J Orthop Sci (2012) 17:233–238
DOI 10.1007/s00776-012-0203-2

ORIGINAL ARTICLE

# Incidence of venous thromboembolism in pelvic and acetabular fractures in the Japanese population

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Received: 30 May 2011 / Accepted: 19 February 2012 / Published online: 20 March 2012


**Abstract**
*Background* There are no detailed reports of the incidence of venous thromboembolism (VTE) in pelvic and acetabular fractures in the Asian population. The purpose of this study was to investigate the incidence of VTE in pelvic and acetabular fractures in the Japanese population.
*Methods* Forty-six Japanese patients with pelvic and acetabular fractures treated at our hospital from February 2004 to April 2011 were analyzed retrospectively. Until April 2009, VTE screening was performed by contrast-enhanced computed tomography (CT) or ultrasonography (US) when the D-dimer value did not decline predictably, still exceeded 20 μg/ml at 5 days after trauma and surgery, or increased >20 μg/ml after a period of decline. After April 2009, contrast-enhanced CT and US were performed routinely irrespective of the D-dimer value. Physical prophylaxis was performed in all patients. The effects of the presence of pelvic and acetabular fractures, fracture types, accompanying injuries, and screening strategies on the incidences of VTE and pulmonary thromboembolism (PTE) were investigated.
*Results* Overall, 19 patients (41.3%) were diagnosed with VTE and PTE in ten (21.7%). All were asymptomatic. Compared with trauma patients without pelvic and acetabular fractures treated during the same period, significantly higher incidences of VTE and PTE were observed in patients with pelvic and acetabular fractures. No significant differences were observed in the incidences of VTE and PTE between pelvic and acetabular fractures or between patients with and without accompanying injuries. Compared with the previous screening strategy, the detection rates of VTE and PTE were higher for the newer screening strategy; however, the difference did not reach statistical significance.
*Conclusions* We should be vigilant for the high incidence of VTE, especially PTE, in patients with pelvic and acetabular fractures in the Japanese population.

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## Introduction

Venous thromboembolism (VTE), including deep vein thrombosis (DVT) and pulmonary thromboembolism (PTE), is now recognized as an important complication in pelvic and acetabular fractures [1–8]. However, there have been no detailed reports written in English about the incidence of VTE in patients with pelvic and acetabular fractures in the Asian population. Historically, the incidence of VTE in the Asian population has been believed to be lower than that in the Western population [9–16]. However, recent reports have shown that the incidence of VTE in the Asian population is similar to that in the Western population for patients who receive hip-fracture or joint-replacement surgery [17–21]. The incidence of VTE in patients with pelvic and acetabular fractures among the Asian population remains unclear.

In addition, prophylactic measures for VTE can influence the incidence of VTE. Until recently, anticoagulant drugs have not been used as commonly in Japan as in the United States and Europe. In Japan, fondaparinux sodium and enoxaparin have been commercially available only since 2007 and 2008, respectively [22]. Consequently, in Japan, the main VTE prophylactic methods have involved physical prophylaxis without drug administration.

The purposes of this study were to investigate the incidence of VTE in patients with pelvic and acetabular fractures with physical prophylaxis in the Japanese population, to evaluate the effects of fracture types and accompanying injuries, and to discuss VTE screening strategies.

## Methods

Forty-six Japanese patients with pelvic and acetabular fractures treated at our hospital from February 2004 to April 2011 were analyzed retrospectively. The Institutional Review Board of our hospital regard this kind of retrospective study as being out of their concern. The D-dimer value was assayed by the latex photometric immunoassay (LPIA) method (Mitsubishi Chemical Medicine Corporation, Tokyo, Japan) upon blood examination. A normal value is <1 μg/ml. The D-dimer value was recorded at least twice weekly from the time of the trauma to >2 weeks posttrauma and postoperatively.

The strategy used for VTE screening at our hospital changed after April 2009. Until that time, contrast-enhanced computed tomography (CT) or ultrasonography (US) were performed when the D-dimer value did not decline predictably, still exceeded 20 μg/ml even at 5 days after trauma and surgery, or increased >20 μg/ml following a decline after trauma and surgery. After April 2009, contrast-enhanced CT and US were performed routinely at 1–3 days preoperatively and 1 week postoperatively, irrespective of the D-dimer value. Observation of the D-dimer dyamic status was continued in the new strategy.

For prophylaxis of VTE, graduated compression stockings and intermittent pneumatic compression were applied for all patients after admission, except for periods involving the use of external fixators, skeletal traction, casts for injuries of the lower extremities, or contraindications for these mechanical prophylactic devices. When graduated compression stockings and intermittent pneumatic compression could not be applied to the injured leg, they were applied to the uninjured leg. Active range of motion exercises of the ankle and toes were indicated for all patients with a clear mental status.

To compare the incidence of VTE between patients with and without pelvic and acetabular fractures, 95 patients with fractures of the lower extremities in the absence of pelvic and acetabular fractures treated at our hospital from February 2004 to April 2009 were evaluated as the control group. The same prophylaxis and screening methods were performed in the control group.

The effect of fracture types, i.e., pelvic (ring) and acetabular, was investigated for the incidence of VTE. The effect of accompanying injuries was also investigated. The accompanying injuries included head, chest, and abdominal injury and vertebral and lower-extremity fractures. The incidence of VTE was compared between patients evaluated by the former and newer screening strategies. For statistical analyses, $2 \times 2$ chi-square, Yates $2 \times 2$ chi-square, and Fisher exact probability tests were used.

## Results

A total of 29 men and 17 women (average age 53.4 years, range 15–84 years) were divided into groups of 32 patients with pelvic (ring) fractures, 13 with acetabular fractures, and one with both pelvic ring and acetabular fractures. The 33 pelvic ring fractures were divided by the Arbeitsgemeinshaft für Osteosynthesefragen (AO) classification: six for A2, three for B1, 17 for B2, one for B3, three for C1, two for C2, and one for C3. For pelvic fractures, open reduction and internal fixation (ORIF) were performed in nine patients, external fixation in 11, percutaneous screw fixation with external fixation in four, and conservative treatment in nine. For acetabular fractures, ORIF were performed in 12 patients and conservative treatment was administered in two. The average period until ORIF was 10.4 days after the trauma. There were 26 patients with accompanying injuries and 20 patients without. Thirty-one patients were followed using the former screening strategy until April 2009, and 15 were followed using the newer screening strategy after April 2009.

Overall, 19 patients (41.3%) were diagnosed with VTE (Fig. 1), and all were asymptomatic. PTE was diagnosed in ten (21.7%). The details of the 19 VTE patients are summarized in Table 1. Among the detected DVTs, seven were identified as proximal (above knee) and six were found in the bilateral leg. VTEs were diagnosed at an average of 13.1 (range 4–20) days after the trauma. In the patients

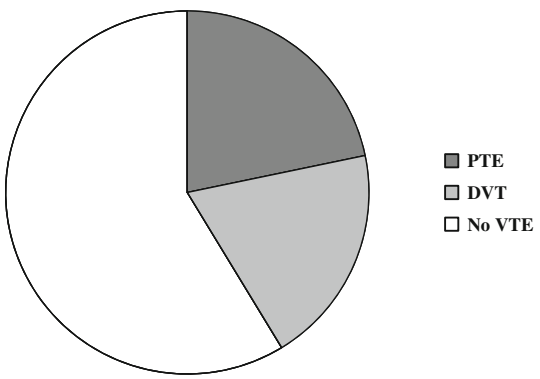


**Fig. 1** Overall incidence of venous thromboembolism (VTE). The detection rate of VTE was 41.3% (19 of 46 patients) and of pulmonary thromboembolism (PTE) and deep vein thrombosis (DVT) 21.7% (ten patients) and 19.6% (nine patients), respectively

**Table 1** Details of venous thromboembolism (VTE) patients

| Case | Age | Sex | VTE | Fracture type | Treatment | Diagnosis posttrauma days | Accompanying injuries |
|---|---|---|---|---|---|---|---|
| 1 | 50 | M | PTE | B2 | Screw + EF | 10 | + |
| 2 | 69 | M | PTE | B3 | EF | 9 | + |
| 3 | 82 | F | PTE | B2 | EF | 11 | − |
| 4 | 73 | M | PTE | C1 | ORIF | 10 | − |
| 5 | 61 | M | PTE | Acetabular | ORIF | 25 | + |
| 6 | 39 | M | PTE | B2 | ORIF | 13 | + |
| 7 | 47 | F | PTE | B2 | Screw + EF | 4 | − |
| 8 | 68 | M | PTE | Acetabular | ORIF | 18 | − |
| 9 | 71 | M | PTE | Acetabular | ORIF | 16 | − |
| 10 | 18 | M | PTE | Acetabular + C3 | ORIF | 8 | + |
| 11 | 65 | M | Proximal DVT | Acetabular | Conservative | 29 | + |
| 12 | 77 | F | Proximal DVT | B2 | Conservative | 6 | + |
| 13 | 75 | M | Proximal DVT | Acetabular | ORIF | 16 | − |
| 14 | 39 | F | Distal DVT | B2 | EF | 5 | + |
| 15 | 62 | F | Distal DVT | B2 | EF | 20 | + |
| 16 | 60 | M | Distal DVT | B2 | Conservative | 15 | + |
| 17 | 84 | F | Distal DVT | A2 | Conservative | 15 | − |
| 18 | 78 | F | Distal DVT | B2 | EF | 11 | + |
| 19 | 51 | M | Distal DVT | C1 | ORIF | 21 | + |

In the fracture type, Arbeitsgemeinshaft für Osteosynthesefragen (AO) classification of type of pelvic ring fracture is shown

*EF* External fixator, *PTE* pulmonary thromboembolism, *DVT* deep vein thrombosis, *ORIF* open reduction and internal fixation

with ORIF, three were diagnosed preoperatively, and five were diagnosed postoperatively at an average of 8.8 days. A temporary inferior vena cava filter was applied preoperatively in one patient (patient 4 in Table 1) owing to the presence of PTE and a proximal DVT.

A comparison of VTE incidences between patients with and without pelvic and acetabular fractures was carried out. Among 95 patients without pelvic and acetabular fractures, 14 (14.7%) were diagnosed with VTE, and asymptomatic PTE was detected in two (2.1%). Among 31 patients with pelvic and acetabular fractures, ten (32.3%) were diagnosed with VTE, and asymptomatic PTE was detected in four (12.9%) (Fig. 2). There were statistically significant differences in the incidences of VTE and PTE between patients with and without pelvic and acetabular fractures ($P < 0.05$).

Patients with pelvic and acetabular fractures were compared. Among 32 pelvic fracture patients, 13 VTE (40.6%) and six PTE (18.8%) patients were diagnosed. In contrast, among 13 acetabular fracture patients, five VTE (38.5%) and three PTE (23.1%) were diagnosed (Fig. 3).

Patients with and without accompanying injuries were compared. Among 26 patients with accompanying injuries, 12 VTE (46.2%) and five PTE (19.2%) patients were diagnosed. In contrast, among 20 patients without accompanying injuries, seven VTE (35.0%) and five PTE (25.0%) patients were diagnosed (Fig. 4).

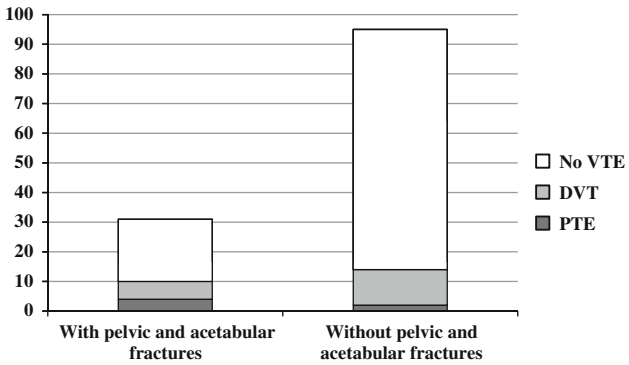


**Fig. 2** Comparison of patients with and without pelvic and acetabular fractures. The detection rates of PTE and VTE [PTE plus DVT] were 12.9% (four patients) and 32.3% (ten patients) among 31 pelvic ring fracture patients. The detection rates of PTE and VTE were 2.1% (two patients) and 14.7% (14 patients) among 95 patients without pelvic and acetabular fractures. There were statistically significant differences in the incidences of VTE and PTE between patients with and without pelvic and acetabular fractures ($P < 0.05$)

The former and newer screening strategies were also compared. Among 31 patients evaluated by the former screening strategy, ten VTE (32.3%) and four PTE (12.9%)

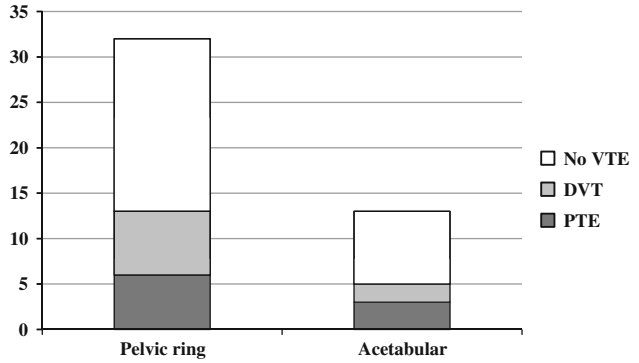


**Fig. 3** Comparison of patients with pelvic ring and acetabular fractures. The detection rates of PTE and VTE were 18.8% (six patients) and 40.6% (13 patients) among 32 patients with pelvic ring fractures. The detection rates of PTE and VTE were 23.1% (three patients) and 38.5% (five patients) among 13 patients with acetabular fractures

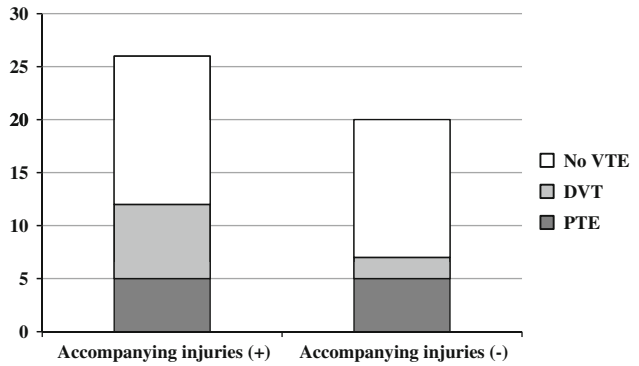


**Fig. 4** Comparison of patients with and without accompanying injuries. The detection rates of PTE and VTE were 19.2% (five patients) and 46.2% (12 patients) among 26 patients with accompanying injuries. The detection rates of PTE and VTE were 25.0% (five patients) and 35.0% (seven patients) among 20 patients without accompanying injuries

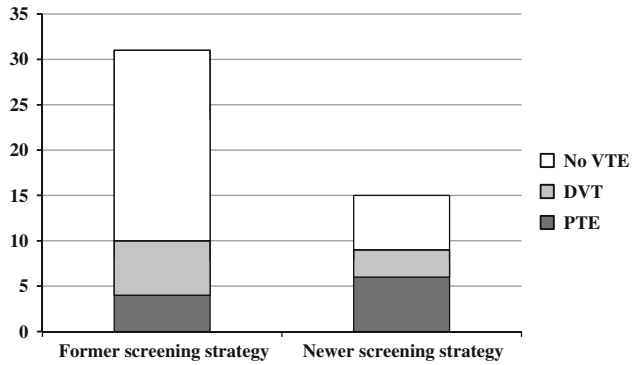


**Fig. 5** Comparison of the former and newer strategies. The detection rates of PTE and VTE were 12.9% (four patients) and 32.3% (ten patients) among 31 patients evaluated by the former screening strategy. The detection rates of PTE and VTE were 40.0% (six patients) and 60.0% (nine patients) among 15 patients evaluated by the newer screening strategy

patients were diagnosed. In contrast, among 15 patients evaluated by the newer screening strategy, nine VTE (60.0%) and six PTE (40.0%) patients were diagnosed (Fig. 5).

No statistically significant differences were observed in the incidences of VTE and PTE between patients with pelvic fractures and acetabular fractures with and without accompanying injuries and evaluated by the former and newer screening strategies.

## Discussion

Incidences of VTE in patients with pelvic and acetabular fractures have been described in previous reports [1–8, 23, 24, 27]. Incidences of VTE varied among studies, which can probably be explained by differences in patient characteristics, fracture treatment types, prophylactic measures [23–25], and VTE detection methods [26, 27]. Compared with these reports, the incidence of VTE in our study was similar or relatively higher. The reason for these observations is probably the difference in prophylactic measures. Anticoagulant drugs have been frequently used in patients with pelvic and acetabular fractures in Western countries [2, 4, 7, 8, 24, 25] but were not used in our patients. Our detection rate was higher than that in a report from the United States with mechanical prophylaxis [23]. However, as the detection method for VTE was different, the effects of ethnicity remain unclear, but we can conclude that the incidence of VTE in the Japanese population with pelvic and acetabular fractures does not differ greatly from that in the Western population.

Historically, the incidence of VTE in the Asian population has been believed to be lower than that in the Western population [9–16]. Klatsky et al. [28] reported that Asian Americans were at very low risk of pulmonary embolism (PE)/DVT, and possible explanations for this observation included the absence of hazardous mutations, or the unspecified PE/DVT protective traits in Asians. On the other hand, several reports show that the incidence of VTE in the Asian population is similar to that in the Western population for patients who receive hip-fracture or joint-replacement surgery [17–21]. Although the effects of ethnicity on the incidence of VTE are still unclear, the incidence of VTE in patients with pelvic and acetabular fractures, which are fractures involving the most high-grade trauma, in the Japanese population was as high as that in the Western population based on our data. We may need to consider a prophylactic method other than physical prophylaxis—for example, anticoagulant drug administration—by reviewing the high incidence of VTE reported in this study.

The incidences of VTE and PTE were significantly higher in patients with than those without pelvic and acetabular fractures. This finding confirms our understanding that pelvic and acetabular fractures have a high risk of VTE, especially PTE.

We observed no statistically significant differences in the incidences of VTE and PTE between patients with pelvic fractures and acetabular fractures with and without accompanying injuries. The difference between pelvic and acetabular fractures or the presence or absence of accompanying injuries may not affect the risk of VTE/PTE. However, one limitation of our study was the small number of patients, and this may be the reason behind the absence of statistically significant differences. In addition, we extensively reviewed previous reports and found no differential effects on the incidence of VTE between fracture types, i.e., pelvic or acetabular. As shown in Table 1, VTE cases included various fracture types, and VTE even occurred in type A pelvic ring fractures, which are caused by relatively lower energy than type B or C fractures. Based on these observations, we suggest that fracture type does not have a strong effect on VTE incidence.

US [1, 3, 7, 8, 23–25] and contrast-enhanced CT [27] have been used as screening tools to detect VTE in pelvic and acetabular fracture patients. US is noninvasive and can be applied to patients at their bedside [3]. Contrast-enhanced CT can detect PTE by scanning the chest, which differs from US. Contrast-enhanced CT can also be used to detect DVT [26], especially pelvic DVT, which is difficult to detect by US [7].

When we compared our former and newer screening strategies, VTE and PTE detection rates were higher with the newer strategy. Our former VTE screening strategy involved imaging examinations after assessing the D-dimer value, and therefore the possibility of undetected VTEs cannot be excluded. Routinely performing imaging examinations preoperatively and postoperatively is thought to be useful for detecting asymptomatic VTEs. However, we observed no statistically significant difference, possibly because of the small number of patients thus far evaluated by the newer screening strategy. Therefore, further investigations are required.

## Conclusions

The incidence of VTE in pelvic and acetabular fractures in the Japanese population is high, and surgeons should pay particular attention to the high incidence of PTE.

**Conflict of interest** None.

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