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ORIGINAL ARTICLE

Incidence of DVT and PE after surgical reconstruction for pelvic and acetabular fractures: Does routine duplex scanning affect management?

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Abstract

Background Prevention and detection of thromboembolism with pelvic and acetabular fractures remains controversial. The aim of this study was to evaluate a protocol using LMWH prophylaxis and duplex screening both pre-operatively (if there is a delay > 72 h to surgery) and post-operatively at day 5–7. We assessed the incidence of thromboembolism and associated risk factors.

Methods A total of 255 consecutive patients who underwent pelvic and/or acetabular reconstruction in a major trauma and tertiary referral centre between January 2013 and December 2015 were studied. Forty-three patients were excluded due to non-adherence to protocol leaving 212 patients included in the study.

Results Patients were of mean age 49 years (15–94) and mean ISS 24.5 (4–66). Pre-operative screening detected two patients with asymptomatic above-knee DVT who then underwent pre-operative IVC filter insertion. Post-operative screening detected seven patients (3%) with lower limb DVTs (3 proximal and 4 below knee). The three patients with proximal DVTs were fully anticoagulated and did not develop symptomatic PE. Six patients (2.8%) developed post-operative PE, four of which were symptomatic and confirmed by CT angiography. Seven patients (3%) died in the post-operative period due to non-VTE-related causes. The overall rate of VTE was 6%, including DVT 4% and PE 2.8%. PE was associated with administration of tranexamic acid in ED ($p > 0.03$) and total amount of blood transfused during admission ($p > 0.001$). VTE was not associated with age, injury type, ISS, delay to surgery or associated injuries.

Conclusion A protocol-based approach to VTE prophylaxis and screening in trauma patients with pelvic and/or acetabular reconstruction resulted in no VTE-related mortality. Pre- and post-operative screening for DVT changed the management in five patients, with none developing PE. Patients requiring more aggressive resuscitation had a higher rate of PE. The VTE rate was lower than previously reported.

Keywords Pelvic and acetabular fractures · DVT · PE · VTE · DVT screening

Background and aim

Venous thromboembolism (VTE) remains a major cause of morbidity and mortality following pelvic and acetabular trauma. The reported incidence of deep vein thrombosis (DVT) and pulmonary embolus (PE) varies depending on the method used for diagnosis, with studies reporting rates of proximal DVT as high as 35% and symptomatic PE as high as 10% [1–3].

Many authors have suggested routine prophylaxis and screening for VTE in this high risk group [3–5]. However, a 2012 study showed discrepancy between different centres in the UK; with 45% of the centres not prescribing chemical prophylaxis after patient discharge. Only three of 18 centres were performing routine pre-op duplex scans if there was a delay to surgery, and only one centre was performing routine post-operative duplex scans [6].

In our unit, a protocol for pelvic and acetabular trauma thromboprophylaxis has been in place since 1993, which includes commencement of low molecular weight

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heparin (LMWH) within 24 h of admission or achievement of haemodynamic stability. Pre-operative screening for DVT using bilateral lower limb duplex scans is performed in all patients when there is a delay more than 72 h to definitive surgery. If a proximal DVT is diagnosed, an inferior vena cava filter (IVC) is placed. Routine post-operative duplex scan screening of bilateral external iliac veins and lower extremities is performed within 5–7 days after surgery and prior to patient discharge.

The aim of this study was to assess whether routine pre- or post-operative duplex scanning affected patient management in patients who sustained pelvic and/or acetabular trauma. Secondary aims were to calculate our unit's DVT and PE rates, PE-related mortality and the factors associated with increased risk of VTE in this group of patients.

Patients and methods

This study was registered as a service evaluation audit with the institution. Case note and radiology images of 255 consecutive patients, who underwent surgical fixation of pelvic and acetabular fractures, presenting in the three calendar years of 2013–2015 were retrospectively reviewed. Forty-three patients were excluded due to non-compliance with the VTE protocol, including 25 patients that did not have pre-operative screening with duplex scans despite more than 72 h delay to surgery, and 20 patients that did not have post-operative duplex scans. Two of these patients did not have either pre-operative or post-operative screening. The overall compliance rate was 83% with the protocol.

All patients were administered a prophylactic dose 40 mg enoxaparin subcutaneously within 24 h of admission or after achieving haemodynamic stability. If a PE or an above-knee DVT was diagnosed the patient was administered a therapeutic dose of 1.5 mg/kg. A duplex scan was performed pre-operatively if there had been a delay more than 72 h from injury till surgery and a routine post-operative duplex at day 5–7.

Duplex scanning was carried out by a specialized vascular testing radiographer on the veins of both lower limbs. The common femoral veins, profunda femoris veins in the groin and the whole of the femoral vein in the thigh together with popliteal veins were assessed. Any presence of thrombus in the above-mentioned veins was considered as positive for above-knee DVT.

The injury severity score (ISS), administration of tranexamic acid (TXA) and associated injuries were obtained from the medical records. The requirement for blood transfusion was obtained from our institution's blood transfusion records. The cause of death was obtained from the coroner's office and the medical records.

Results

The study cohort of 212 patients who were managed according to protocol were of mean age 49 (range 15–94) years and mean ISS 24.5 (range 4–66). One hundred and two patients sustained pelvic fractures, 92 acetabular fractures and 18 had combined pelvis and acetabular fractures. Associated injuries were present in 169 patients (80%). The majority of injuries resulted from road traffic accidents.

The mean time from injury to definitive surgery was 4 days (range 0–44). Pre-operative screening for DVT with bilateral lower limb duplex scan was performed in 58 patients who waited more than 72 h to surgery. Screening detected two patients with asymptomatic above-knee DVTs, and both patients underwent IVC filter insertion prior to surgery. The IVC filters were removed after 3 months without complication. Neither patient developed symptomatic PE.

Seven patients had DVTs detected on routine post-operative duplex scanning, all being asymptomatic. Three of these patients had above-knee DVTs and were prescribed therapeutic anticoagulation for a 3-month period; none developed further VTE complications. Four patients had below-knee DVTs and continued to receive prophylactic dose LMWH anticoagulation without developing further VTE complications (Table 1). From the seven patients who developed post-op DVTs, two of them had negative pre-operative duplex scans, and the remainder were not scanned pre-operatively as their surgery was not delayed more than 72 h.

Six patients (2.8%) developed post-operative pulmonary embolism confirmed by CT angiography. Four of these patients were symptomatic and two were incidental findings on CT scans performed for other injuries. Four patients developed PE within 5 days, before routine post-operative DVT screening with duplex scan was scheduled, while two developed PE after a negative scan. All patients who developed PE required 6 months of full anticoagulation and did not develop further complications.

The overall rate of VTE was 6% in our cohort of patients. The overall DVT rate was 4%, with 2.3% being clinically significant, above-knee DVT, and the PE rate was 2.8%. The

Table 1 Results of duplex screening

	VTE screening pre-op (%)	VTE screening post-op (%)
Number of patients	58 (27.4)	212 (100)
Number of positive DVT	2 (3.4)	7 (3.3)
Number of above-knee DVTs	2 (3.4)	3 (1.4)
Number of patients PE	0	6 (2.8)
Total VTE	2 (3.4)	13 (6.1)

detection rate for routine pre-operative duplex screening was 3.5%, with two DVTs picked up after screening 58 patients. The detection rate for post-operative DVT was 3.3%, with seven DVTs detected after screening 212 patients.

There was no significant association between DVT or PE with age, delay to surgery, type of fracture, ISS or associated injuries.

The development of PE was significantly associated with the total amount of blood units transfused during admission. The patients who developed a PE had mean of 8 units of blood transfused during their hospital stay (range 2–30, median 3.5), while the patients who did not develop a PE had a mean of 1.6 units transfused (range 0–32, median 0). This relationship was statistically significant. ($p = 0.001$).

Development of PE was also significantly associated with the use of tranexamic acid in the Emergency Department setting ($p = 0.03$). Five of the six patients (83%) who developed PE had tranexamic acid administered during initial resuscitation, compared to 35% in the rest of the study population.

Seven patients (3.3%) died post-operatively during the study period. None of these deaths were due to VTE. Causes of deaths included chest trauma, head trauma, ARDS and SIRS. None of these patients had a DVT or PE diagnosed or clinically suspected pre or post-operatively.

Death was significantly associated with a higher ISS, older age, amount of blood units transfused, use of tranexamic acid and delay to definitive pelvic surgery. Patients with pelvic fractures had a significantly higher mortality rate than those with acetabular fractures ($p = 0.039$).

Discussion

Development of VTE can best be explained by the classical Virchow's triad: haemodynamic changes, endothelial dysfunction and hypercoagulability [7]. The three factors are profoundly demonstrated in pelvic and acetabular fractures both following the initial injury and surgical intervention.

The incidence of DVT following pelvic fractures has been reported to be as high as 60% without prophylaxis [8], and as low as 10% with routine thromboprophylaxis [4]. The incidence of pulmonary embolism has been reported to be between 2 and 10% with a mortality rate of 2% [2]. This highlights the importance of clear protocols in this patient group. A study in the same istitution by Steele et al. [4] demonstrated a significant difference in thrombosis rate when LMWH was commenced within 24 h following injury compared to delayed administration.

Duplex screening in this patient group has been described in a number of studies. Moed et al. described a protocol with routine scanning for all patients on the day of surgery or the evening before, followed by a duplex scan before discharge. They also administered LMWH when haemodynamic stability was achieved, but delayed the use of LMWH for 3 days following surgery. They detected asymptomatic DVTs in 15% of the patients (7% pre-operatively, and 8% post-operatively). Similar to the current report, they did not encounter a fatal PE [9]. Similarly, Fishmann et al. [10] implemented a protocol of routine pre-operative scans and post-operative warfarin and also did not encounter VTE-related morbidity. Wang et al. reported an incidence of 19% of proximal DVT following mechanical and chemical prophylaxis, and using duplex to scan patients both pre- and post-operatively. Age above 60, associated injuries and surgical delay for more than 2 weeks were risk factors for DVT in their cohort [11].

Borer et al. compared screening versus non-screening for DVTs in patients with closed pelvis and/or acetabular fractures. Screening was done with ultrasound and magnetic resonance venography. They concluded that there was no difference in PE rates in the screened versus the non-screened group and thus recommended against the screening program. However, it is noteworthy that in both the screened and non-screened groups, prophylactic IVC filters were inserted for the high risk groups, which may have affected their results [12].

In the current report, five above-knee DVTs were detected on routine scanning, two of which were pre-operative. With appropriate treatment of these patients, none of them went on to develop VTE-related morbidity or mortality.

Although duplex scanning is not the most sensitive method for detection of DVTs yet it is a low-cost, rapid and safe bedside method for screening, with an estimated cost of 46 GBP [13] per scan. It is performed by an ultrasound technician rather than a radiologist, with little burden on the vascular testing department. Contrast venography is more sensitive than duplex scanning, but the use as a routine scanning tool is not practical, particularly in the trauma setting.

We aim to operate on our pelvic and acetabular patients within 72 h from injury; this time frame has also been recommended in the recent guidelines from the British orthopaedic association [14]. However, delays in this group of patients may be inevitable due to haemodynamic instability, associated injuries and patient transfer from local their hospital or logistics. This was the rationale behind using 72 h of delay as the cut-off for pre-operative screening. Post-operatively, the patients were screened in day 5–7 as most patients would be discharged or transferred to their local hospital in 5–7 days.

Duplex scanning successfully screened 6 positive DVT patients. However, it was negative in two cases which later developed symptomatic PEs. It also failed to detect 4 DVTs which occurred early on. This raises an important question in regards to the optimal timing of duplex screening. It has been shown in the current report and other studies [12] that PE can occur after the patient has been screened and found

to be negative for DVT. It is also impossible to know when thrombosis might occur, whether it might develop following injury, during the surgery or a few days later. This has also been highlighted in the work of White et al. [15] using serial ultrasound screening for lower limbs DVT following pelvic fractures. Thus, the optimal timing of screening is difficult to determine and a considerable limitation against it use. However, it is a clinically important finding that in patients identified with above-knee DVT and who were then treated, none of these progressed to PE. Furthermore, the detection rates for DVT were 3.5% with pre-operative screening and 3.3% with post-operative screening of asymptomatic patients in the current report. The authors recommend continuing this screening protocol.

The VTE rate found in the current study is lower than reported in the literature [2, 4, 8], suggesting that strict adherence to LMWH within 24 h of injury or as soon as haemodynamical stability is achieved contributes to lowering thrombosis rates. LMWH was also commenced as soon as 12 h post-surgery. Although we did not review the drug charts of the 255 patients in this study to check compliance with LMWH prescription, a departmental audit performed in the same time period showed 100% compliance with LMWH prescription in all trauma patients when indicated.

A recent literature review on risk factors for thrombosis in trauma patients performed by The Eastern Association for the Surgery of Trauma (EAST) categorized spinal injuries as level 1, at highest risk, and level 2 risk factors included age, ISS, need for blood transfusion, pelvic fractures, head injuries and long bone fractures [16]. The current study confirms an apparent association between the need for blood transfusion and PE.

There is no evidence that tranexamic acid increases risk of thrombosis, whether in trauma or orthopaedic surgery [17–19]. Our data showed that the use of tranexamic acid was associated with a higher rate of PE. However, the data also demonstrated that PE was significantly associated with the amount of blood units transfused, thus use of tranexamic acid may be a confounding factor reflecting injury severity rather than a cause of thrombosis.

The strength of the study lies in the relatively large cohort of 212 patients over a three year period. The main limitation was the retrospective design and the absence of a control group.

Conclusion

A protocol-based approach to VTE prophylaxis and screening in trauma patients undergoing pelvic and/or acetabular reconstruction resulted in no PE-related mortality. Pre- and post-operative screening for DVT changed the management in five patients, with none developing PE. The VTE rate was lower than previously reported.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interests.

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