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Mini Review

Viscoelastic hemostatic assays for orthopedic trauma and elective procedures

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Abstract

When compared to other surgical specialties, the use of Viscoelastic Haemostatic Assays (VHAs) (e.g., Thromboelastographic (TEG) and rotational Thromboelastometry in orthopaedics is in its infancy. Fortunately, a number of recent research have described the growing utilization of VHAs.to monitor real-time coagulation and fibrinolytic state in both orthopaedic and surgical patients Orthopaedic trauma and elective surgery Trauma-induced coagulopathy—a range of abnormalities Clotting factor deficiency, insufficient thrombin production, and platelet dysfunction are all coagulation phenotypes. Malfunction and dysregulated fibrinolysis—remains a potentially lethal consequence in critically ill patients. Patients who have been hurt or are bleeding and whose quick diagnosis and management are supported by the VHAs are used. Furthermore, VHAs are a beneficial addition to standard coagulation testing. Assisting in the diagnosis of hypercoagulable conditions that are typically associated with orthopaedic injury and postoperative condition. The use of VHAs to detect hypercoagulability allows for an accurate assessment of VTE risk and monitoring of VTE prophylaxis. Until far, the data have been insufficient to allow for a customised strategy to VTE thromboprophylaxis dosing and duration. By adding VHAs into everyday practise, orthopaedic surgeons will be better able to diagnose and treat the whole range of coagulation disorders encountered by orthopaedic patients. This paper serves as an educational primer as well as a current review of the research on the use of VHAs in orthopaedic surgery.

Keywords: Assistive technology, amputation, hemicorporectomy, rehabilitation, prosthesis

INTRODUCTION

Orthopaedic surgical patients can have a range of coagulopathies, ranging from hypo coagulopathy pelvic fracture trauma patients in shock who require huge transfusion to postoperative hypercoagulopathic elective arthroplasty patients who require DVT prevention. There was inadequate data until recently to provide a personalized approach with bedside point-of-care precision testing to guide orthopaedic surgeons through resuscitation and VTE prophylaxis. However, Viscoelastic Hemostatic Tests (VHAs, which include Thromboelastography (TEG) and Rotational Thromboelastometry (ROTEM)) allow for the detection and tailored therapy of a diverse range of coagulation abnormalities. VHAs efficiently direct Blood Component Therapy (BCT) and Hemostatic Adjunctive Therapy (HAT) to address hypo coagulopathy, as well as anticoagulant prophylaxis to address hyper coagulopathy, using simple algorithms. An estimated 25% of severely injured patients present to emergency departments with Trauma-Induced Coagulopathy (TIC) this relatively high frequency of acute hypo coagulopathy in trauma patients has prompted more research into the use of VHAs [1].

TIC has been shown to be an independent predictor of death, as well as a risk factor for multisystem organ failure and increased transfusion needs. Because of the point-of-care nature of VHAs and the quick turnaround time for results, many trauma centers consider VHAs to be the standard of care for all severely injured trauma patients who arrive to an emergency department and/or trauma center. There is a vast and growing amount of literature demonstrating the use of VHAs to better define the spectrum of coagulopathy at presentation and the developing changes during trauma resuscitation.

In trauma patients with coagulopathy, using VHAs to assist goal-directed resuscitation and transfusion may improve patient-centred care and outcomes. According to a 2016 Cochrane analysis, VHA-guided transfusion techniques lowered blood product use while improving death rates. However, the majority of the papers evaluated addressed cardiothoracic surgery patients, underlining the need for greater study into orthopaedic injury and polytrauma. Several previous trauma trials have shown lower BCT administration and no inferior or better mortality when utilizing VHA to guide resuscitation. VHAs have been shown in randomized controlled studies to guide BCT and HAT not just in trauma, but also in the management of bleeding patients in the critical care situation. However, the optimal use of VHAs in resuscitation is not entirely settled: for example, the Implementing Treatment Algorithms for the correction of Trauma-Induced Coagulopathy (ITACTIC) study found no difference in mortality between VHAs and Common Coagulation Tests (CCTs) (e.g., PTT, PT, INR, platelet count, and fibrinogen level). Although the trial investigators found a lower-than-expected incidence of TIC, they did find a mortality benefit in the subgroup of patients with traumatic brain injury. In conclusion, more trauma research on the use of VHA-guided resuscitation techniques is needed [2].

VHAs in orthopaedic trauma have received minimal attention in the literature. TEG revealed early hypercoagulability and early hypercoagulability, as well as transfusion requirements, in the first systematic description of the use of VHA in modern trauma.

Before the efficacy of VHAs in directing BCT for bleeding in orthopaedic trauma pelvic fracture patients was presented, there was a substantial gap of nearly 20 years. Aside from its well-documented utility in the treatment of hypo coagulopathy, the capacity of VHAs to detect hyper coagulopathy has recently received attention. VHA detectably hypercoagulable more than 85 percent of wounded individuals after trauma, and this hypercoagulability is associated with a twofold increase in the incidence of VTE after recovery. VTE rates in current series remain as high as 28%, exceeding 15% even with the most strict prophylactic regimens, with the presence of orthopaedic damage being one of the most relevant risk factors. Despite growing interest in VHAs in orthopaedic trauma, there is only one orthopedic-specific review study on the subject. A hurdle to the use of VHA has been an overreliance on CCTs to assist identify bleeding patterns in patients with musculoskeletal injuries, as well as a lack of expertise among orthopaedic traumatologists with the indications for and interpretation of these tests. As a result, a concise overview of VHA testing is required [3].

THROMBOELASTOGRAPHY TEG

A 0.36 mL citrated sample of whole blood is placed into a heated cup kept at 37 C to perform a first-generation TEG assay (using the TEG 5000 Hemostasis Analyzer: Haemonetics, Braintree, MA, USA), and citrate anticoagulation is reversed by the addition of calcium [4].

To initiate coagulation, a coagulation activator (such as kaolin for a standard TEG or tissue factor-containing reagent for a "rapid" TEG) is introduced; "native" coagulation can also be evaluated when the assay is activated solely by anticoagulant reversal. A concentric pin connected to a sensor suspended in the cup spins the sample cup 4.45° every ten seconds. The pin does not move in viscous, unclotted blood; nevertheless, as a clot forms, elastic clot fibres bind the cup to the pin, exerting rotating forces on the pin. These forces are communicated to an electrical transducer, which generates a graphical output depicting clot dynamics over time. TEG has five primary parameters: reaction time, clot kinetics (K), alpha angle, Maximum Amplitude (MA), and lysis after 30 minutes (LY30). The Haemonetics TEG 6s Hemostasis Analyzer (Braintree, MA, USA) is a fully automated, cartridge-based test designed for ease of use and reproducibility. The FDA approved it for use in the trauma context based on a recent multicenter technique comparison trial including over 500 trauma patients.

Rather than employing mechanical transduction to feel the viscoelastic properties of clot formation, the TEG 6s uses an automated cartridge system to measure changes in resonant frequency of a 1 mL blood sample (avoiding mistakes associated with pipetting by hand as in the previous TEG 5000 system). The shift in resonant frequency as the blood clots can be utilized to detect changes in viscoelasticity, resulting in a trace and parameters that are conceptually similar, but not directly equivalent, to the TEG 5000 legacy cup-and-pin system.

PREDICTION AND PREVENTION OF VENOUS THROMBOEMBOLISM

In the realm of orthopaedics, VHAs have found the most utility in the prognosis and prevention of VTE. VTE was discovered in 58% of patients sustaining serious trauma who were screened by venography and were not given chemical thromboprophylaxis in a large study of 349 patients at eight level 1 European trauma centres. A total of 69% of 182 patients with pelvic and/or long bone lower extremity fractures experienced VTE, with multivariate analysis revealing femur or tibia fracture as an independent risk factor for VTE . Increased ISS scores have also been linked to an increased risk of developing VTE [5].

FUTURE STUDY

The current literature on the use of VHAs in orthopaedic surgery has established a framework; however there are gaps that need to be filled. Longitudinal investigations following orthopaedic patient outcomes with and without the use of VHAs to guide care remain necessary. Furthermore, research into the predictive significance of VHAs in both elective and non-elective orthopaedic surgery patients could lead to preemptive and positive modifications in patient care [6].

Summary of Principles for VHA Use in Orthopaedic Patients This evaluation summarized facts to support three important claims: In both orthopaedic trauma and elective surgical patients, VHAs improve resuscitation and intraoperative management of hypercoagulability and hyper fibrinolysis. VHAs can also identify clinically significant hypercoagulability and poor fibrinolysis, which CCTs cannot. VHA-based hypercoagulability diagnosis and treatment has major implications for risk assessment and chemoprophylaxis management of VTE prophylaxis in orthopaedic patients [7].

CONCLUSION

Orthopaedic coagulopathy is characterized by a range of phenotypes that are complex in terms of patient variables, injury patterns, resuscitation and surgical methods, and perioperative VTE prevention efforts. Over the last two decades, there has been a remarkable increase in the use of bedside VHA for the care of both hypo- and hyper coagulopathies, with orthopaedic surgery coming in late. There has been an increase in the routine use of these tests not just in the management of trauma, but also in all postsurgical, obstetrical, and medical intensive care units where serious bleeding is common. Beyond orthopaedic trauma, there is compelling evidence that VTE prophylaxis should include a VHA-driven personalized approach to dosing and duration as opposed to the obsolete empiric paradigm. VHAs must be used more frequently in orthopaedic trauma and elective surgery in the future. Current and future orthopaedic surgeons must be taught on the applied science, reasoning, and methodical use of VHAs in BCT transfusions, the administration of HAT products, the pre-operative assessment and management of anticoagulant patients, and the management of VTE prophylaxis. Future research is required to expand the routine adoption and usage of VHAs over CCTs, which will only begin with general acceptance of VHAs by the orthopaedic surgery community.

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