Management of Trauma-Induced Coagulopathy with Thrombelastography

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KEYWORDS

• Coagulopathy • Resuscitation • Thrombelastography • TEG • Fibrinolysis • Transfusion

KEY POINTS

- Thrombelastography characterizes the life-span of a clot; from initial fibrin formation, to incorporation of platelets, to fibrinolysis.
- Thrombelastography yields the following real-time coagulation variables: reaction time (R-time), activated clotting time (ACT), rate of clot formation angle (angle), maximum amplitude (MA), and clot lysis at 30 minutes (LY30).
- These point-of-care variables enable the clinician with "live" management-driving data in the trauma bay, allowing for goal-directed hemostatic resuscitation of bleeding injured patients.
- A recent clinical trial demonstrated that the use of thrombelastography to guide massive transfusion in trauma patients, compared with conventional coagulation assays, resulted in a decrease in mortality while using less blood products.
- Thrombelastography is currently used for patient-personalized administration of anti-fibrinolytics (eg, tranexamic acid) based on LY30 parameters.

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INTRODUCTION

Contemporary trauma care comprises advanced prehospital care, regionalized trauma systems, damage control operative techniques, advanced critical care, rehabilitation with reintegration into society, and injury prevention.[1,2] Despite these efforts, deaths from injury have increased in the United States over the last decade relative to other causes of mortality.[3,4] To make strides in trauma outcomes this high mortality of severe injuries must be mitigated.

Injury mortality was classically described as having a trimodal distribution with immediate deaths at the scene, early deaths caused by hemorrhage, and late deaths caused by organ dysfunction.[5] Damage control surgery and advances in critical care have decreased the incidence and severity of organ dysfunction after injury,[6,7] although it is arguable that immediate deaths at the scene can only be addressed through injury prevention. Thus, deaths caused by hemorrhage continue to represent a target for intervention to mitigate mortality from severe injuries. Recent studies analyzing the time course of hemorrhage-related mortality report that these deaths occur despite ongoing therapies of resuscitation.[8] Such data call for a paradigm shift in the resuscitation of patients with injury-related hemorrhage.

Resuscitation from hemorrhage is compounded by dysfunctional hemostasis seen in severely injured patients,[9,10] hindering the effectiveness of resuscitation and damage and bleeding control surgery if patients are not resuscitated from this coagulopathy. Thus, in the severely injured patient hemodynamic and hemostatic resuscitation go hand in hand. Furthermore, experimental and clinical data exist to suggest that some current resuscitation strategies, particularly the use of crystalloid and colloid fluids, may in fact exacerbate coagulopathy and further worsen bleeding.[11–15]

In this context, viscoelastic assays, such as thrombelastography (TEG) and rotational thrombelastometry (ROTEM), have emerged as point-of-care tools that can guide the hemostatic resuscitation of bleeding injured patients.[16] These assays provide information about patients' coagulation status, which paired with other point-of-care available assays, such as hemoglobin and blood gas, enable the clinician with early management-driving data in the trauma bay. Furthermore, TEG and ROTEM assessments can be continued in the point-of-care mode into patients' anesthesia course in the operating room and during resuscitation and recovery in the critical care unit. Recently, a randomized clinical trial demonstrated that the use of TEG to guide a massive transfusion protocol (MTP) in trauma patients, compared with conventional coagulation assays (CCA) (ie, international normalized ratio of prothrombin time [PT/INR], partial thromboplastin time [PTT], fibrinogen level, platelet count), resulted in a statistically significant decrease in mortality while using less plasma and platelet blood products.[17]

This article describes the role of TEG in contemporary trauma care by explaining this assay' methodology, clinical applications, and result interpretation through description of supporting studies to provide the reader with an evidence-based user's guide. Although TEG and ROTEM are assays based on the same viscoelastic principle, this article is focused on data supporting the use of TEG in trauma, because it is available in trauma centers in North America; ROTEM is mostly available in Europe.

HISTORICAL CONTEXT

Hartert[18] conceived TEG in Germany, at the Heidelberg University School of Medicine in 1948. TEG was applied increasingly throughout Europe during the 1950s, validating its use for assessment of anticoagulant effect, effect of thrombocytopenia,