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Symptomatic venous thromboembolism following circular frame treatment for tibial fractures

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ABSTRACT

Introduction: Venous thromboembolism (VTE) is a significant cause of morbidity and mortality following tibial fractures. The risk is as high as 77% without prophylaxis and around 10% with prophylaxis. Within the current literature there are no figures reported specifically for those individuals treated with circular frames. Our aim was to evaluate the VTE incidence within a single surgeon series and to evaluate potential risk factors.
Methods: We retrospectively reviewed our consecutive single surgeon series of 177 patients admitted to a major trauma unit with tibial fractures. All patients received standardised care, including chemical thromboprophylaxis within 24 h of injury until independent mobility was achieved. We comprehensively reviewed our prospective database and medical records looking at demographics and potential risk factors.
Results: Seven patients (4.0% ± 2.87%) developed symptomatic VTE during the course of frame treatment; three deep vein thrombosis (DVTs) and four pulmonary embolisms (PEs). Those with a VTE event had significantly increased body mass index (BMI) ($p = 0.01$) when compared to those without symptomatic VTE. No differences ($p > 0.05$) were observed between the groups in age, gender, smoking status, fracture type (anatomical allocation or open/closed), delay to frame treatment, weight bearing status post-frame, inpatient stay or total duration of frame treatment.
Conclusion: This study suggests that increased BMI is a statistically significant risk factor for VTE, as reported in current literature. In addition, we calculated the true risk of VTE following circular frame treatment for tibial fracture in our series is from 1.13% to 6.87%, which is at least comparable to other forms of treatment.

Introduction

Venous thromboembolism (VTE) is a frequent and potentially life-threatening complication after trauma [1,2]. Without prophylaxis the incidence of deep vein thrombosis (DVT) following trauma is over 50% [3–5]. The risk of pulmonary embolism (PE) can range from 2.3% to 20% depending on associated injuries [3]. The risk of fatal PE is fortunately limited to less than 0.5% [6]. Overall, the risk of VTE is five times higher in patients with fractures of the tibia, as compared to trauma patients without these injuries [3].

Pathogenesis is multifactorial but relates to venous stasis, direct and indirect damage to the vascular intimal layer, and generalised activation of the coagulation cascade; Virchow's triad [7,8]. Hypercoagulability is found in 85% of trauma patients [9] and persists for more than one month in 80% of cases. Most DVTs that occur in trauma patients begin in the deep veins of the calf and often do not extend proximally. For that reason they often remain asymptomatic [3,11]. In fact, less than 2% of trauma patients suffer *symptomatic* DVT. This can be mostly attributed to the fact that in lower limb trauma patients, the presence of pre-existing leg pain and swelling complicate the clinical diagnosis of DVT [12,13]. Various mechanical and chemical methods are available for prophylaxis. None of these methods have been shown to provide complete prevention from VTE. The risk of venographic proven DVT can be

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reduced to less than 10% with prophylaxis regardless of the type of treatment for fracture or the VTE prophylaxis used [14].

Circular frames are now widely used in the treatment of tibial fractures and these results are not currently represented in the literature. There are few reports available regarding the risk of VTE in this subset of patients during their course of treatment. Sems et al. [15] reported a risk of 2.1% following their protocol of early spanning external fixation followed by definitive internal fixation, while Ramos et al. [16] reported no cases of DVT when they treated 39 distal tibial fractures with circular frames.

The aim of this paper was to review data from a large single surgeon series of consecutive circular frames treating tibial fractures of all types. We planned to calculate the incidence of VTE events in our series. In addition, to further identify contributory risk factors leading to VTE events.

Patients and methods

A retrospective review of prospectively collected data within our unit was performed. Hull Royal Infirmary is a major trauma centre, treating patients directly from its own Emergency Department and surrounding hospitals. Consecutive patients treated between 2004 and 2011 with circular frames for acute tibial fracture were included.

Patients were treated initially with an above knee plaster back-slab including the foot. If soft tissue resuscitation or provisional reduction/alignment was required, a temporary external fixator was applied, which remained until definitive surgery. All patients had a standardised VTE risk assessment on admission and if no contraindications, received a single subcutaneous prophylactic dose of Dalteparin 5000 units once daily starting immediately. Chemical thromboprophylaxis was continued until patients were mobilising weight bearing as tolerated. Patients with tibial shaft fractures were allowed to fully weight bear postoperatively, but those with periarticular fractures were advised to non-weight bear, progressing to weight bearing as tolerated at 6 weeks. Where either the ankle or knee joint was spanned, prophylaxis was continued until the joint spanning fixation was removed—this was irrespective of weight bearing status.

Potentially symptomatic patients were deemed to be so if they subjectively complained of increasing pain and swelling in the lower limb. Wells score (two-level DVT score) as recommended by the National Institute of Clinical Excellence [17] was not felt appropriate, as all patients would score above the threshold value of 2, leading to further investigation. Suspected patients underwent ultrasound Doppler scan to diagnose DVT and Computed Tomography Pulmonary Angiogram (CTPA) to diagnose PE. Once VTE was diagnosed, patients received treatment dose of Dalteparin initially and warfarin thereafter for 3–6 months.

All patients were operated on by the senior author, who was directly involved in peri-operative care until discharge. Fractures were classified according to anatomy (plateau, shaft or pilon) and whether they were closed or open. Patients received either Ilizarov or Taylor Spatial Frame (TSF) based on fracture configuration.

We retrospectively reviewed all patients' notes in addition to our database to confirm there were no other admissions under other specialities with VTE events. We made note of the following parameters: age, gender, body mass index (BMI), smoking status, fracture type (anatomy and open/closed), delay to frame treatment, weight bearing status post-frame, inpatient stay, total duration of frame treatment and injury severity score (ISS). Descriptive statistics were calculated; means with standard deviation (s.d.) for parametric, and medians with interquartile ranges for non-parametric data. The Student *T*-test (TT) was used to compare age and BMI (unpaired parametric data). Fishers exact test (FE) for gender, smoking, fracture type and postop weight bearing status (categorical data). Mann–Whitney *U* test (MW) was used to analyse delay to frame, inpatient stay and duration of frame treatment (unpaired nonparametric data).

Results

During the study period 177 patients were treated with circular frames for tibial fractures. The average ISS score was 9 (mode), 4 individuals had previous history of VTE and 3 females were on the oral contraceptive pill on admission. Sixty-two individuals required spanning external fixation prior to definitive surgery and the remaining individuals had an above knee back-slab until surgery. Ilizarov frames were used in 115 patients, and TSFs in 62. There was 100% compliance of VTE prophylaxis, with all patients receiving low molecular weight heparin (LMWH) within 24 h of injury. The median delay to surgery was 9 days in the non-VTE group and 4 days in the VTE group. The median inpatient stay was 11 days in the non-VTE group and 15 days in the VTE group. The frame duration was 23 weeks in the non-VTE group and 29 weeks in the VTE group. The interquartile ranges of these median averages were such that these three results were not statistically significant.

Symptomatic VTE occurred in 7 patients (Table 1), which represents a proportion of 4.0% ± 2.87% (95%CI); DVT in 3 patients (1.7%) and PE in 4 (2.3%). None of the seven patients had either a past medical history of VTE or were taking the oral contraceptive pill. Diagnosis of VTE events was made between 2 weeks and 38 weeks post injury. PE tended to be diagnosed earlier than DVT, but the numbers were too small to analyse further.

The demographics (age, gender, BMI and smoking status) of the complete case series, in addition to subgroups of patients with and without VTE events are shown in Table 2. The BMI of the VTE group was found to be significantly higher than the non-VTE group ($p = 0.01$). The other patient related factors were found to be non-significant ($p > 0.05$).

The non-demographic related variables with statistical analysis are illustrated in Table 3. In all these results the VTE group was comparable to the non-VTE group, with no statistical difference seen, though *trends* in the VTE group were observed towards earlier surgery, longer inpatient stay and longer frame durations.

Table 1
VTE group demographics, including whether DVT or PE and time from injury to diagnosis.

	Age	Gender	BMI	Smoking	Fracture type	Open or closed	Delay to frame/days	Weight bearing	Inpatient stay/days	Frame duration/weeks	VTE Occurrence/weeks after injury
1	46	M	32	N	Plateau	C	4	NWB	37	54	PE 15/52
2	31	F	29	N	Shaft	O	1	FWB	7	21	DVT 2/52
3	57	M	32	N	Pilon	C	8	NWB	25	18	PE 4/52
4	33	F	33	N	Shaft	C	4	FWB	12	29	PE 10/52
5	53	F	39	Y	Shaft	O	9	FWB	11	30	DVT 38/52
6	60	M	29	Y	Plateau	C	3	NWB	44	33	DVT 38/52
7	60	M	28	N	Pilon	C	31	NWB	15	26	PE 13/52