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Incidence of Preoperative Deep Vein Thrombosis in Calcaneal Fractures.

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1 Incidence of Preoperative Deep Venous Thrombosis in Isolated Calcaneal

2 Fractures

3Abstract

4Objectives: This study examined the incidence and risk factors of preoperative deep vein
5thrombosis (DVT) in patients presenting to an outpatient setting with an isolated
6calcaneal fracture.

7Design: Retrospective chart review

8Setting: All patients included in the study presented to the treating surgeon at a Level I
9trauma center with isolated calcaneal fractures as an outpatient between 2005-2013.

10Methods: These patients were either referred from outside hospitals, had been evaluated
11in the emergency department initially and presented for definitive care, or presented
12initially to the outpatient clinic. Patients included were over the age of 18, had a
13preoperative duplex ultrasonography of bilateral lower extremities per the treating
14surgeon's protocol, and had at minimum 6 weeks follow-up. Patients were excluded if
15they were a polytrauma, had a documented hypercoagulable state, or were on baseline
16pharmacologic anticoagulation for another condition. All patients had a preoperative
17duplex ultrasound of both lower extremities to evaluate for DVT at least 7 days after
18injury.

19**Main Outcome Measure:** Patients found to have a preoperative DVT were compared
20with those who did not have preoperative DVT for possible risk factors.

21Results: One hundred fifty-nine patients qualified for our study and of these, 19 (12%)
22were found to have a DVT preoperatively, almost all of which were in distal veins. All
23risk factors, including age, sex, and BMI were analyzed as continuous variables. Older

24age was found to be a risk factor for DVT ($p = 0.009$, Odds Ratio = 1.06, 95%
25Confidence Interval: 1.01-1.11). All other predictor variables, including BMI ($p = 0.05$)
26and sex ($p = 0.08$), were not statistically significant predictors in our sample.
27**Conclusions:** The incidence of preoperative DVT found here is almost 2 times as high as
28any previously published examination of lower extremity injuries. Physicians should be
29aware of this increase so they may counsel patients about the risks of DVTs and the
30likelihood of any sequelae from developing a DVT that may affect a patient's recovery.

31**Level of Evidence: III**

32Introduction

33 Calcaneal fractures represent a complex injury that can lead to significant
34morbidity despite surgical treatment. Many characteristics contribute to poor outcomes
35in patients who sustain calcaneal fractures. Wound complications are one of the most
36common and worrisome complications and occur in nearly 20% of patients with
37calcaneal fractures who undergo surgical fixation^[1]. Because injury to the soft tissue
38envelope can contribute to wound healing complications, surgical intervention is often
39delayed until the soft tissue envelope is deemed safe. This may be 7-10 days after injury^[2]
40. This prolonged period of extremity elevation and limited mobility may place patients at
41increased risk for the development of deep vein thrombosis (DVT) both pre- and
42postoperatively.

43 There is currently much debate about whether or not to treat patients with lower
44extremity fractures below the knee with chemoprophylaxis for DVT. Some physicians
45routinely give immobilized patients chemoprophylaxis to limit the development of lower
46extremity DVT or proximal propagation of known DVTs. Chemoprophylaxis is not,

47however, without its own risks, such as increased bleeding or heparin induced
48thrombocytopenia, and a large financial burden on both the patient and national
49healthcare systems is associated with it^[3].

50 Multiple studies in the recent literature have reported the incidence and risk
51factors of thromboembolic events after lower extremity fracture surgery (Table 1) and
52conclude that the incidence of symptomatic DVT or nonfatal PE after lower extremity
53fracture surgery is low and that thromboprophylaxis is not indicated^[4-11]. Correlation of
54the incidence of thromboembolic events after lower extremity fractures to age and BMI
55has also been documented.^[9,10,12]

56 Hindfoot fractures have been reported to be a risk factor for DVT and for
57occlusive DVT, but how substantial this risk is and whether or not calcaneal fracture
58patients are particularly at risk is not known as no previous studies to our knowledge
59have examined the rate of DVT in isolated calcaneal fractures^[10]. We sought to conduct
60this observational study of the incidence and risks factors of preoperative DVT in
61calcaneal fractures in order to determine whether these injuries do have a higher
62likelihood of DVT due to the higher energy nature of the injuries and prolonged
63immobilization prior to surgery and whether these DVTs are more likely to be located in
64the proximal veins unlike other fractures occurring below the knee.

65Materials and Methods

66 After approval from our institutional review board, we conducted a retrospective
67review of all operatively treated, isolated calcaneus fractures from 2005-2013 that were
68treated by a single surgeon (SKB) and that presented in an outpatient setting. These
69patients were either referred from outside hospitals, had been evaluated in the emergency

70department initially and presented for definitive care, or presented initially to the
71outpatient clinic. All patients included in the study were over the age of 18, had a
72preoperative duplex ultrasonography of bilateral lower extremities per the treating
73surgeon's protocol at a minimum of 7 days after injury, and had at minimum 6 weeks
74follow-up. Only patients undergoing surgical fixation of their fracture were included as
75the treating surgeon only gets preoperative duplex ultrasounds on surgical patients out of
76concern that positioning and manipulation of the extremity during operative intervention
77may dislodge or cause an undiagnosed clot to propagate increasing the risk of PE.
78Patients were immobilized either in an external fixator, splint, or open posterior
79mold splint depending on where they were seen prior to presenting in clinic. No
80foot pumps were employed. Patients were able to move their foot preoperatively if
81they were in the open posterior mold splint. Patients were excluded if they
82experienced polytrauma, had a documented hypercoagulable state, or were on baseline
83pharmacologic anticoagulation for another condition. There were 294 patients with
84operatively treated calcaneal fractures by the senior author between 2005-13. Of these,
85135 were excluded based on the above criteria leaving 159 patients available for inclusion
86in the study. 130 polytrauma patients were excluded, two patients excluded for being
87under 18, two for having a documented hypercoagulable state, and one for being on prior
88anticoagulation.

89 The electronic medical records (EMR) of these 159 patients were examined for
90American Society of Anesthesiologist Scores (ASA), tobacco use, alcohol use, body mass
91index (BMI), diabetes, oral contraceptive use, and peripheral vascular disease. All
92patients were evaluated for mechanism of injury, travel time to treating institution (if

93transferred), time to surgery, presence and type (serous vs hemorrhagic) of fracture
94blisters, AO/OTA classification, and presence of external fixation. The presence and
95location of DVT, as assessed preoperatively by duplex ultrasound, was also noted.

96 We compared the rate of DVT in our study to that of the three studies that
97employed a similar prospective DVT diagnosis approach on more general injury patterns
98(Table 1), using the binomial probability for small sample size test. Multiple logistic
99regression analysis was conducted to ascertain the rate of DVT when adjusted for various
100patient or injury characteristics (age, sex, mass, stature, BMI, oral contraceptive use,
101tobacco or alcohol use, diabetes, peripheral vascular disease, presence of fracture blisters,
102or placement of external fixator). All analysis was performed in Stata (StataCorp, College
103Station, TX) and statistical significance was established using $p < 0.05$.

104Results

105 Of 159 isolated calcaneus fracture patients that qualified for our study, 113 were
106male and 46 female. The average age was 46.5 (18-77) years. The average BMI was
10726.2 (17.9-42.1) kg/m^2 and the average time to surgery was 19 (8-105) days.

108 All patients had a preoperative duplex ultrasound done at least 7 days after their
109injury. Nineteen patients (16 males and 3 females; 12%) had a DVT preoperatively. Their
110average age was 53.4 (25-74) years and average BMI was 23.4 (18.5-33.3) kg/m^2 . There
111were 7 former and 4 current tobacco users in this group and one of the females was on
112hormone replacement therapy. None of these patients had a history of DVT or diabetes.
113All of the DVTs were in the operative extremity with the exception of one patient who
114had bilateral DVTs. The average time to surgery for the patients who had a DVT was 23.6
115(11-105) days (Table 2). Of note, the patient who had surgery 105 days after injury was

116incarcerated which was the reason for delay to treatment. The preoperative ultrasound
117for this patient was done the day prior to their surgery, not 7 days after the injury. There
118were no PEs associated with the lower extremity DVTs and all of these DVTs were
119asymptomatic.

120 The majority of DVTs were distal and were found in the following distribution.
121There were 10 in the peroneal vein, 6 in the soleal vein, 5 in intramuscular calf veins, 4 in
122the posterior tibial vein, 2 in the gastrocnemius vein, and 1 each in the popliteal and
123femoral veins (Table 3). Seven patients had DVTs in multiple veins in the leg. The
124patient who had bilateral DVTs had them in the posterior tibial vein in both legs. Only 2
125(1.25%) patients had DVTs in a proximal vein.

126 The proportion of calcaneal patients with DVT in our study (12%) is significantly
127different from the rates reported in the literature (5-6.5%) for all types of foot and ankle
128trauma ($p < 0.01$). We used multiple logistic regression with the presence or absence of a
129DVT as the outcome variable, and the patient or injury characteristics (including age; sex;
130mass; stature; BMI; oral contraceptive, tobacco or alcohol use; diabetes; peripheral
131vascular disease; presence of fracture blisters or external fixation) as the potential
132predictor variables. Older age was found to be a risk factor for DVT ($p = 0.009$, Odds
133Ratio = 1.06, 95% CI: 1.01-1.11; coefficient = 0.06 95% CI 0.02-0.11). All other
134predictor variables, including BMI ($p = 0.05$) and sex ($p = 0.08$), were analyzed as
135continuous variables and not statistically significant predictors in our sample. From this
136we found that for every 1 year increase in age the odds of developing a DVT increase by
137approximately 6%. The baseline rates for DVT in each age group in our study were 4.5%

138for ages 20-30, 9.6% for ages 31-40, 13.8% for ages 41-50, 22.2% for ages 51-60, and
13925% for ages 61 and over.

140Discussion

141 Previous studies ^[4, 6-9] have reported the incidence of DVT in isolated lower
142extremity fractures to be 3-11% while the rate of DVT diagnosed from duplex ultrasound
143is 5-6.5%. None of these studies have, however, examined isolated calcaneal fractures,
144which typically result from high energy trauma and require prolonged periods of
145immobilization both prior to and after surgical fixation. This is the first large series to
146evaluate the incidence of preoperative DVT in isolated calcaneal fractures. We found a
147significantly higher rate of 12% than studies that included more varied fracture patterns
148and treatment methods. The DVT in our patients were diagnosed preoperatively, but on
149average 24 days after injury, using duplex ultrasound. The reason that many of the
150injuries had a delay in diagnosis or surgery was due to a delay in patients being
151transported to our center from remote hospitals for definitive treatment and this may in
152fact, have increased our rate of DVTs as it is more of a delay than other centers may have
153for treatment.

154 We found increasing age to be a risk factor for the presence of a DVT, as have
155others^[9,10,12-14]. Although we collected data on other potential risk factors, none of these
156attained statistical significance in multiple logistic regression.

157 Unlike other studies, the diagnosed DVTs in our population were almost solely in
158the injured limb whereas other studies have shown a more equal distribution in the
159injured and noninjured limb. It is possible that this is an underrepresentation of
160contralateral limb DVTs as our study used ultrasound for detection rather than venograms

161which are more sensitive for detecting DVTs. Similar to previous studies, we found that
162all of these DVTs were asymptomatic with the majority located in the distal veins rather
163than the proximal veins, which are more typically associated with pulmonary emboli^{[4,}
164^{10,15]}.

165 There are many limitations to our study. Patients in this study prospectively
166received duplex examination, but the other data were collected retrospectively.
167Additionally, because patients presenting and referred to our hospital are often those with
168higher energy trauma or increased complexity of their injuries, there may be inherent
169selection bias in our cohort.

170 Despite these limitations, the large cohort and consistent preoperative protocol
171provides the only series of isolated calcaneus fractures examined for the preoperative risk
172of DVT formation. To our knowledge, this is the only study that looks at isolated
173calcaneal fractures and the incidence found here is significantly higher than previously
174published examinations of lower extremity injuries, which typically included ankle
175fractures. Further examination of the possible sequelae of these DVTs and the treatment
176strategies in preparation for the operative fixation of these patients is warranted.
177However, physicians should be aware of the 12% incidence of these DVTs so that they
178are better able to counsel patients on the risks of these DVTs and how they may affect
179their recovery.

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181**References**

1821. Zhang W, Chen E, Xue D, et al. Risk Factors For Wound Complications of Closed
183 Calcaneal Fractures After Surgery: A Systematic Review and Meta-analysis.
184 Scand J Trauma Resusc Emerg Med, 2015; 23: 18.
1852. Epstein N, Chandran S, Chou L. Current concepts review: intra-articular fractures
186 of the calcaneus. Foot & Ankle International, 2012; 33(1): p. 79-86.
1873. Manafi RA, Kazemian G, Emami Moghdam M, et al. Deep vein thrombosis
188 following below knee immobilization: The need for chemoprophylaxis. Trauma
189 Monthly, 2013; 17: p. 367-9.
1904. Iqbal HJ, Dahab R, Barnes S. UK national survey of venous thromboembolism
191 prophylaxis in ankle fracture patients treated with plaster casts. Foot Ankle Surg,
192 2012; 18: p. 157-9.
1935. Patel A, Ogawa B, Charlton T, et al. Incidence of deep vein thrombosis and
194 pulmonary embolism after Achilles tendon rupture. Clin Orthop Relat Res, 2012;
195 470: p. 270-274.
1966. Patil S, Gandhi J, Curzon I, et al. Incidence of deep=vein thrombosis in patients
197 with fractures of the ankle treated in a plaster cast. JBJS Br, 2007; 89: p. 1340-3.
1997. Pelet S, Roger M, Belzile EL, et al. The incidence of thromboembolic events in
200 surgically treated ankle fracture. JBJS Am, 2012; 94: p. 502-6.
2018. Selby R, Geerts WH, Kreder HJ, et al. Symptomatic venous thromboembolism
202 uncommon without thromboprophylaxis after isolated lower-limb fracture. The
203 knee-to-ankle fracture (KAF) cohort study. JBJS Am, 2014; 96(e83): p. 1-5.
204

2059. Shibuya N, Frost C, Campbell JD. Incidence of acute deep vein thrombosis and
206 pulmonary embolism in foot and ankle trauma: Analysis of the National Trauma
207 Data Bank. The Journal of Foot & Ankle Surgery, 2012; 51: p. 63-8.
20810. Solis G, Saxby T. Incidence of DVT following surgery of the foot and ankle. Foot
209 & Ankle International, 2002; 23(5): p. 411-4.
21011. Yi X, Zhu J, Wei M, et al. Risk factors of venous thrombosis in patients with
211 ankle fractures. International Angiology, 2014; 33(4): p. 324-8.
21212. Makhdom AM, Cota A, Saran N, et al. Incidence of symptomatic deep venous
213 thrombosis after Achilles tendon rupture. The Journal of Foot & Ankle Surgery,
214 2013; 52: p. 584-7.
21513. Goel DP, Buckley R, deVries G, et al. Prophylaxis of Deep-Vein Thrombosis in
216 Fractures Below the Knee: A Prospective Randomised Controlled Trial. JBJS
217 Am, 2009; 91(3): 388-94.
21814. Abelseth G, Buckley RE, Pineo GE, et al. incidence of Deep-Vein Thrombosis in
219 Patients with Fractures of the Lower Extremity Distal to the Hip. J Orthop
220 Trauma, 1996; 10(4): 230-5.
22115. Lapidus LJ, Ponzer S, Elvin A, et al. Prolonged thromboprophylaxis with Dalteparin
222 during immobilization after ankle fracture surgery: a randomized placebo-
223 controlled, double-blind study. Acta Orthop, 2007; 78: p. 528-535.
224
225