Thromboelastography

Point of Care Coagulation Testing Workshop

Linda Shore-Lesserson MD
Professor of Anesthesiology
Chief of Cardiothoracic Anesthesiology
Monefiore Medical Center
Bronx, NY USA

Thromboelastography (TEG) is a whole blood test of viscoelastic blood clot formation. Developed in 1948, it has been used in many different clinical scenarios to diagnose coagulation abnormalities. The TEG is a test of whole blood clot strength whose mechanism uses a warmed cup made of disposable plastic. Suspended inside the cup is a piston that does not touch the walls of the cup. The cup moves through an arc of 4.5 degrees once every second, pauses for 1 second, and then moves back through the arc in the opposite direction. When whole blood is placed in the cup, coagulation begins. 360 microLiters of blood is needed to perform this test. With the current disposables, an activator is needed because the onset to coagulation is quite variable, probably due to imperfections in the plastic. Celite, kaolin, or tissue factor have all been used to activate the TEG.

The TEG measures clot strength over time by maintaining the piston stable in an electromagnetic field. A paper tracing relates the amount of power necessary to maintain that as the rotational motion of the cup is transferred to the piston. TEG is performed "on site" either in the operating room, or in a laboratory, and provides a rapid whole blood analysis that yields information about clot formation and clot dissolution. Within minutes, information is obtained regarding the integrity of the coagulation cascade, platelet function, platelet-fibrin interactions, and fibrinolysis. Thromboelastography measures the strength of a clot graphically over time. There are five parameters of the TEG tracing:

- **R**- a period of time from initiation of the test to the initial fibrin formation
- **K**- a measure of time from beginning of clot formation until the amplitude of thromboelastogram reaches 20 mm, and represents the dynamics of clot formation
- **alpha angle**- an angle between the line in the middle of the tracing and the line tangential to the developing "body" of the tracing, measuring acceleration (kinetics) of fibrin build up and cross-linking
- **MA**- maximum amplitude reflecting the strength of a clot, which is dependent on number and function of platelets and its interaction with fibrin
• MA30- the rate of amplitude reduction 30 min. after MA, representing the stability of the clot. (see Figure).

Use of TEG reportedly reduces bleeding and transfusion requirements in liver transplantation, pediatric surgery, and adult cardiac surgery. It also reduces the number of reoperations for presumed coagulopathy after cardiac surgery. Recent modifications to the TEG permit improved monitoring capabilities. Use of recombinant human tissue factor as an activator accelerates the rate of thrombin formation and shortens the time required for development of MA. Since MA is primarily reflective of clot strength and platelet function, this information can be obtained more quickly with tissue factor enhancement (5 to 10 minutes). The name of this test is the RapidTEG®.

In vitro addition of a large dose of abciximab to the test cuvette enhances the diagnostic ability of the test to discriminate between hypofibrinogenemia and platelet dysfunction as a cause of decreased MA. Most recently, the test has been modified to be able to test for specific drug inhibition of platelet function. This test is termed “Platelet Mapping Assay” and utilizes a series of 3 cuvettes. These tests measure the maximal thrombin-induced platelet clot strength (MAkh), the minimal platelet function of a fibrin-based clot (MAf), and the strength of the clot when ADP or arachidonic acid is added. A mathematical formula compares the platelet response to the agonist, to the maximal and minimal platelet responses and arrives at a percentage platelet function. For the arachidonic acid assay, this would be a measure of the platelet response to aspirin. For the ADP assay, this is a measure of the platelet response to
clopidogrel. This technique has been used in clinical practice but requires further validation in order for it to be used to make sound clinical judgments about anti-platelet medication dosing.

Thromboelastography can also be used to assess hypercoagulability in patients at risk for adverse thrombotic events. The test, in its native form, has been used to predict thrombotic events after surgery and after cardiac interventional procedures. The presence of a large native MA has been shown to be a marker for hypercoagulability and may perhaps pave the way for early intervention in patients at risk for thrombosis.

**Summary:**
Dynamic tests such as the bleeding time, or the viscoelastic measures of clot formation offer a better option to assess the contribution of platelet function to overall clot formation since they take into account the time-dependent nature of platelet-mediated hemostasis. They are non-specific in nature due to the absence of a platelet-specific agonist, but the tests can generally be modified to overcome this limitation.

**References:**


