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Venous thromboembolism after traumatic amputation: an analysis of 366 combat casualties

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Combat injury;
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Abstract

BACKGROUND: We sought to determine the incidence, risk factors, and time course for deep vein thrombosis and pulmonary embolism (DVT/PE) after combat-related major limb amputations.

METHODS: Patients with amputation in Iraq or Afghanistan from 2009 through 2011 were eligible. Details of postinjury care, date of diagnosis of DVT/PE, and injury specific data were collected. Military databases and chart reviews were used.

RESULTS: In 366 patients, 103 (28%) had DVT/PE; PE was diagnosed in 59 (16%) and DVT in 59 (16%). Most DVT (69%) and PE (66%) occurred within 10 days. Increasing ventilator days (odds ratio [OR], 1.97; 95% CI, 1.16 to 3.37) and units of blood transfused (OR, 1.72; 95% CI, 1.11 to 2.68) were associated with DVT. Increasing units of fresh-frozen plasma were associated with PE (OR, 1.31; 95% CI, 1.10 to 1.55).

CONCLUSIONS: The incidence of DVT/PE is high after combat-related amputation. Most DVT/PE occur early and prophylaxis is indicated.

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Venous thromboembolism (VTE) is a significant and potentially deadly complication after trauma. The overall incidence of deep vein thrombosis (DVT) in civilians after injury is 1.06%, whereas the incidence of pulmonary embolism (PE) is approximately 4%, with an associated mortality of 12%.[1] Multiple risk factors for VTE have been identified, including spinal cord injury, spine fracture, increasing age, increasing Injury Severity Score (ISS), blood transfusion, long bone fracture, and mechanical ventilation for longer than 3 days after injury.[2,3] Although limb amputation is a prominent injury in combat trauma, VTE has not been studied in an exclusively amputee population. In a large trauma registry study, the overall incidence of VTE after combat-related injury was 2.2%, whereas in those with lower extremity amputations, 7.5% had DVT, 7.0% had PE, and 2.9% had both.[4] A single institution study of patients injured in combat included 110

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individuals with traumatic amputations (TAs), incidence of PE after combat-related TA were 9.1% and as high as 21.4% in those with bilateral amputations.[5] The previous studies found that multiple amputations and pelvic fractures were independently associated with increased likelihood of developing VTE.[4,5]

Patients sustaining combat-related TA often have multiple factors, which may increase risk for developing VTE.[2,3] In addition, these patients have long periods of hospitalization with multiple operations and a prolonged period of relative immobility. This appears to be particularly true for patients who sustained dismounted (ie, foot patrols) complex blast injuries, including amputations, in Afghanistan after 2009.[6] We sought to determine the incidence of DVT and PE in a large cohort of patients with combat-related major limb amputation, to identify early treatment variables, which may be the risk factors for DVT/PE, and to determine the time of diagnosis of DVT/PE in this population.

Methods

All patients who had TA proximal to the wrist or ankle and initially presented to Navy Role 2 or 3 facilities in Iraq or Afghanistan from January 2009 through December 2011 were eligible for the study. Data collected included level of initial surgical amputation; number of units and type of blood products transfused during the initial 24 hours; duration of mechanical ventilation; intensive care unit (ICU) length of stay; ISS, Abbreviated Injury Scale score greater than 2 for head, chest, or abdomen; pelvic fracture (ICD-9 codes 808.0 to 808.9), spinal cord injury (ICD-9 codes 806.0 to 806.5, 806.8, 806.9, 952.0 to 952.3, 952.8, and 952.9), diagnosis of DVT (ICD-9 codes 453.40 to 453.42, 453.8, 453.82 to 453.86) or PE (ICD-9 codes 415.1, 415.11, 415.13, and 415.19), and the date of VTE diagnosis. We defined TA as a completion surgical amputation occurring within 48 hours from the time of injury.

Military databases, including the Expeditionary Medical Encounter Database (EMED), were used to collect data for 12 months postinjury. The Naval Health Research Center's EMED was used to provide injury specific and early treatment data beginning within hours of combat injury at Role 2 or Role 3 facilities. The Career History Archival Medical and Personnel System and the Military Health System Data Repository were used to provide additional inpatient and outpatient diagnoses throughout the first year of injury. Paper chart and electronic medical record reviews from point of injury to continental US medical facilities were performed to obtain early postinjury data. Patients who were pronounced dead on arrival to the Role 2 or Role 3 facility, arrived alive but died of their wounds, or had inadequate documentation were excluded from the analysis.

Means and medians were calculated to summarize demographic variables and to indicate how the distributions might be skewed. Nonparametric significance tests identified any demographic differences. Chi-square tests were used where appropriate to compare frequency data for different samples. Univariate analysis of multiple risk factors for incidence of DVT and PE was performed as well as a logistic regression to determine independent risk factors for DVT and PE. This study was approved by the institutional review board of the Naval Health Research Center.

Results

A total of 422 patients with amputations were identified in the EMED. Forty-seven patients were excluded because of inadequate records or documentation, 5 died of wounds and 4 were killed in action. This resulted in 366 patients included in the analysis. Of these, the majority were injured in Afghanistan (95.7%) from a blast mechanism (97.5%). The median ISS for the cohort was 23, and the vast majority of those injured in combat were male (99.5%), with a mean age of 24 years.

In the entire TA cohort, 59 (16%) PE and 59 (16%) DVT patients were identified. There were 103 (28%) total VTE events; 44 (12%) patients had DVT, 44 (12%) had PE, and 15 (4%) had both DVT and PE. Of all traumatic amputees with PE, only 25% had concomitant DVT identified. The median ISS was significantly higher in amputees with DVT compared with those without DVT (29 vs 19, $P < .02$) and in amputees with PE compared with those with no PE (26 vs 21, $P < .03$). Most patients, 318 (86.9%), received chemical VTE prophylaxis.

Table 1 shows the timing of VTE diagnoses. The vast majority of DVT (69%) and PE (66%) were diagnosed within 10 days of injury. For those patients who survived and were evacuated from the Role 2 or Role 3 facility, the overall mortality was low at 2.5%. Pulmonary embolism was not a contributing factor in any death. Of the 9 patients who died, 1 died on the day of injury after transfer to a higher level of care, 4 died of complications related to traumatic brain injury, 2 died from multiorgan dysfunction syndrome, and 2 patients died more than 2 years after their initial injuries.

Table 2 shows the incidence of PE and DVT associated with the total units of packed red blood cells plus fresh

Table 1 Timing of PE/DVT diagnosis

Days after injury	DVT, n (%)	PE, n (%)
1–10	41 (69)	39 (66)
11–30	4 (7)	9 (15)
31–60	6 (10)	4 (7)
>60	4 (7)	5 (8)
Date unknown	4 (7)	2 (3)
Total (n)	59	59

DVT = deep vein thrombosis; PE = pulmonary embolism.