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Venous Thromboembolism in Pediatric Orthopedics

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Abstract

Venous thromboembolism (VTE), as deep vein thrombosis or pulmonary thromboembolism is a major clinical complication of orthopedic surgeries in adult population. To answer the question of how often and in what circumstances the surgeon should be worried about it in pediatric patients; the current paper reviewed the recent publications on the matter. It seems that the incidence of VTE increased and certain clinical conditions have strong relationships with it. It is uncertain that the increased reported incidence of VTE in pediatric population is due to unknown conditions or it just reflects the advanced diagnostic tools. Whatever the cause is, it is known that age increase, trauma severity and a number of other medical interventions and medical conditions directly affect the VTE occurrence in children. There is no evidence for prophylactic VTE treatment in pediatric orthopedic patients yet. Further information is under investigation in multiple large studies which may change the current opinion.

Keywords: Pediatrics, Venous Thromboembolism, Orthopedics

1. Context

Venous thromboembolism (VTE) can be manifested as two different clinical scenarios. The first is the well-known deep vein thrombosis which can cause pulmonary thromboembolism if untreated or unrecognized. The latter is a serious medical condition with a significant morbidity rates. It is long known as a complication of various surgical procedures. Most of the information regarding its etiology, treatment and prophylaxis comes from studies on adult population. Today, VTE prophylaxis is an essential part of orthopedic practice. But it is also well known that the complication rarely happens in the pediatric patients. A review on some of the recent findings on this matter is presented here.

2. Incidence

Historically, one of the first reports on the incidence of VTE in pediatric population was from Canada (1). In their review of 137 patients, the authors reported the incidence of DVT/PE of 5.3/10,000 hospital admissions or 0.07/10,000 children in Canada. Infants under one year old and teenagers predominated with equal numbers of both genders. DVT was located in the upper (n = 50) and lower (n = 79) venous system, or as PE alone (n = 8). Central venous lines (CVLs) were present in approximately 33% of children with DVT (n = 45). Associated conditions were present in 96% of children and 90% of children had two or more associated conditions with DVT.

In another research in pediatric trauma population, VTE was identified in 2.7 per 1000 pediatric trauma discharges. Although injury severity was strongly associated with an increased risk of VTE, the occurrence rate was low even among critically injured patients (< 2%) (2).

Sandoval et al. reviewed the incidence and changes in recent years and found that the overall incidence of DVT was 9.7 per 10,000 hospital admissions (99 DVTs in 102,502 admissions). From 1992 to 1995, a prevalence of 0.3 per 10,000 admissions was observed; this trend increased to approximately 9 from 1996 to 2001, 18 from 2002 to 2004, and precipitously escalated to 28 per 10,000 admissions in 2005 (3).

Kim and Sabharwal reviewed a total of 761 patients with VTE from six published studies and found a mean prevalence of 9.7/10,000 in children admitted to the hospital (4).

A different research tried to determine the changes in the incidence of VTE among the pediatric population. Eventually, they concluded that children > 13 years were at statistically significant greater risk to develop VTE after trauma than the children under 12 years; the greatest increase in the risk was observed after the age of 16 (5).

It should also be considered that the true incidence of VTE strongly depends on the general condition of patients. For example, in the severely ill children, the reported inci-

dence is significantly higher than that of the general pediatric population. Hanson et al., offered evidences that support this fact. Nine of the 144 children admitted to the pediatric intensive care unit when trauma developed VTE (incidence 6.2%), with a median age of 8.6 years (range, 2.3 - 17.9). VTE was diagnosed at a median of nine days after admission, with 67% of the VTE was located at the site of previous or existing central venous line (CVL) (6).

The role of trauma is noticed as an important factor to increase the risk of VTE. A nine-year study on children with trauma revealed that the incidence of VTE events associated with lower extremity orthopedic trauma was 0.058 %. Patients with polytrauma and injuries of the femur/femoral neck, tibia/ankle, and pelvis were more commonly affected (7).

Table 1. Results of a Systematic Review on VTE Risk Factors (4)

Risk Factors	Number of Patients With Risk Factor/ Number of Available Patients With VTE (%)
Central venous catheter	210/727 (29)
Infection	153/752 (20)
Surgery	78/664 (12)
Malignancy	79/761 (10)
Trauma	65/732 (9)
Cardiac failure	59/761 (8)
Nephritic syndrome	18/430 (4)
Obesity	7/260 (3)
No risk factor	20/352 (6)

Abbreviations: VTE, venous thromboembolism.

3. Risk Factors

Identified risk factors for VTE in pediatric patients include trauma, age increase, central catheter line placement and chronic conditions such as malignancy, obesity, inflammatory bowel disease and respiratory and cardiovascular comorbidities (8-10).

Risk of VTE increased with age increase and injury severity scores. VTE was clearly associated with head, thoracic, abdominal, lower extremity and spinal injuries. Craniotomy, laparotomy and spinal operations were also associated with VTE. The greatest risk of VTE was in children with venous catheters (11).

Baker et al. (12), reported the relationship between age, American society of anesthesiologists (ASA) classification score and medical comorbidities with increased risk of VTE. They concluded that patients who experienced VTE had an average age of 12.0 $\pm$ 4.0 years, compared with 11.3 $\pm$4.3 years for those who did not (P = 0.552). According to ASA classification, 46.7% of patients who experienced VTE had a score of $\geq$ 3, compared with 25.5% of the ones who did not (P = 0.075). No difference was observed in age, gender, obesity or race. Significant associations were observed between VTE and comorbidities in patients receiving oxygen support (13.3% versus 1.6%, P = 0.025) and the ones with structural pulmonary abnormality (20.0% versus 4.4%, P = 0.026), GI comorbidity (33.3% versus 9.7%, P = 0.011), renal comorbidity (6.7% versus 0.1%, P = 0.016), and hematologic disorders (13.3% versus 1.4%, P = 0.019). Other comorbidities that demonstrated a trend toward association, but were not statistically significant, included pulmonary comorbidity and the need for nutritional support.

In addition, a significantly higher risk of VTE was found in severely injured patients requiring critical care (6). These risk factors, along with consideration of the ages identified in this study at which VTE risk begins to rise considerably, may allow the development of a more standardized approach to recognize a subset of pediatric patients with trauma at significant risk of VTE that would justify the use of prophylaxis with low-molecular-weight heparin (LMWH). Implementation of such a standardized approach to prevent VTE improved VTE prophylaxis rates among hospitalized pediatric patients (13) and adult patients (14) with trauma and decreases the incidence of VTE among critically ill children after trauma (8).

VTE increases both the length of stay and hospitalization costs in spite of injury severity, demonstrating the need to consider thromboprophylaxis in the critically injured population. However, the low overall prevalence of VTE in young patients with trauma, even in the intensive care units, highlights the need for additional studies on risk factors and the potential risks of prophylactic anticoagulation; therefore, thromboprophylaxis can more directly target the children at high risk (2).

Footnote

Authors' Contribution: Amir Reza Vafaee: developing the original idea and the protocol, abstracted and analyzed data, wrote the manuscript, and was the guarantor; Taghi Baghdadi: development of the protocol, data abstraction, and preparing the manuscript

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