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Review

Thromboelastography and Rotational Thromboelastometry use in trauma

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HIGHLIGHTS

- Trauma patients are at risk of developing an intrinsic coagulopathy.
- Viscoelastic analysis can accurately identify coagulopathy in trauma patients.
- Patient directed transfusions are possible using viscoelastic analyzers.

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ABSTRACT

The appropriate resuscitation of patients in hemorrhagic shock is critical to improving survival. Current strategies for massive transfusions utilize fixed ratio protocols to rapidly deliver plasma and platelets to the patient. However, there is some concern that these larger volumes of transfusions can lead to untoward effects. Efforts are ongoing to provide patient-specific transfusion therapy in order to avoid excess transfusions. Thromboelastography (TEG) or Rotational Thromboelastometry (ROTEM) are two viscoelastic analyzers capable of providing Viscoelastic testing.

1. Introduction

The resuscitation and transfusion of a patient in hemorrhagic shock can be a daunting task. Although hemorrhage is commonplace in trauma patients, there are some patient populations who receive large volume transfusions. Therefore, it is incumbent on all healthcare providers to be familiar with strategies to guide resuscitative conduct.

Complications arise during hemorrhage resuscitation when large volumes of coagulation factor-deficient fluids such as crystalloid, albumin, or packed red blood cells (pRBCs) are administered. This produces a resuscitation-associated coagulopathy which leads to more hemorrhage, and if not corrected, to death. Recent advances in trauma surgery have also identified an intrinsic, resuscitation-independent coagulopathy that results from injury and hemorrhage and is instigated in part by activated Protein C [1]. This intrinsic coagulopathy further confounds resuscitation conduct and imparts a significant increase in mortality. These concepts are critical, as early resuscitative efforts have not just immediate effects, but affect long term outcomes as well [2].

Current transfusion strategies focus on replenishing circulatory volume by transfusing blood component therapy in fixed ratios that mimic whole blood concentrations, resulting in high plasma and platelet transfusion rates. While this does improve survival when compared to lower plasma and platelet transfusion volumes [3,4], there is significant evidence of increased morbidity and mortality in patients who receive excessive transfusions [5–8]. As a result, efforts now focus on methods to reduce the use of blood component therapy in patients with severe hemorrhage, while maintaining or improving survival. However, standard laboratory values lag behind in their ability to correctly identify which specific aspect of coagulation is needed in a bleeding patient. Whole blood viscoelastic testing can identify deficits in clotting factors, clot strength, and excessive clot breakdown, thereby allowing a goal-directed transfusion strategy that can replenish deficient factors and

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targeted minimize transfusions.

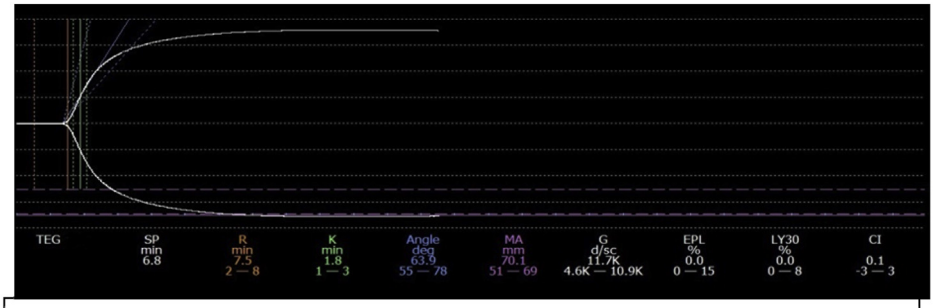
2. Whole blood viscoelastic analysis

Thromboelastography (TEG) and Rotational Thromboelastometry (ROTEM) are two methods of whole blood viscoelastic analysis. Standard laboratory tests, such as prothrombin time (PT) and partial thromboplastin time (PTT) are measured from patient plasma, ignoring other components of coagulation such as platelets and fibrin. Additionally, platelet counts and fibrinogen concentrations only give static numbers with no information regarding functionality. Whole blood viscoelastic analysis is a rapid method that measures whole blood capability to make and sustain clot formation. Although based on the same guiding principle, TEG and ROTEM have subtle differences in their mechanics and interpretation.

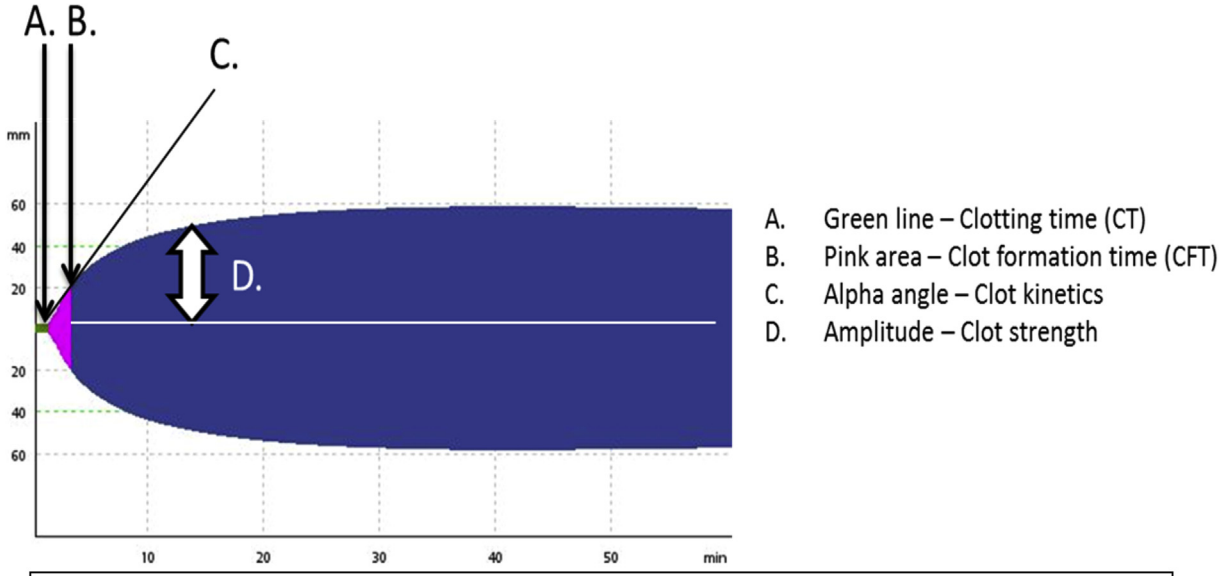
For both TEG and ROTEM, a sample of whole blood is placed into a small cup and a pin is suspended within the sample. The sample is rotated and as the blood begins to clot, the increase in viscosity is relayed through sensors on the pin that are graphically transmitted (Fig. 1). These graphics can be measured and correct interpretation can identify specific coagulation abnormalities. In a TEG analysis, whole blood is placed within a cup that is rotated gently while a thin wire tension probe is suspended within the sample. ROTEM is performed in a similar fashion to TEG, but instead of the cup being spun within the cuvette, it is the sensor probe itself that rotates within the sample. LED reflections off of the pin are used to determine pin rotation speed which is graphically transmitted. This method is much less prone to error in the face of vibration and mechanical disturbances. Both TEG and ROTEM produce graphical shapes that can be used to identify coagulation disturbances, but (Fig. 2) ROTEM graphics are easily discernable from TEG graphics as the ROTEM tracings are in solid color.

3. TEG and ROTEM parameters

The goal of whole blood viscoelastic analysis is to provide targeted transfusions of specific coagulation deficiencies. Proper interpretation of each test parameter is critical in order to provide appropriate therapy. Although similar in nature, each test uses slightly different terminology. Table 1 shows the range of possible measurements, the differing nomenclature between the two tests and the clinical utility of each.



TEG Analysis. The vertical bars are color coated to match the TEG parameter on the X-axis



ROTEM Analysis. ROTEM analyses are in solid color. Each parameter is associated with distinct color in the graphical representation.

Fig. 1. Graphical outputs for TEG and ROTEM.