Title
Incidence of Preoperative Deep Vein Thrombosis in Calcaneal Fractures

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Incidence of Preoperative Deep Venous Thrombosis in Isolated Calcaneal Fractures

Abstract

Objectives: This study examined the incidence and risk factors of preoperative deep vein thrombosis (DVT) in patients presenting to an outpatient setting with an isolated calcaneal fracture.

Design: Retrospective chart review

Setting: All patients included in the study presented to the treating surgeon at a Level I trauma center with isolated calcaneal fractures as an outpatient between 2005-2013.

Methods: These patients were either referred from outside hospitals, had been evaluated in the emergency department initially and presented for definitive care, or presented initially to the outpatient clinic. Patients included were over the age of 18, had a preoperative duplex ultrasonography of bilateral lower extremities per the treating surgeon's protocol, and had at minimum 6 weeks follow-up. Patients were excluded if they were a polytrauma, had a documented hypercoagulable state, or were on baseline pharmacologic anticoagulation for another condition. All patients had a preoperative duplex ultrasound of both lower extremities to evaluate for DVT at least 7 days after injury.

Main Outcome Measure: Patients found to have a preoperative DVT were compared with those who did not have preoperative DVT for possible risk factors.

Results: One hundred fifty-nine patients qualified for our study and of these, 19 (12%) were found to have a DVT preoperatively, almost all of which were in distal veins. All risk factors, including age, sex, and BMI were analyzed as continuous variables. Older

age was found to be a risk factor for DVT (p = 0.009, Odds Ratio = 1.06, 95% Confidence Interval: 1.01-1.11). All other predictor variables, including BMI (p = 0.05) and sex (p = 0.08), were not statistically significant predictors in our sample.

Conclusions: The incidence of preoperative DVT found here is almost 2 times as high as any previously published examination of lower extremity injuries. Physicians should be aware of this increase so they may counsel patients about the risks of DVTs and the likelihood of any sequelae from developing a DVT that may affect a patient's recovery.

Level of Evidence: III

Introduction

Calcaneal fractures represent a complex injury that can lead to significant morbidity despite surgical treatment. Many characteristics contribute to poor outcomes in patients who sustain calcaneal fractures. Wound complications are one of the most common and worrisome complications and occur in nearly 20% of patients with calcaneal fractures who undergo surgical fixation[1]. Because injury to the soft tissue envelope can contribute to wound healing complications, surgical intervention is often delayed until the soft tissue envelope is deemed safe. This may be 7-10 days after injury[2]. This prolonged period of extremity elevation and limited mobility may place patients at increased risk for the development of deep vein thrombosis (DVT) both pre- and postoperatively.

There is currently much debate about whether or not to treat patients with lower extremity fractures below the knee with chemoprophylaxis for DVT. Some physicians routinely give immobilized patients chemoprophylaxis to limit the development of lower extremity DVT or proximal propagation of known DVTs. Chemoprophylaxis is not,

however, without its own risks, such as increased bleeding or heparin induced thrombocytopenia, and a large financial burden on both the patient and national healthcare systems is associated with it [3].

Multiple studies in the recent literature have reported the incidence and risk factors of thromboembolic events after lower extremity fracture surgery (Table 1) and conclude that the incidence of symptomatic DVT or nonfatal PE after lower extremity fracture surgery is low and that thromboprophylaxis is not indicated[4-11]. Correlation of the incidence of thromboembolic events after lower extremity fractures to age and BMI has also been documented. [9,10,12]

Hindfoot fractures have been reported to be a risk factor for DVT and for occlusive DVT, but how substantial this risk is and whether or not calcaneal fracture patients are particularly at risk is not known as no previous studies to our knowledge have examined the rate of DVT in isolated calcaneal fractures[10]. We sought to conduct this observational study of the incidence and risks factors of preoperative DVT in calcaneal fractures in order to determine whether these injuries do have a higher likelihood of DVT due to the higher energy nature of the injuries and prolonged immobilization prior to surgery and whether these DVTs are more likely to be located in the proximal veins unlike other fractures occurring below the knee.

Materials and Methods

After approval from our institutional review board, we conducted a retrospective review of all operatively treated, isolated calcaneus fractures from 2005-2013 that were treated by a single surgeon (SKB) and that presented in an outpatient setting. These patients were either referred from outside hospitals, had been evaluated in the emergency

department initially and presented for definitive care, or presented initially to the outpatient clinic. All patients included in the study were over the age of 18, had a preoperative duplex ultrasonography of bilateral lower extremities per the treating surgeon's protocol at a minimum of 7 days after injury, and had at minimum 6 weeks follow-up. Only patients undergoing surgical fixation of their fracture were included as the treating surgeon only gets preoperative duplex ultrasounds on surgical patients out of concern that positioning and manipulation of the extremity during operative intervention may dislodge or cause an undiagnosed clot to propagate increasing the risk of PE. Patients were immobilized either in an external fixator, splint, or open posterior mold splint depending on where they were seen prior to presenting in clinic. No foot pumps were employed. Patients were able to move their foot preoperatively if they were in the open posterior mold splint. Patients were excluded if they experienced polytrauma, had a documented hypercoagulable state, or were on baseline pharmacologic anticoagulation for another condition. There were 294 patients with operatively treated calcaneal fractures by the senior author between 2005-13. Of these, 135 were excluded based on the above criteria leaving159 patients available for inclusion in the study. 130 polytrauma patients were excluded, two patients excluded for being under 18, two for having a documented hypercoagulable state, and one for being on prior anticoagulation.

The electronic medical records (EMR) of these 159 patients were examined for American Society of Anesthesiologist Scores (ASA), tobacco use, alcohol use, body mass index (BMI), diabetes, oral contraceptive use, and peripheral vascular disease. All patients were evaluated for mechanism of injury, travel time to treating institution (if

transferred), time to surgery, presence and type (serous vs hemorrhagic) of fracture blisters, AO/OTA classification, and presence of external fixation. The presence and location of DVT, as assessed preoperatively by duplex ultrasound, was also noted.

We compared the rate of DVT in our study to that of the three studies that employed a similar prospective DVT diagnosis approach on more general injury patterns (Table 1), using the binomial probability for small sample size test. Multiple logistic regression analysis was conducted to ascertain the rate of DVT when adjusted for various patient or injury characteristics (age, sex, mass, stature, BMI, oral contraceptive use, tobacco or alcohol use, diabetes, peripheral vascular disease, presence of fracture blisters, or placement of external fixator). All analysis was performed in Stata (StataCorp, College Station, TX) and statistical significance was established using $p < 0.05$.

Results

Of 159 isolated calcaneus fracture patients that qualified for our study, 113 were male and 46 female. The average age was 46.5 (18-77) years. The average BMI was 26.2 (17.9-42.1) kg/m^2 and the average time to surgery was 19 (8-105) days.

All patients had a preoperative duplex ultrasound done at least 7 days after their injury. Nineteen patients (16 males and 3 females; 12%) had a DVT preoperatively. Their average age was 53.4 (25-74) years and average BMI was 23.4 (18.5-33.3) kg/m^2. There were 7 former and 4 current tobacco users in this group and one of the females was on hormone replacement therapy. None of these patients had a history of DVT or diabetes. All of the DVTs were in the operative extremity with the exception of one patient who had bilateral DVTs. The average time to surgery for the patients who had a DVT was 23.6 (11-105) days (Table 2). Of note, the patient who had surgery 105 days after injury was

incarcerated which was the reason for delay to treatment. The preoperative ultrasound for this patient was done the day prior to their surgery, not 7 days after the injury. There were no PEs associated with the lower extremity DVTs and all of these DVTs were asymptomatic.

The majority of DVTs were distal and were found in the following distribution. There were 10 in the peroneal vein, 6 in the soleal vein, 5 in intramuscular calf veins, 4 in the posterior tibial vein, 2 in the gastrocnemius vein, and 1 each in the popliteal and femoral veins (Table 3). Seven patients had DVTs in multiple veins in the leg. The patient who had bilateral DVTs had them in the posterior tibial vein in both legs. Only 2 (1.25%) patients had DVTs in a proximal vein.

The proportion of calcaneal patients with DVT in our study (12%) is significantly different from the rates reported in the literature (5-6.5%) for all types of foot and ankle trauma ($p < 0.01$). We used multiple logistic regression with the presence or absence of a DVT as the outcome variable, and the patient or injury characteristics (including age; sex; mass; stature; BMI; oral contraceptive, tobacco or alcohol use; diabetes; peripheral vascular disease; presence of fracture blisters or external fixation) as the potential predictor variables. Older age was found to be a risk factor for DVT ($p = 0.009$, Odds Ratio = 1.06, 95% CI: 1.01-1.11; coefficient = 0.06 95% CI 0.02-0.11). All other predictor variables, including BMI ($p = 0.05$) and sex ($p = 0.08$), were analyzed as continuous variables and not statistically significant predictors in our sample. From this we found that for every 1 year increase in age the odds of developing a DVT increase by approximately 6%. The baseline rates for DVT in each age group in our study were 4.5%

for ages 20-30, 9.6% for ages 31-40, 13.8% for ages 41-50, 22.2% for ages 51-60, and 25% for ages 61 and over.

Discussion

Previous studies [4, 6-9] have reported the incidence of DVT in isolated lower extremity fractures to be 3-11% while the rate of DVT diagnosed from duplex ultrasound is 5-6.5%. None of these studies have, however, examined isolated calcaneal fractures, which typically result from high energy trauma and require prolonged periods of immobilization both prior to and after surgical fixation. This is the first large series to evaluate the incidence of preoperative DVT in isolated calcaneal fractures. We found a significantly higher rate of 12% than studies that included more varied fracture patterns and treatment methods. The DVT in our patients were diagnosed preoperatively, but on average 24 days after injury, using duplex ultrasound. The reason that many of the injuries had a delay in diagnosis or surgery was due to a delay in patients being transported to our center from remote hospitals for definitive treatment and this may in fact, have increased our rate of DVTs as it is more of a delay than other centers may have for treatment.

We found increasing age to be a risk factor for the presence of a DVT, as have others[9,10,12-14]. Although we collected data on other potential risk factors, none of these attained statistical significance in multiple logistic regression.

Unlike other studies, the diagnosed DVTs in our population were almost solely in the injured limb whereas other studies have shown a more equal distribution in the injured and noninjured limb. It is possible that this is an underrepresentation of contralateral limb DVTs as our study used ultrasound for detection rather than venograms

which are more sensitive for detecting DVTs. Similar to previous studies, we found that all of these DVTs were asymptomatic with the majority located in the distal veins rather than the proximal veins, which are more typically associated with pulmonary emboli[4, 10,15].

There are many limitations to our study. Patients in this study prospectively received duplex examination, but the other data were collected retrospectively. Additionally, because patients presenting and referred to our hospital are often those with higher energy trauma or increased complexity of their injuries, there may be inherent selection bias in our cohort.

Despite these limitations, the large cohort and consistent preoperative protocol provides the only series of isolated calcaneus fractures examined for the preoperative risk of DVT formation. To our knowledge, this is the only study that looks at isolated calcaneal fractures and the incidence found here is significantly higher than previously published examinations of lower extremity injuries, which typically included ankle fractures. Further examination of the possible sequelae of these DVTs and the treatment strategies in preparation for the operative fixation of these patients is warranted. However, physicians should be aware of the 12% incidence of these DVTs so that they are better able to counsel patients on the risks of these DVTs and how they may affect their recovery.

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