Risk factors of venous thromboembolism in Indian patients with pelvic-acetabular trauma

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ABSTRACT

Purpose. To determine risk factors of venous thromboembolism (VTE) in Indian patients undergoing surgery for pelvic-acetabular fractures.

Methods. 48 men and 8 women aged 17 to 61 (mean, 36) years who underwent open reduction and internal fixation for pelvic-acetabular fractures were evaluated for VTE in the postoperative period. Pulmonary angiography and indirect computed tomographic venography were used in the hospital, whereas colour Doppler ultrasonography was used in an outpatient setting until postoperative week 6. Patients with evidence of VTE were treated according to the American College of Chest Physician guidelines. Correlations between VTE and putative variable were assessed, and risk factors determined.

Results. 16 patients developed VTE. Six patients with proximal DVT had associated pulmonary embolism (PE). There were 12 cases of proximal deep vein thrombosis (DVT), 2 cases of distal DVT, and 10 cases of PE. The rate of VTE was significantly higher in patients who had predominantly posterior injury (as opposed to anterior injury) [13/27 vs. 3/29, p=0.003], who were operated on in the lateral position (as opposed to the supine position) [13/30 vs. 3/26, p=0.016], or via the Kocher-Langenbeck or combined approach (as opposed to others) [13/30 vs. 3/26, p=0.016]. Patients were more likely to develop VTE when they had predominantly posterior injuries (7.8 fold) or were operated on in a lateral position (2.96 fold) or via the Kocher-Langenbeck approach (2.27 fold).

Conclusion. Pelvic-acetabular trauma is a significant risk factor for VTE, even in Indians. Patients who have posterior injuries or are operated on in the lateral position, or via the Kocher-Langenbeck approach have a significantly higher risk of VTE.

Key words: hip fractures; India; pelvis; pulmonary embolism; venous thromboembolism

INTRODUCTION

Venous thromboembolism (VTE) encompasses deep
vein thrombosis (DVT) of lower extremities/pelvic veins and pulmonary embolism (PE). Potential factors influencing VTE include age, gender, ethnicity, presence of medical and/or surgical co-morbidities, prolonged immobilisation, and the administration of corticosteroids, oral contraceptives, or hormone replacement therapy. Patients with spinal and pelvis-acetabular fractures secondary to high-velocity trauma have higher risks of developing VTE as these fractures are usually associated with injury to the vascular structures around the hip and require prolonged immobilisation. Subsequent manipulation causes further damage to vascular endothelium and precipitates thrombus generation. The incidence of DVT and PE among Asians has been considered low but may actually be higher. We analysed potential factors influencing VTE in Indian patients who underwent surgery for pelvic-acetabular fractures.

MATERIALS AND METHODS

Between January 2008 and December 2009, 48 men and 8 women aged 17 to 61 (mean, 36) years underwent open reduction and internal fixation for pelvic-acetabular fractures and were evaluated for VTE. Informed consent was obtained from each patient. Patients with renal failure, allergy to dye, any associated head/chest/abdominal/long bone/spine injuries, in receipt of heparin or anticoagulant therapy were excluded, as were those having other risks of VTE (myocardial infarction, nephrotic syndrome, hormone replacement therapy or oral contraceptives, underlying malignancy and systemic vascular diseases).

After resuscitation and haemodynamic stabilisation, patients with fracture dislocations were immediately put on skin/skeletal traction. Early active or passive physiotherapy was started, as soon as tolerated by the patient. Haemograms, renal and liver function tests, coagulation profile testing, and arterial blood gas analyses were performed.

The patients were operated on as soon as they were deemed fit for surgery. The type of fracture, associated injury, interval between injury and surgery, type of anaesthesia, and surgical position and approach were recorded. A compression dressing was applied over the surgical wound and non-weight bearing physiotherapy was initiated within 24 hours of surgery. No mechanical or chemical thromboprophylaxis was administered.

Patients were evaluated daily for signs and symptoms of VTE. The thrombi were defined as proximal if they involved popliteal or more proximal veins, and distal if they involved tibial or calf muscle veins. Clinical evaluation for DVT was based on the onset of lower-limb swelling, calf tenderness, and Homán’s sign. Patients with breathing difficulty, pleuritic chest pain, and pleural rubs were evaluated for underlying PE.

Pulmonary angiography and indirect computed tomographic (CT) venography were used to confirm the presence of VTE. Patients with no clinical evidence of VTE were tested on day 5 (±2), and a contrast study involving a 16-slice spiral CT and 130 ml of non-ionic dye infused at a rate of 2 ml per second was also performed. A venous-phase study was obtained after a delay of 180 seconds. Films were appraised by radiologists. Patients with evidence of VTE were treated according to the American College of Chest Physicians (ACCP) guidelines, namely: 80 mg/kg intravenous heparin bolus followed by 18 mg/kg/hr infusion with a simultaneous 5 mg dose of oral warfarin. Patients were regularly monitored for their international normalised ratio (INR) and activated partial thromboplastin time. Heparin infusion was stopped once a target INR of 2.5 was achieved for 24 hours.

Patients with clinical evidence of VTE were tested on the same day and treated as per the ACCP guidelines. Patients who were positive for PE were monitored by pulse oxymetry and those with low saturations were supplied with oxygen via a mask.

Patients were discharged once the sutures were removed. They were followed up for 6 weeks by a senior radiologist, using colour duplex ultrasonography for bilateral calf, thigh and pelvic veins. They were also followed up by telephone, regarding any complaint suggestive of VTE.

Correlations between VTE and putative variables were assessed. For quantitative variables, means, medians and standard deviations were calculated. Means of both groups were compared using Student’s t test. Qualitative or categorical variables were described as frequencies and proportions. Proportions were compared using the Fisher’s exact test. Multiple logistic regression analysis was applied to factors showing a significant effect on the VTE rate after univariate analysis. Statistical tests were 2-sided and performed at a significance level of \( \alpha = 0.05 \).

RESULTS

The most common types of acetabular fractures were bicolumnar (29%, Fig. 1) and transverse with posterior wall involvement (21%, Fig. 2). 11 patients had 13
associated injuries: clavicular fracture (n=2), humeral fracture (n=2), Galleazi or Monteggia fracture-dislocations (n=2), fractures of both forearm bones (n=1), scapular fracture (n=1), shoulder dislocation (n=1), metatarsal fracture (n=2), and patellar fracture (n=2). Four patients had associated sciatic nerve injury.

The mean delay in surgery was 12.2 days; 15 patients were operated on within 5 days, 19 within 5 to 10 days, and 22 after 10 days. Patients were operated on under general (n=6) or spinal-epidural (n=50) anaesthesia, and in a lateral (n=30) or supine (n=26) position.

During hospitalisation, 6 patients had clinical evidence of VTE (chest pain in one, calf tenderness in 2, thigh tenderness in 2, and fever in one). The patient with chest pain was confirmed to have PE. Two patients with calf tenderness were confirmed to have PE but not DVT. The remaining 3 patients (with thigh tenderness or fever) were confirmed to have proximal DVT. The patient with fever was of low grade and had no other complaints.

During hospitalisation, 15 patients had radiological evidence of VTE. There were 11 cases of proximal DVT, 2 cases of distal DVT, and 10 cases of PE. Six patients with proximal DVT had associated PE. Two patients had both distal and proximal DVT; one of them also had PE (Fig. 1). Three patients had bilateral proximal DVT. In 4 cases of PE, no DVT locus was identified (Fig. 2). Two cases of PE had clinical evidence of distal DVT.

During the 6-week follow-up period, only one patient developed proximal DVT. Another had limb oedema but no radiological evidence of DVT. All patients with VTE had complete resolution of thrombus at week 6, and no death occurred.

The rate of VTE was significantly higher in patients who had predominantly posterior injury (as opposed to anterior injury) [13/27 vs. 3/29, p=0.003, Fisher’s exact test, Table 1], who were operated on in the lateral position (as opposed to the supine position) [13/30 vs. 3/26, p=0.016, Fisher’s exact test], or via the Kocher-Langenbeck or combined approach (as opposed to others) [13/30 vs. 3/26, p=0.016, Fisher’s exact test, Table 2]. Presence of VTE did not correlate with age (p=0.173), gender (p=0.546), associated injuries (p=0.48), sciatic nerve injury (p=0.57), type of anaesthesia (p=0.662), and interval between injury and surgery (p=0.471). The number of confirmed VTE cases at different locations is shown (Fig. 3).

In multiple logistic regression analysis, patients were more likely to develop VTE when they had predominantly posterior injuries (as opposed to anterior injuries) [odds ratio (OR), 7.8; p=0.125], or were operated on in the lateral position (as opposed to supine position) [OR, 2.96; p=0.527], or via the

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**Figure 1**  A 38-year-old man with a bicolumnar acetabular fracture of the left hip is treated with open reduction and internal fixation using recon plates. A popliteal vein thrombus in the left lower limb and an embolus in the right pulmonary vasculature (arrows) are shown.

**Figure 2**  A 21-year-old man with a transverse acetabular fracture and vertically unstable pelvic injury is treated with open reduction and internal fixation using recon plates, pedicle screws, rods, and multiple partially threaded cancellous screws. Complete obstruction of the right pulmonary artery (arrow) leads to pulmonary infraction, but no thrombus is identified in the lower-limb veins.
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Kocher-Langenbeck approach (as opposed to others) [OR, 2.27; p=0.334].

DISCUSSION

VTE is a major cause of morbidity and mortality in patients with orthopaedic trauma. According to the ACCP, its incidence is higher in these patients than those having arthroplasty. Routine mechanical and chemical thromboprophylaxis is widely practised in western countries. Asian studies report a low incidence of VTE; most of which are related to arthroplasty or surgery for hip fractures. The rate of DVT was 7.2% and no PE was detected (based on colour duplex ultrasonography) in 125 patients undergoing high-risk lower-limb surgeries without prophylaxis. Most thrombi were in distal veins and resolved without any treatment. Using repeat venography at 6 months, most thrombi in Thais undergoing THR and TKR were distal (with low risk of proximal propagation), and almost all resolved spontaneously without any consequences. Asians living in western countries also appear to have lower rates of VTE. Nonetheless, a few studies have reported higher rates of VTE in Asians. This is attributed to increased life expectancy, changing lifestyle, and better diagnosis modalities. The DVT rate (based on venography) was 63% in 88 Malaysian patients undergoing total hip/knee arthroplasty or repair of proximal femoral fractures (without prophylaxis). In the largest multicentre, centrally audited venographic trial in Asian patients, the rate was 41% in patients undergoing total hip/knee arthroplasty or hip fracture surgery without prophylaxis. The rate of proximal DVT was 10 to 17%. In Indian patients undergoing total hip/knee arthroplasty, the DVT rate (based on venography) was 60%; all except one patient had general anaesthesia. Similarly, in our Indian patients who underwent surgery for pelvic-acetabular traumas, the VTE rate was 29%, and most thrombi were proximal and/or involved the pulmonary vasculature.

The pathophysiology of VTE in trauma patients

### Table 1
Rates of venous thromboembolism (VTE) in patients with predominantly anterior or posterior pelvic-acetabular injuries

| Injury Type                      | No. of VTE | No. (%) of VTE |
|----------------------------------|------------|----------------|
| Anterior injuries (n=29)         |            |                |
| Anterior wall (n=0)              | 0          |                |
| Anterior column (n=1)            | 0          |                |
| Anterior wall + post-hemitransverse (n=4) | 0     |                |
| Transverse type (n=2)            | 0          |                |
| Bicolumnar fractures (n=15)      | 1          |                |
| T-type fracture (n=7)            | 2          |                |
| Posterior injuries (n=27)        |            |                |
| Posterior wall (n=6)             | 2          |                |
| Posterior column (n=2)           | 2          |                |
| Posterior column + posterior wall (n=4) | 0    |                |
| Transverse with posterior wall (n=12) | 6    |                |
| Pelvic fracture with vertical displacement (n=3) | 3 |                |

* One patient had distal deep vein thrombosis

![Figure 3](image)

Figure 3 The number of confirmed venous thromboembolism at different locations.

### Table 2
Venous thromboembolism (VTE) risk with different surgical approaches

| Approach           | No. of patients | No. (%) of VTE |
|--------------------|-----------------|----------------|
| Kocher-Langenbeck  | 29              | 12 (41)        |
| Modified iliopmental | 18              | 2 (11)         |
| Iliinguinal        | 8               | 1 (13)         |
| Combined           | 1               | 1 (100)        |
| Total              | 56              | 16 (29)        |
differs from those undergoing elective surgery; most thrombi in trauma patients are proximal in location.\textsuperscript{2,3} Particularly in patients with pelvic-acetabular injuries, high-velocity trauma itself is an inciting factor for VTE, which is aggravated by surgical manipulation and prolonged postoperative immobilisation.\textsuperscript{3,4} The rates of DVT in patients with pelvic-acetabular injuries vary from 10 to 60\%, and about 50\% involve proximal veins.\textsuperscript{2-4,17} Proximal thrombi have a high propensity to propagate and cause PE, which is the most common cause of death during postoperative period. The rates of PE in patients with pelvic-acetabular injuries range from 2 to 10\%, compared to an overall rate of 0.5 to 2\% in trauma patients.\textsuperscript{18} In our study, despite the higher rate of PE (18\%), there was no mortality, owing to appropriate diagnostic screening of all patients.

Clinically silent PE and the possible indications of sudden death may be missed when diagnosis relies on clinical features. In those having acetabular and pelvic fracture surgery, 2 deaths were attributed to VTE out of 103 patients,\textsuperscript{19} and 2 more in a series of 197 patients.\textsuperscript{20} Clinical diagnosis was inadequate, as only one of our patients had chest pain, whereas 9 had clinically silent PEs that would have been missed. Routine screening for PE in patients undergoing surgery for pelvic-acetabular trauma is therefore recommended, as PE may manifest without any evidence of DVT (4 cases in our series). The rate of PE was 19\% and that of DVT was 7\% in 247 patients sustaining major trauma.\textsuperscript{21} Nonetheless, some thrombi in the pulmonary circulation may not be related to DVT and could arise de novo.\textsuperscript{22} The reported rates of VTE after pelvic-acetabular trauma in different studies are compared (Table 3).

Colour Doppler ultrasonography is largely insensitive in diagnosing pelvic vein thrombi, and a second diagnostic tool for evaluation of PE is needed.\textsuperscript{22,23} The relatively low reported rates of VTE could be attributed to this problem.\textsuperscript{19,20} Magnetic resonance venography (MRV) is non-invasive and has 100\% sensitivity and 97\% specificity.\textsuperscript{23} It can detect very small thrombi which may not be clinically significant. CT pulmonary angiography and indirect venography (CTVPA) are highly sensitive (97\%) and specific (100\%) for femoro-popliteal thrombus and can detect both PE and DVT using same contrast in the circulation.\textsuperscript{24,25} It can also detect pelvic and vena caval thrombi, which are not detected by ultrasonography. All our patients were evaluated with CTVPA during their hospital stay, and with colour Doppler ultrasonography (an ideal non-invasive diagnostic tool for outpatients) during the follow-up period.\textsuperscript{23}

The effect of limb position and manipulation during surgery (flexion, adduction and internal rotation) that may cause femoral vein occlusion has

| Table 3 |
|-----------------------------|
| Reported venous thromboembolism (VTE) rates in patients with pelvic-acetabular trauma\textsuperscript{1,4,19,20,28,31} |
| Study | Our study | Geerts et al,\textsuperscript{4} 1994 | Fishmann et al,\textsuperscript{20} 1994 | Montgomery et al,\textsuperscript{3,31} 1997 | Stannard et al,\textsuperscript{28} 2001 | Steel et al,\textsuperscript{19} 2005 |
| Nature of study | Postoperative | Postoperative | Postoperative | Preoperative | Postoperative | Preoperative |
| No. of men+women | 48+8 | 100 | 105+45 | 69+42 | 107 | 83+20 |
| Mean patient age (years) | 36 | 39 | 40 | 42 | 66 (66) | 77 (76) |
| No. (%) of associated injuries | 11 (19) | - | 120 (61) | - | - | - |
| Prophylaxis | No | No | Mechanical + warfarin | Heparin + inferior venacava filter | Magnetic resonance venography | Magnetic resonance venography |
| Radiological assessment | Computed tomographic pulmonary angiography and indirect venography | Conventional venography | Colour duplex ultrasonography | Magnetic resonance venography | Magnetic resonance venography | Colour duplex ultrasonography |
| No. (%) of proximal deep vein thrombosis | 11 (20) | 29 (29) | 20 (10) | 37 (37) | 15 (14) | 10 (10) |
| No. (%) of pulmonary embolism | 10 (18) | - | 2 (1) | 1 | 1 | 5 (5) |
| No. (%) of acute VTE | 15 (27) | 61\% | 20 (10) | 38 (38) | 16 (15) | 10 (10) |
| No. (%) of clinical VTE | 6 (40) | - | - | 0 | 0 | 0 |
| No. of deaths | 0 | - | 2 | 0 | 0 | 2 |
| No. of late deep vein thrombosis | 1 | - | - | - | 1 | - |
been studied during total hip replacement.\textsuperscript{26,27} A study reported a trend toward the development of DVT with the Kocher-Langenbeck and Extensile or combined approaches, with 13 of the 15 patients with DVT via such approaches.\textsuperscript{28}

Injury to posterior structures is associated with more severe trauma than anterior injuries, and occurs when the limb is flexed and adducted at the time of impact, which is the same position that causes kinking of femoral vessels\textsuperscript{29,30} and the associated posterior dislocation. These patients are operated on in the lateral position, and the higher rate of VTE associated with posterior injuries could be due to the cumulative effect of the surgical position and injury type.

Prolonged immobilisation is associated with VTE pathogenesis.\textsuperscript{28,31} In our study, the duration from injury to surgery was not significantly associated with VTE (10 days in patients who developed VTE vs. 13 days in those who did not, \( p=0.471 \)). The surgery and subsequent manipulation of trauma patients increases the VTE risk.\textsuperscript{17}

\section*{CONCLUSION}

Pelvic-acetabular trauma is a significant risk factor for VTE, even in Indians. Most VTEs involve proximal veins and the pulmonary vasculature. The relatively high rates of isolated PE, without a DVT locus, indicate the need for universal screening of all patients with pelvic-acetabular trauma. Patients who have posterior pelvic-acetabular injuries or are operated on in the lateral position or via the Kocher-Langenbeck approach have a significantly higher risk of VTE.

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