Trauma patients warrant upper and lower extremity venous duplex ultrasound surveillance

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ABSTRACT

Background: Due to the high incidence of thromboembolic events (deep venous thrombosis [DVT] and pulmonary embolus [PE]) after injury, many trauma centers perform lower extremity surveillance duplex ultrasounds. We hypothesize that trauma patients are at a higher risk of upper extremity DVTs (UEDVTs) than lower extremity DVTs (LEDVTs), and therefore, all extremities should be evaluated. Materials and Methods: A retrospective chart and trauma registry review of Intensive Care Unit trauma patients with upper and LEDVTs detected on surveillance duplex ultrasound from January 2010 to December 2014 was carried out. Variables reviewed were age, gender, injury severity score, injury mechanism, clot location, day of clot detection, presence of central venous pressure catheter, presence of inferior vena cava filter, mechanical ventilation, and fracture. Results: A total of 136 patients had a DVT in a 5-year period: upper - 71 (52.2%), lower - 61 (44.9%), both upper and lower - 4 (2.9%). Overall, 75 (55.2%) patients had a UEDVT. Upper DVT vein: Brachial (62), axillary (26), subclavian (11), and internal jugular (10). Lower DVT vein: femoral (58), popliteal (14), below knee (4), and iliac (2). 10.3% had a PE: UEDVT - 5 (6.7%) and LEDVT - 9 (14.8%) \( P = 0.159 \). Conclusions: The majority of the DVTs in the study were in the upper extremities. For trauma centers that aggressively screen the lower extremities with venous duplex ultrasound, surveillance to include the upper extremities is warranted.

Key Words: Anticoagulation, deep venous thrombosis, ultrasound duplex surveillance, upper extremity deep venous thrombosis, venous thromboembolism prophylaxis

INTRODUCTION

Venous thromboembolic (VTE) disease encompasses deep venous thrombosis (DVT) and pulmonary embolus (PE). It is an important source of morbidity and mortality in hospitalized patients. With an increasing focus on patient safety and quality of care, VTE has become a target measure of quality by multiple quality improvement organizations and also consumer watch groups. Despite the implementation of screening protocols and guidelines for DVT prophylaxis, the incidence of VTE is particularly elevated in high-risk trauma patients. There are no uniformly accepted DVT surveillance programs in the United States, and as a result, the reported incidence of DVT varies greatly depending on which studies are evaluated. It has been reported that trauma centers that aggressively screen for DVT have a tendency to report a higher incidence of these events. Most VTE screening programs are focused solely on the evaluation of the lower extremity deep venous system. We hypothesize that for trauma patients in the Intensive Care Unit (ICU) the incidence of upper extremity DVT (UEDVT) is higher than the incidence of lower extremity DVT (LEDVT),

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and as a result, trauma centers that aggressively screen for DVT should include the upper extremities in their surveillance protocols.

**MATERIALS AND METHODS**

After approval by the Institutional Review Board, a retrospective trauma registry and chart review of ICU trauma patients with upper and LEDVTs detected on surveillance duplex ultrasound from January 2010 to December 2014 was carried out at our institution. All patients 18 years of age or older who were admitted to the ICU and received an upper and lower extremity surveillance duplex study that demonstrated a DVT were included in this study. Patients with a known preexisting DVT and DVTs identified outside of the ICU setting were excluded. All patients received prophylaxis with low molecular weight heparin unless there was an existing contraindication to anticoagulation. Variables reviewed were patient age, injury severity score (ISS), ICU length of stay, total length of stay, gender, mechanism of injury, whether the patient was on a ventilator, presence of central venous pressure (CVP) line, presence of CVP line in same extremity as DVT, presence of large bore vascular access catheter, presence of prior CVP line, presence of prior CVP line in same extremity as DVT, presence of a fracture in the same extremity as DVT, presence of an inferior vena cava filter before DVT detection, clot location, and development of PE.

Continuous variables were described using mean and standard deviation (SD) while categorical variables with frequency and proportion. The Student’s t-test was used to access the difference between upper and LEDVT in the continuous variable. Fishers’ exact test was used to access the difference between upper and LEDVT in the categorical variables. P < 5% was considered statistically significant. Statistical Analysis System v9.3 (Cary, NC, 27513, USA) was used for the analysis.

**RESULTS**

One hundred and thirty-six DVTs were identified during the 5-year study period. Mean age was 50.1 years (SD 20.9). The mean ISS for our study population was 24.9 (SD 13.1). The mean time to identification of DVT was 7.2 days (SD 5.7). Mean ICU and total hospital length of stay were 18.7 days (SD 12.9) and 24.7 days (SD 17.4), respectively.

When looking at the mechanism of injury for our study population, 126 DVTs were from patients that sustained blunt injury, and 10 DVTs were from patients with penetrating injury, which is representative of our trauma patient population. When looking at the location of DVT, 75 or 55.1% were in the upper extremities, and 61 or 44.9% were in the lower extremities. The anatomic distribution of the identified UEDVTs is brachial (62), axillary (26), subclavian (11), and internal jugular (10). The anatomic distribution of LEDVT is femoral (58), popliteal (14), below knee (4), and iliac (2). Fourteen patients or 10.3% had a PE. Five of these patients had a UEDVT, and nine had an LEDVT [Table 1].

When looking at the association between upper and lower DVT on selected variables, none of the variables had a statistically significant association with DVT. Only presence of

| Table 1: Descriptive summary on the variables (n=136) |
|------------------------------------------------------|
| Variable                                             | n=136 (%) |
| Age: mean (std)                                      | 50.1 (20.9) |
| ISS: mean (std)                                      | 24.9 (13.4) |
| Days after injury that a DVT was identified: mean (std) | 7.2 (5.7) |
| ICU Length of Stay: mean (std)                       | 18.7 (12.9) |
| Total Length of Stay: mean (std)                     | 24.2 (17.4) |
| Gender                                              |
| Male                                                 | 98 (75.4) |
| Female                                               | 27 (20.6) |
| Mechanism of Injury                                   |
| Blunt                                                | 126 (92.6) |
| Penetrating                                          | 10 (7.4) |
| Ventilator                                           |
| Yes                                                  | 99 (72.8) |
| No                                                   | 37 (27.2) |
| Presence of CVP line                                 |
| Yes                                                  | 63 (46.3) |
| No                                                   | 73 (53.7) |
| Presence of CVP line in same extremity as DVT        |
| Yes                                                  | 39 (33.9) |
| No                                                   | 45 (33.0) |
| N/A                                                  | 72 (52.2) |
| Presence of large bore vascular access catheter      |
| Yes                                                  | 3 (2.2) |
| No                                                   | 94 (69.1) |
| N/A                                                  | 39 (28.7) |
| Presence of a prior CVP line and DVT                 |
| Yes                                                  | 71 (52.3) |
| No                                                   | 53 (38.9) |
| N/A                                                  | 12 (8.8) |
| Presence of a prior CVP line in same extremity as DVT |
| Yes                                                  | 16 (19.1) |
| No                                                   | 48 (35.3) |
| N/A                                                  | 62 (45.6) |
| Presence of a fracture in the same extremity as DVT  |
| Yes                                                  | 27 (20.8) |
| No                                                   | 109 (80.2) |
| Presence of an IVC filter prior to DVT               |
| Yes                                                  | 16 (11.7) |
| No                                                   | 120 (88.2) |
| Clot Location                                        |
| Upper                                                | 71 (52.2) |
| Lower                                                | 63 (44.8) |
| Both                                                 | 4 (2.9) |
| DVT                                                  |
| Upper                                                | 75 (55.5) |
| Lower                                                | 63 (44.8) |
| PE                                                   |
| Yes                                                  | 14 (10.2) |
| No                                                   | 122 (89.7) |
a CVP line in the same extremity and presence of a fracture in the same extremity trended toward a statistically significant association [Table 2].

Twenty-six patients with UEDVT underwent a repeat duplex scan with 16 showing a persistent clot and ten showing resolution of clot. Eighteen patients with LEDVT had a repeat duplex scan with nine showing a persistent clot and another nine showing resolution of clot. Four new UEDVTs and five new LEDVTs were identified on repeat duplex scan. Repeating a duplex scan did not have a significant association with upper and LEDVT [Table 2].

**DISCUSSION**

To the best of our knowledge, ours is the only study of a DVT surveillance protocol to examine the upper extremities as well as the lower extremities, and the higher incidence of UEDVT than LEDVT is a striking finding. In addition, 6.7% of the patients with UEDVT also developed a PE. While the rate of PE for patients with LEDVT was higher (14.8%), the number of patients with UEDVT and PE was higher than we expected. The results of our study indicate a need for further assessment of screening protocols for DVT in high-risk trauma patients. The reported incidence rates vary widely (0.36%–58%) and depend on diagnostic procedures, patient demographics, ISS, medications, and other factors.[2] In addition, screening protocols are not uniform across institutions, and some studies suggest that institutions with more aggressive screening protocols have higher DVT rates. Pierce et al. found that for every 1% increase in ultrasound rate there is a +1.07% in DVT rate.[2] In contrast, Adams et al. described an aggressive prophylaxis and screening protocol during which lower extremity duplex scans were performed on a weekly basis, and duplex examinations of the upper extremities were performed only if a patient was symptomatic. This study found low rates of VTE and 86% of LEDVTs in this study were identified on repeat duplex scan. Repeating a duplex scan did not have a significant association with upper and LEDVT [Table 2].

| Table 2: Association between upper and lower DVT on some selected variables |
|---------------------------------|----------------|----------------|------|
| Age: mean (std)                 | Upper          | Lower          | P    |
| 49.7 (23.5)                     | 50.7 (29.9)    | 0.78           |
| ISS: mean (std)                 | 25 (9.9)       | 24.9 (16.4)    | 0.949|
| Days after Injury that a DVT was identified: mean (std) | 6.5 (3.7) | 8.1 (7.4) | 0.143 |
| ICU Length of Stay: mean (std)  | 17.0 (12.0)    | 21.2 (13.7)    | 0.069|
| Total Length of Stay: mean (std)| 23.6 (17.7)    | 24.9 (17.3)    | 0.664|
| Gender                         | Male           | Female         |      |
| Presence of CVP line: Yes       | 55 (82.09)     | 43 (74.14)     | 0.384|
| Presence of CVP line: No        | 42 (56)        | 15 (25.86)     |      |
| Presence of CVP line in same extremity as DVT: Yes | 68 (90.67) | 58 (95.08) | 0.511 |
| Presence of CVP line in same extremity as DVT: No | 22 (84.62) | 12 (66.67) | 0.159 |
| Presence of CVP line in same extremity as DVT: N/A | 8 (1.64) | 1 (1.64) | 0.069 |

| Table 3: Association between upper and lower DVT, if the patient had a repeat duplex |
|---------------------------------|----------------|----------------|------|
| Persistent clot                 | Upper          | Lower          | P    |
| Yes                             | 16 (61.54)     | 9 (50)         | 0.542|
| No                              | 10 (38.46)     | 9 (50)         |      |
| New clot                        | Yes            | No             |      |
| Yes                             | 4 (15.38)      | 5 (27.78)      | 0.260|
| No                              | 22 (84.62)     | 12 (66.67)     |      |
| Presence of a fracture in the same extremity as DVT: Yes | 5 (6.67) | 9 (14.75) | 0.159 |
| Presence of an IVC filter prior to DVT: Yes | 65 (86.67) | 44 (72.13) | 0.051 |
| Presence of an IVC filter prior to DVT: No | 6 (8) | 10 (16.39) | 0.181 |
| Presence of an IVC filter prior to DVT: N/A | 9 (9.22) | 51 (83.61) |      |

**Table 2:** Association between upper and lower DVT on some selected variables

**Table 3:** Association between upper and lower DVT, if the patient had a repeat duplex
not be identified and some of these may progress to PE or patients may develop other complications such as postthrombotic syndrome.

Our data are limited by a relatively small, single institution patient population and as a result did not show any statistically significant association between development of upper or LEDVT and the analyzed variables. Our data were retrospectively reviewed and nonrandomized. Future multi-institutional studies may help clarify whether the increased incidence of UEDVT is reproducible outside of our institution. Reproducibility may also be hindered by different practice patterns across the nation, including timing to initiation of VTE prophylaxis and different screening practices. Further study could help identify individual risk factors which may aid in selection of a subset of high-risk patients for surveillance for DVT. Some studies argue against surveillance and cite an increase in cost with no significant increase in identification of DVT. If more studies are done to further tease out individual risk factors, perhaps a better selection of patients can maximize the utility of a screening protocol without compromising cost efficiency and decrease selection bias. This would be particularly beneficial in the age of increasing concerns for patient safety and pay for performance models. With the currently available data, it is evident that DVT rate is a poor quality indicator and that selection bias plays an important role in DVT rates at different institutions. Further study is, therefore, needed to identify a subset of patients that will benefit from surveillance protocols without compromising an institution's perceived quality of care provided.

CONCLUSIONS

Trauma centers that perform aggressive surveillance duplex screening for DVT have demonstrated a higher incidence of LEDVT in high-risk trauma patients than centers that do not routinely screen. One can debate the merits of an aggressive thromboembolic screening program, especially since hospitals may receive financial penalties resulting from the Affordable Care Act due to “preventable” hospital-acquired conditions. The latest iteration of the American College of Chest Physicians practice guidelines recommend against periodic surveillance for identification of DVT with compression ultrasound in critically ill and high-risk trauma patients. On the other hand, many studies have documented that severely injured trauma patients are at significant risk of developing venous thromboembolisms despite appropriate prophylaxis. Published guidelines by the Eastern Association for the Surgery of Trauma have supported the use of ultrasound to assess asymptomatic patients for DVT. This study in a level one trauma center demonstrated that with a weekly four extremity ultrasonographic screening program, UEDVT's were shown to be more common than LEDVT's. In fact, UEDVT's which were de novo and not induced by CVP line and fracture proved to have a higher incidence that LEDVT's. This was an unexpected finding with ramifications for screening recommendations, treatment, and financial consequences. We propose that for trauma centers that aggressively screen the lower extremities with venous duplex ultrasound, surveillance to include the upper extremities is warranted.

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Conflicts of interest

There are no conflicts of interest.

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