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Management of a Postpartum Coagulopathy Using Thrombelastography

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Thrombelastography (TEG), which evaluates the elastic properties of whole blood and provides a global assessment of hemostatic function, is useful in managing peripartum coagulopathy. A case of severe bleeding after vaginal delivery, in which TEG was used successfully to manage hemostatic defects, is presented. © 1997 by Elsevier Science Inc.

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Introduction

Thrombelastography (TEG) evaluates the elastic properties of whole blood and provides a global assessment of hemostatic function. It is a recommended method that is employed in assessing coagulopathies and in guiding their treatment during liver transplantation and cardiac bypass surgery.[1,2] The TEG may be useful in determining hypocoagulable states in patients with preeclampsia,*[3] and it may also be helpful in the management of peripartum coagulopathy.[4–6] The value of TEG in managing coagulopathies in bleeding obstetric patients is gaining recognition. We present a case of severe bleeding following vaginal delivery, in which we successfully used TEG for the management of hemostatic defects.

Case Report

A 22-year-old woman, gravida 4 para 3, with twin pregnancy at 40 weeks' gestation, presented in active labor. Her medical history and her prenatal course were unremarkable. Her labor progressed over four and one half hours to spontaneous vaginal delivery of the first twin. The second twin presented in breech presentation, requiring internal pelvic version and subsequent forceps delivery at 1810 hours with general anesthesia. The patient showed signs of postpartum uterine atony with mild vaginal bleeding following delivery of the second twin. However, this situation responded to fundal massage and administration of oxytocin 40 units intravenous (IV) infusion and prostaglandin $F_{2\alpha}$ 500 mcg intramuscularly (IM). Following uneventful extubation, the patient was taken to the postanesthesia care unit (PACU) at 1900 hours with stable hemodynamics. Vaginal bleeding recommenced 30 minutes after arrival to the PACU. The patient was immediately returned to the operating room (OR) where she continued to bleed despite undergoing dilatation and curettage. Thus, an exploratory laparotomy with general anesthesia followed, and a hysterectomy was planned.

General anesthesia was induced at 2000 hours for exploratory laparotomy with ketamine 70 mg and succinylcholine 140 mg in a rapid-sequence fashion and maintained with nitrous oxide (N_2O) 70%, oxygen (O_2) 30%, isoflurane 0.5% to 1.0%, and fentanyl 50 to 100 mcg boluses. At the time of induction, her heart rate (HR) was 150 beats per minute (bpm) and arterial blood pressure (aBP) was 86/40 mmHg. Her estimated blood loss by that time was 2000 ml and her hematocrit (Hct) was 22%. On induction of anesthesia, rapid transfusion of compatible packed red blood cells (PRBCs) and lactated Ringer's (LR) solution was instituted to replace ongoing blood loss.

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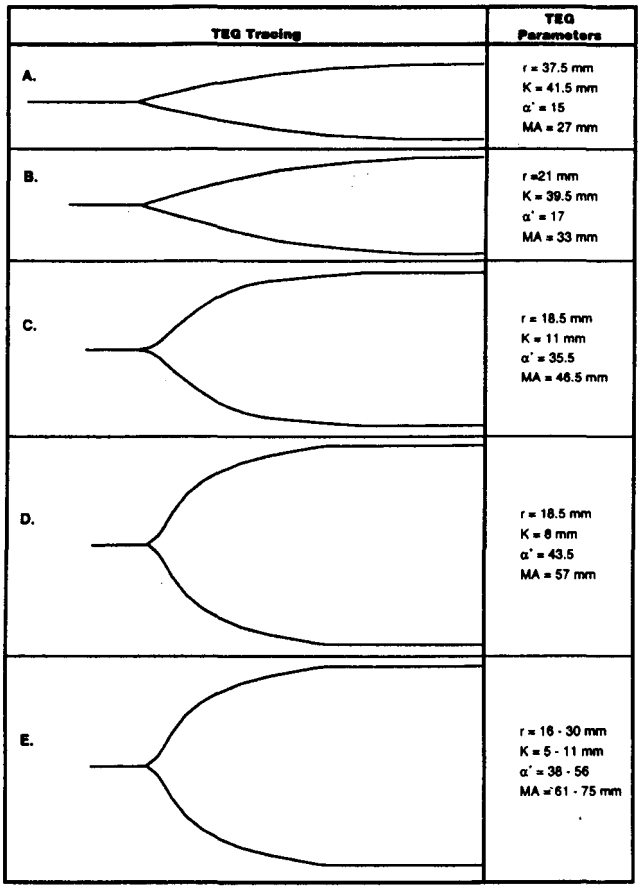

Figure 1. Perioperative thrombelastograms (TEG) from a patient with postpartum coagulopathy. Within 4 minutes after each blood sample the TEG was begun, and each TEG test was performed for approximately 60 minutes using 4 channels in two TEGs. **A:** 2010 hours = prehysterectomy and before clotting factor and platelet replacement. **B:** 2040 hours = posthysterectomy and after initial clotting factor and platelet replacement. **C:** 2200 hours = postsurgery and after clotting factor and platelet replacement. **D:** 2325 hours = in the postanesthesia care unit after cryoprecipitate administration. **E:** Normal TEG with normal values of TEG parameters in pregnant women at term using disposable cups and pins.[7] r = reaction time; K = clot formation time, α angle (°) = clot formation rate; MA = maximum amplitude.

On exposure of the uterus, diffuse and severe oozing was noted by the surgical team. At this point, the urine was also noted to be blood tinged. The right brachial artery was cannulated at 2010 hours, and blood samples were obtained (after drawing 10 ml of flush/blood mixture from the indwelling arterial catheter to rid the line of any traces of heparin) for TEG (Thrombelastograph, computerized version, Haemoscope Corp., Skokie, IL, using disposable cups and pins and 0.36 ml aliquot of whole blood for TEG analysis), standard coagulation profile (SCP), and complete blood count (CBC). Based on the progress of the r (37.5 mm) (normal values: r = 16–30 mm)[7] and the alpha angle on the computer screen at 2035 hours, approximately 25 minutes after the sample was drawn, the patient was diagnosed as having a severe coagulopathy (*Figure 1*). Fresh frozen plasma (FFP) and platelet concentrate infusions were instituted immediately. The results of the SCP and CBC were available at 2110 hours (60 minutes after the blood sampling), by which time FFP and platelets were already being infused (*Table 1*).

By the time the uterus was removed at 2040 hours, the patient had received 4 units of PRBCs, 4 units of FFP, 3 units of pooled platelets (half of a six unit bag of platelets), and 4,000 ml of LR solution. By this time, her hemodynamics had improved (BP was 110/78 mmHg, HR was 110 bpm). A TEG and a SCP were repeated after the uterus was removed at 2040 hours. The results of the TEG were interpreted at 2110 hours. Although still abnormal, some improvement on the thrombelastogram was noted (*Figure 1*). Oozing also was still evident but noted to be less by the surgeons. Her estimated blood loss by this time was 3,000 ml and her Hct was 18%. Three more units of pooled platelets, 2 more units of FFP, and 2 units of PRBCs were infused at 2120, after which a TEG, SCP, and CBC were repeated, just near the end of surgery at 2200 hours (*Figure 1c* and *Table 1*). After completion of the surgery, the patient was taken to the PACU in stable condition. The estimated blood loss by that time was 4,000 ml and Hct was 26%.

While the patient was in the PACU, the results of the TEG performed near the end of surgery were interpreted at 2235 hours. The TEG revealed further improvement, but was still abnormal (*Figure 1c*). The urine also was still blood tinged. Therefore, the patient was transfused with 10 units of cryoprecipitate in the PACU at 2245. A TEG, SCP, and CBC were repeated at 2325 hours following the infusion of cryoprecipitate. The results of the TEG were interpreted at 0000 hours, and the TEG was now normal (*Figure 1d*). The urine also was now clear. While in the PACU, the patient's trachea was ventilated for approximately one hour and then extubated. The patient remained hemodynamically stable (BP was 130/75 mmHg, HR was 92 bpm), with a core temperature of 36°C, urinary output of more than 100 ml/hr, and an arterial oxygen saturation of 100% on 35% supplemental O_2 by face mask. The patient had received a total of 6 units of PRBCs, 6 units of pooled platelets, 6 units of FFP, 10 units of cryoprecipitate, and 7,000 ml of LR solution. The total estimated blood loss was 4,000 ml. Predelivery Hct was 36%, and postsurgery Hct was 30%. The remainder of the patient's recovery and hospital stay were uneventful, and the patient was discharged home on the fifth postoperative day.

Discussion

Postpartum hemorrhage is a major cause of maternal morbidity and mortality, uterine atony being the most common cause for postpartum hemorrhage and also the most common indication for performing a hysterectomy postdelivery. In such patients, hemorrhage may be associated with a coagulopathy, which may develop as a result of either (1) dilution of clotting factors and/or platelets

Table 1. Values of Standard Coagulation Profile in the Perioperative Period

		Time (hours)	aPTT (Sec)	PT (Sec)	PC (10^3/mm^3)	Fib. (mg%)	DD (μg/ml)
A.	Prehysterectomy	2010	90.7	>60	54	<15	>8
B.	Posthysterectomy	2040	71.6	39	81	<15	>8
C.	Postsurgery	2200	39.4	>18	99	120	>8
D.	PACU	2325	27.9	13.3	98	217	>8

The normal values: aPTT (activated partial thromboplastin time) = 25–38 sec, PT (prothrombin time) = 11–13 sec, PC (platelet count) = 140–450 × 10^3/mm^3, Fib. (fibrinogen) = 148–400 mg %, and D-Dimer = <0.5 μg/ml; PACU = postanesthesia care unit.

following crystalloid and/or PRBC administration or (2) disseminated intravascular coagulation (DIC) secondary to tissue trauma. In a bleeding patient, it is often difficult to differentiate a coagulopathy from surgical bleeding. The diagnosis of alterations within the hemostatic mechanism and the need for clotting factor replacement are usually based on the clinical observation of microvascular bleeding in the surgical field and/or results of a standard coagulation profile [activated partial thromboplastin time (aPTT), prothrombin time (PT), fibrinogen level, platelet count (PC), and D-Dimer].

Thrombelastography can reflect the adequacy of whole blood coagulation within 20 to 30 minutes from the time a small amount of whole blood (0.36 ml) is sampled from the patient. The principle and interpretation of the TEG is well described in the literature.[8] The parameters of a TEG tracing are interrelated and reflect activities of clotting factors and platelets, and their interaction.[9] Instead of monitoring an isolated portion of the coagulation cascade, as occurs with a standard laboratory coagulation profile, TEG monitors clot initiation and formation as well as its stability and strength. Therefore, it provides a better idea of the coagulability of whole blood.[10] The r (reaction time) on a TEG indicates clotting factor activity and correlates best with PT and aPTT. The K (clotting time), MA (maximum amplitude), and alpha angle (clot formation rate) indicate platelet and fibrinogen activity. The A_{60} (amplitude of MA at 60 minutes) measures fibrinolytic activity and corresponds to D-Dimer (cross-linked fibrin degradation products).

Thrombelastography is useful in diagnosing and treating coagulopathies in obstetrics. Landers *et al.*[4] rapidly evaluated the patient's coagulation status and monitored the patient's response to goal-directed therapeutic interventions during the management of severe coagulopathy in a pregnant patient. Steer *et al.*[5] found the TEG to be a quick and cost-effective method of diagnosing and treating coagulation abnormalities in a patient with abruptio placentae and DIC.

Blood component therapy must be justifiable in a bleeding patient. The treatment of a hemostatic defect on an empirical basis is associated with an increased potential for the misuse of blood components.[11] After the exploratory laparotomy had begun in our patient, blood samples were obtained to perform a TEG and a SCP to determine whether the bleeding was related to coagulation defects. The TEG results were interpreted, as the TEG tracing was developing, within approximately 25 minutes from the time the blood sample was obtained. The results indicated a severe deficiency of clotting factors and platelets, reflected by a prolonged r and an alpha angle with an abnormal acceleration (*Figure 1a*). The r reflects the activity of clotting factors, and the alpha angle represents platelet-fibrin interaction and the acceleration of coagulation. Based on these TEG findings, FFP and platelet infusions were immediately instituted. After the uterus was removed, and after 4 units of FFP and 3 units of pooled platelets were given, surgical oozing decreased and TEG parameters improved (*Figure 1b*). This improvement in the coagulation status of the patient was most likely attributable to an increase in circulating clotting factors from that which was transfused, and/or a decreased stimulus for the consumption of clotting factors following removal of the uterus. On transfusion of 2 more units of FFP and 3 more units of pooled platelets, there was further improvement in the patient's clinical condition as well as TEG parameters (*Figure 1c*). However, following the infusion of FFP and platelets, the MA and alpha angle were still lower than normal and the urine remained blood tinged (*Figure 1c*). Therefore, 10 units of cryoprecipitate were rapidly infused at this stage. Although FFP contains some fibrinogen [400 mg/200 ml (1 unit)], 10 units of cryoprecipitate is much richer in fibrinogen [150 mg/15 ml (1 unit)]. Consequently, the patient's condition improved even further and the urine became clear. The MA and alpha angle also improved following the transfusion of cryoprecipitate (*Figure 1d*). Thus, the additional use of specific blood products was justified.

The amplitude of MA on a TEG at 60 minutes (A_{60}) is a measure of fibrinolysis (*Figure 2*). Reduction of the MA by more than 5 mm after 60 minutes indicates clot instability and fibrinolysis. The TEG in this case did not show signs of fibrinolysis. This finding was reflected by the MA on the TEG tracing that did not decrease after 60 minutes. This, however, was not consistent with results of the SCP. The SCP indicated fibrinolysis, reflected by very low fibrinogen levels in the first two samples and by D-Dimer levels that were increased in all four samples (*Table 1*). However, D-Dimer levels are known to be elevated following major surgery and do not necessarily indicate a pathologic fibrinolytic process, and fibrinogen levels may be low due to either increased consumption or to dilution. On the other hand, TEG has been shown to be

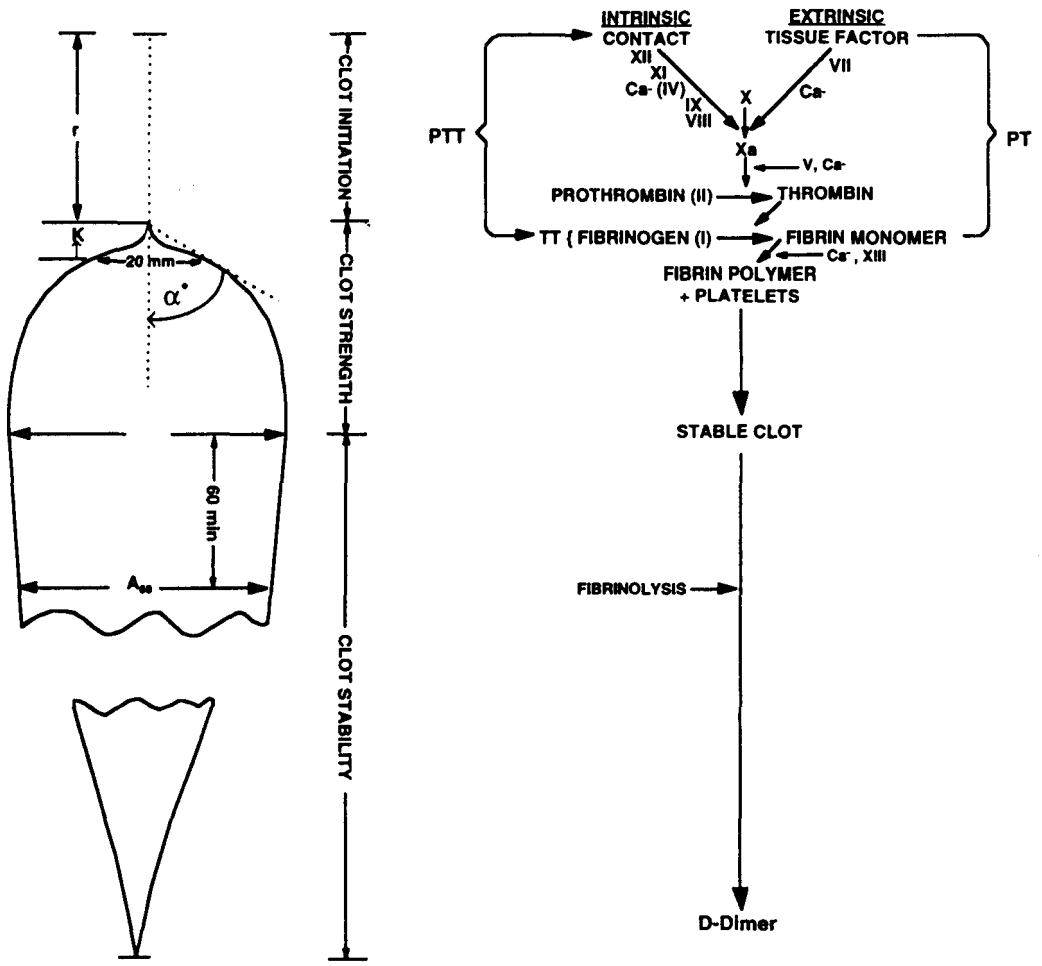

Figure 2. A simplified schematic representation of sequential thrombelastographic parameters related to intrinsic, extrinsic, common coagulation pathways, and fibrinolysis. r = reaction time; K = clot formation time, α angle (°) = clot formation rate; MA = (maximum amplitude), clot strength; A_{60} = amplitude 60 minutes after MA indicates clot stability. aPTT = activated partial thromboplastin time, PT = prothrombin time, TT = thrombin time.

a more clinically reliable test of fibrinolysis compared with plasma concentrations of D-Dimer.*

In the management of this case, TEG allowed us to rapidly diagnose the coagulopathy. The time for receiving results of a standard coagulation profile vary in different institutions. In the OR, it generally takes 45 to 60 minutes to receive results from the time of sample collection. We were able to determine the deficiency of clotting factors and platelets much more rapidly by using TEG. Furthermore, changes in the TEG parameters in response to clotting factor replacement were reliable and correlated with the clinical improvement of the patient.

In conclusion, we report the successful management of severe coagulopathy following vaginal delivery using TEG. In this case, we found TEG to be a reliable and rapid method of diagnosing coagulation defects and guiding their treatment.

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