the initial admission or if the patient was being treated with an antihypertensive on admission. Diastolic, systolic and mean arterial pressures were noted for each patient during his or her hospitalization.

Patients were then grouped as having either an operative complication or an uneventful operative and postoperative course. Statistical analysis included comparison of prevalence of complications with and without a given risk factor with a chi-square test with  $p < 0.05$  considered significant. ANOVA and logistic regression analyses also were performed.

Radiographic review included evaluation of anteroposterior, mortise, and lateral radiographs taken at the time of injury, after closed reduction, at the time of operative fixation, and at each subsequent clinic visit (Figure 1). All fractures were classified by the Lauge-Hansen and Weber classification systems. Postoperative radiographs were evaluated to document any loss of reduction, healing of the fracture, and the development of Charcot arthropathy.

## RESULTS

Twelve (14%) of the 84 patients developed 14 postoperative complications (two patients had both an infection and Charcot arthropathy). Ten patients (13%) developed infections. Two were superficial and were treated successfully with a brief course of oral antibiotic therapy and wound care. Eight deep infections resulting in osteomyelitis developed. The causative organism was *Staphylococcus aureus* in all eight. All deep infections were managed with irrigation and debridement, hardware removal, and a 6-week course of intravenous antibiotics. Five of the eight patients eventually had fracture union and did not require further operative procedures. One patient had a persistent wound breakdown and was managed with a rectus abdominus free tissue transfer, which also became infected. This patient

also developed Charcot arthropathy and eventually required a transtibial amputation. The second patient had persistent drainage and malunion of the fracture. After antibiotic treatment and three debridements, the patient had a transtibial amputation. The third patient had an infection that resolved after irrigation and debridement and hardware removal but developed nonunion and Charcot changes. He was ultimately treated with an ankle-foot orthosis.

In addition to the above patient, three others developed Charcot arthropathy. One patient developed Charcot arthropathy after symptomatic hardware removal and later underwent successful ankle fusion. At the time of hardware removal 6 months after open reduction and internal fixation, the fracture was clinically and radiographically united (Figure 2). In another patient, the Charcot arthropathy appeared as an isolated complication and was managed with a CROW (Charcot Restraint Orthotic Walker) boot. A third patient developed Charcot arthropathy after successful treatment of a superficial infection. The average time from surgery to the development of Charcot changes was 4.3 months.

Nine of 84 patients (12%) sustained open fractures (Table 1): seven type I and two type II. Two of the open fractures (25%) were among those infected. One patient with a type I fracture developed a superficial wound infection that resolved without complication. One patient with a type I fracture was one of the patients who subsequently developed Charcot arthropathy and required with a transtibial amputation. No statistical significance was found in this small series of open fractures.

Fifty-two patients (69%) had supination-external rotation (SER) type IV injuries (Weber B). Twenty-eight patients (31%) had pronation-external rotation (PER) type IV injuries (Weber C). Eight patients with SER IV (Weber B) fractures had complications, and four patients who had PER IV (Weber C) fractures had complications. No correlation was found between the fracture classification and the complication rate. The average age in the noncomplication group was 47.9 years and in the group who developed complications was 51.1 years, which was not statistically significant. The method of diabetes control also was found not to be correlated with complications. Of the 39 insulin-dependent diabetic patients, seven had complications. Of the 21 patients who used oral hypoglycemics, three had postoperative complications, and of the 24 patients who had diet-controlled diabetes, two developed complications. Unfortunately, an accurate assessment of glucose control was not available because of the retrospective nature of the study. A trend toward increased complications was noted with hypertension and nephropathy.

Of the 12 patients who had peripheral vascular disease defined by absent pedal pulses, 10 developed complications ( $p < 0.001$ ). (Table 2) Sixteen patients also were noted to have palpable but decreased pulses, and none

**Table 1:** Univariate analysis of complications with associated factors

Variable	Complications		Test of difference
	Yes	No	
Peripheral neuropathy			$p < 0.0001^a$
Yes	11 (91.7)	69 (95.8)	
No	1 (8.3)	3 (4.2)	
Peripheral vasculopathy			$p < 0.0001^a$
Yes <sup>c</sup>	12 (100)	6 (8.3)	
No	0	66 (91.7)	
Hypertension			$p = 0.24^a$
Yes	9 (75)	3 (25)	
No	41 (56.9)	31 (43.1)	
Nephropathy <sup>d</sup>			$p = 0.09^a$
Yes	2 (16.7)	3 (4.2)	
No	41 (56.9)	31 (43.1)	
Type of fracture			$p = 0.34^a$
Closed	10 (83.3)	65 (90.3)	
Grade 1 open	1 (8.3)	6 (8.3)	
Grade 2 open	1 (8.3)	1 (1.4)	
Grade 3a open	0	0	
Grade 3b open	0	0	
Fracture pattern			$p = 0.7^a$
Weber A	0	4 (5.6)	
Weber B	8 (66.7)	44 (61.1)	
Weber C	4 (33.3)	24 (33.3)	
Age of patient (year)	51.1 (mean)	47.9 (mean)	$p = 42^b$
Sex			$p = 0.65^b$
Male	8 (66.7)	43 (59.7)	
Female	4 (33.3)	29 (40.3)	
Type of diabetes			$p = 0.37^a$
NIDDM	5 (41.7)	40 (55.6)	
IDDM	7 (58.3)	32 (44.4)	

<sup>a</sup>Chi-square test; <sup>b</sup>independent t-test; <sup>c</sup>absent pulses; <sup>d</sup>data unavailable for seven patients.

of these developed complications. Of the 50 patients with normal pulses preoperatively, only one developed a complication.

Of 12 patients with peripheral neuropathy defined as decreased sensation before surgery, 11 developed complications ( $p < 0.0001$ ).

## DISCUSSION

Ankle fractures are one of the most common type of fractures treated operatively by orthopaedic surgeons. Although the exact number of ankle fractures in diabetic patients is not known, they are not uncommon injuries, and their prevalence will most likely increase as diabetic patients continue to live longer. Older literature reported very high rates of complications in diabetic patients with ankle fractures.<sup>9,10,12,14</sup> Low and Tan evaluated 10 patients with diabetes with ankle fractures treated operatively.<sup>12</sup> Five of the 10 patients developed

**Table 2:** Univariate logistic regression analysis of ankle fractures associated with diabetes leading to complications in postoperative period

Associated factors	R value	Test of difference
Peripheral neuropathy	0.53	$p < 0.0001$
Peripheral vascular disease	0.422	$p < 0.002$



**Fig. 1:** A, Preoperative mortise radiographs of a 67-year-old woman who sustained a closed SER IV fracture-dislocation. B, Preoperative lateral view. C, Patient was treated with open reduction and internal fixation. Six months postoperatively, the fracture was healed and the patient was able to ambulate without difficulty.

an infection, with two requiring below-knee amputations. Risk factors were not evaluated in this group.

McCormack and Leith<sup>14</sup> reported 26 diabetic patients with ankle fractures, 19 of which were treated operatively. They noted one wound complication and four infections with two transtibial amputations in their operatively treated group, with an overall complication rate of 47%. They did not have any complications in their nonoperatively treated patients; however, selection bias existed regarding the type of treatment for this group.

Kristiansen<sup>10</sup> reported a 30% infection rate after operative treatment of ankle fracture in diabetic patients. However, nonoperative management of fractures of the foot and ankle were found by Holmes and Hill<sup>7</sup> to result in a higher rate of Charcot arthropathy than operative treatment. Nonoperative treatment of ankle fractures also has been found to have a very high rate of complications. Flynn et al.<sup>5</sup> noted that of six ankle fractures treated nonoperatively four became infected.

They also noted that four of 19 patients treated operatively developed infections. Therefore, there is an increased risk of infection with both nonoperative and operative treatment of ankle fractures in patients with diabetes.

More recent studies have more carefully evaluated the effect of comorbidities of diabetes on outcomes of operative treatment of ankle fractures. We found a higher rate of complications in patients with the comorbidities of peripheral vascular disease and peripheral neuropathy. Jones et al.<sup>8</sup> also found a higher rate of complications in a series of 42 patients with diabetes if they had comorbidities.<sup>8</sup> In their group without comorbidities, they noted no effect on their complication rate compared to an age matched non-diabetic group. They found that surgery did not increase the risk of infection, but noted that eight of 42 patients developed Charcot arthropathy, and this was associated with the presence of peripheral neuropathy and nephropathy. They also noted that six of 42 patients developed infections, with a trend toward



**Fig. 2:** **A**, Preoperative anteroposterior radiograph of a 47-year-old man who sustained a SER IV fracture-dislocation. **B**, Preoperative lateral view. **C**, Immediate postoperative anteroposterior view. **D**, Immediate postoperative lateral view. **E**, Final postoperative radiographs. By 12 weeks postoperatively, Charcot changes were visible radiographically. The patient eventually had hardware removal.

this being associated with nephropathy. In another study of 21 patients, Blotter et al.<sup>2</sup> reported 13 complications in nine diabetic patients. Two patients had transtibial amputations with a third refusing amputation after an infection.

Another study using data from a national databank, the Nationwide Inpatient Sample database, found significant

increases of in-hospital postoperative complications, length of hospital stay, rate of nonroutine discharge, and total charges in diabetic patients with ankle fractures.<sup>6</sup> Regardless of fracture severity, they found it added approximately one additional hospital day and an increase of \$2,000 of increased charges.

Another study evaluated outcomes of open ankle fractures in diabetics.<sup>15</sup> White et al.<sup>15</sup> evaluated 14 diabetic patients with open ankle fractures between 1981 and 2000, with nine of the 14 developing wound complications, five requiring transtibial amputations, and only three without complications. Of our nine patients with open fractures, only two developed a complication.

The major limitations of this study arise from its retrospective design. It is possible that patients with undiagnosed glucose intolerance or borderline diabetes may not have been identified in our computerized patient search. However, early cases such as these would have been less likely to develop sequelae that were found to be risk factors for operative complications. Also, we did not perform quantitative testing of the patients' neuropathy, such as Semmes-Weinstein monofilament testing, or quantitative evaluation of their vasculopathy, such as noninvasive arterial studies. Thus, more subtle cases of neuropathy or vasculopathy may have been missed.

Although our study and others have noted an increased rate of complications after operative treatment of ankle fractures in diabetic patients, we strongly advocate fixation of persistently displaced fractures in patients who are medically stable to try to minimize the risk of developing Charcot arthropathy and skin breakdown. We agree with Flynn et al.<sup>5</sup> that nonoperative treatment of an unstable ankle fracture has a very high risk of wound complications in diabetic patients. If pedal pulses are absent, we agree with Bibbo et al<sup>1</sup> that patients should have an adequate vascular evaluation including noninvasive arterial profile, transcutaneous oxygen measurements, and vascular consultation if indicated. If the patient has a dysvascular extremity and is medically stable, we advocate a concomitant revascularization procedure and definitive fixation of the fracture. Additionally, we agree with Marks<sup>13</sup> that patients with documented peripheral neuropathy have their postoperative immobilization period increased two- to threefold. Future studies could evaluate whether newer fixation techniques, such as multiple syndesmotic

screws or locking plates, may decrease the incidence of Charcot arthropathy in neuropathic patients.

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