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The Role of Thromboelastography during the Management of Postpartum Hemorrhage: Background, Evidence, and Practical Application

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Introduction

80% of maternal mortality is caused by postpartum hemorrhage (PPH), which is related to coagulopathy, particularly **hypofibrinogenemia**. In order to guide the treatment, conventional coagulation tests (CCT) are used, which can take as long as one hour, as well as point-of-care viscoelastic tests (POC-VET), providing a quick diagnose (10 minutes) and continuous monitoring. Nevertheless, there is no conclusive scientific evidence on the use of POC-VET in PPH.

The article we discuss is an **outstanding update** on the issue: definitions, etiology, types of coagulopathy, and their treatment [CCT and POC-VET (ROTEM & TEG)].

Definition of postpartum hemorrhage

It is the occurrence of blood loss within 24 hours of delivery. Most guides, as well as the WHO, define PPH as bleeding ≥ **500 mL**, considered severe when estimated as **≥ 1000 mL**, regardless of the delivery method.

Changes in coagulation during pregnancy

Pregnancy prepares women to prevent massive hemorrhage during delivery, hence becoming a **prothrombotic state**. This is due to an increase in coagulation factors, particularly **fibrinogen** (which can go up to 4-6 g/L) and **factor VIII** (which causes shortening of TP and TTPa). The only factor that decreases during pregnancy is the clot stabilizing factor (**factor XIII**).

Coagulopathy of postpartum hemorrhage

The coagulopathy of PPH is fundamentally due to the **loss of fibrinogen**. Hence, that is the main pillar for its treatment. During PPH, factor deficiency is infrequent, except for massive hemorrhage

situations with a blood loss > 2000 mL. Likewise, thrombocytopenia has only been reported in 10% of PPHs, and it is seldom significant. Empiric transfusion of frozen fresh plasma (FFP) ratios versus red blood cell concentrates has not been studied in PPH, and the existing evidence in massive hemorrhage of traumatized patients has been assumed.

Coagulopathy of postpartum hemorrhage depending on the hemorrhage etiology.

Early. Due to a loss of fibrinogen through consumption. It is mostly associated to PPH caused by placental abruption.

Late. Due to the persistence of bleeding, where the loss and dilution of coagulation factors plays a more significant role.

1. **Uterine atony or uterine trauma**. Lead to over 80% of PPHs, but the ratio of patients that eventually develop coagulopathy is very low, and due to the loss of **fibrinogen**. It has been proven that even with losses over 2000 mL only 20% of patients had fibrinogen values < 2 g/L. In such situations, POC-VET-guided transfusion is recommended. **Retention of conception products**. It is not considered a cause of PPH as such, but it is closely linked to the presence of uterine atony.

2. **Placenta praevia / Placenta accreta**. Placenta praevia occurs in 0.5% of pregnancies, and placenta accreta, in 0.05%. In these cases, blood loss happens very quickly, leading to serious coagulopathy and challenging surgery. The main cause is hypofibrinogenemia, which in the case of placenta accreta may be observed in up to 39.5% of patients. In such situations, POC-VET-guided transfusion is recommended.

3. **Placental abruption**. It occurs in 0.65% of pregnancies. With this condition, PPH might be serious and early. Placental abruption is the etiology most commonly associated to **hypofibrinogenemia** (40% PPH). Up to 10 g of fibrinogen might be required to correct coagulopathy and control hemorrhage. A late restoration of fibrinogen can quickly lead to massive hemorrhage. Unlike all other etiologies, **thrombocytopenia** with values < 75x10^9/L is also involved. In such situations, POC-VET-guided transfusion is recommended.

4. **Amniotic fluid embolism**. A coagulopathy caused by massive consumption of **fibrinogen** and **factor V**. Subsequently, **thrombocytopenia** and **factor consumption** takes place. In this condition, **early hyperfibrinolysis** occurs, and early treatment with tranexamic acid is fundamental. In such situations, POC-VET-guided transfusion is recommended.

Bleeding news

5. **Preeclampsia**. It occurs in 5% of pregnancies, and when complicated with the HELLP syndrome (hemolysis, elevated liver enzymes, and low platelet count), a coagulopathy can appear in up to 15% of patients. Moreover, placental abruption is associated to preeclampsia, thus coagulopathy is usually combined.

6. **Sepsis**. PPH occurs together with an infection, and management can be very complicated, since both fibrinogen and coagulation factors, such as platelets, can be altered.

PPH treatment algorithms based on POC-VET

Let's recall the parameters provided by POC-VET:

CT (ROTEM) / R(TEG): Time it takes for a clot to form. It depends on coagulation factors or the presence of heparin.

CFT (ROTEM) / K (TEG): Time it takes for the clot to widen from 2 to 12 mm. It depends on fibrinogen and platelets.

A5, A10, A20 (MA) (ROTEM) / A5, A10, A20 (MCF) (TEG): Clot width after 5, 10, 20 minutes (maximum width). It depends on fibrinogen, platelets, and factor XIII.

LY 30 (ROTEM) / ML 30 (TEG): Clot lysis percentage after 30 minutes.

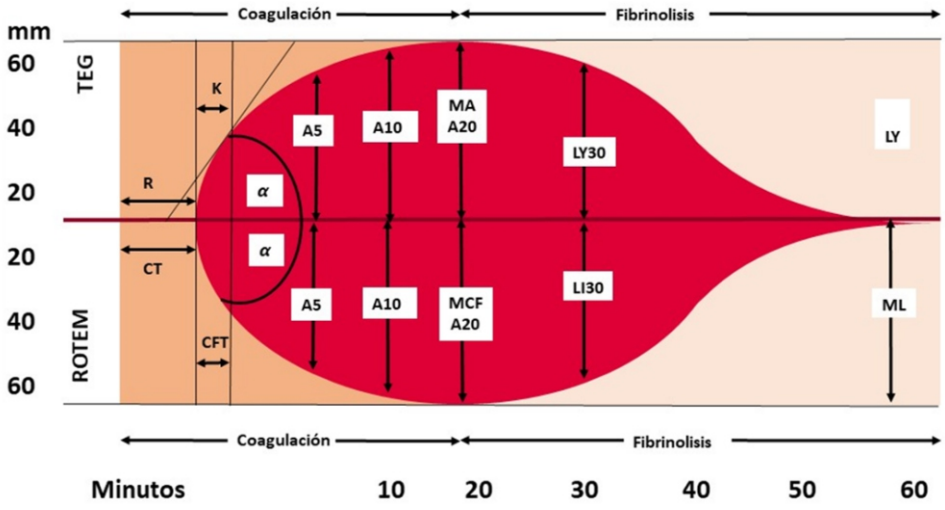

Figure 1. Description of POC-VETs (ROTEM & TEG).

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POC-VET-guided fibrinogen administration: It is very useful. Indeed, it has been proven that cut-off points of 17mm for MA 10 (TEG) and 11 mm for FIBTEM A5 (ROTEM) predict a Clauss fibrinogen < 2 g/L, with a 0.74-0.76 sensitivity; a specificity of 0.96-0.97; a positive predictive value of 0.54-0.57, and a negative predictive value of 0.98-0.99.

POC-VET-guided FFP administration: No robust triggers have been found yet that allow POC-VET-guided transfusion of prothrombin complex concentrate or FFP. This is due to the low incidence of factor deficiency in PPH. The early use of FFP is not recommended either in the treatment of PPH, since it contains a very low level of fibrinogen (≈2 g fibrinogen / 1 L PFC).

POC-VET-guided platelet administration: No robust triggers have been found yet that allow POC-VET-guided transfusion of platelets. This is due to the low incidence of **thrombocytopenia** in PPH.

Fibrinolysis and POC-VET-guided tranexamic acid administration: The WOMAN clinical trial (Lancet, 2017) proved that an early administration of tranexamic acid (1 + 1 g) reduced mortality caused by PPH, with no higher risk of thrombosis. The trial was not based on any viscoelastic test, therefore the administration of tranexamic acid should not be discontinued if there is no hyperfibrinolysis in POC=VET. A likely explanation is that tranexamic acid reduces fibrinogen degradation products and the plasmin-antiplasmin complex.

Summary of the treatment algorithm suggested by Anesthesiology in Cardiff, Wales

1) **Estimated blood loss > 1000 mL?:**
   1. If the patient suffers from von Willebrand disease, on antiaggregation or anticoagulation, check with the hematologist.
   2. Ca^{2+} > 1 mmol/L + pH > 7,2 + temp. > 36° C.
   3. **Tranexamic acid** if not yet administered (1 g and, if bleeding persists, 1 g more).

2) **Is there hypofibrinogenemia?** (Fibrinogen ≤ 2 g/L):
   1. FIBTEM A5 = 7-11 mm **or** CFF A10 = 10-17 mm **4 g fibrinogen**.
   2. FIBTEM A5 < 7 mm **or** CFF A10 < 10 mm **6 g fibrinogen**.

   Where FIBTEM (ROTEM) and CFF (TEG) are the channels analyzing fibrinogen.

3) **If the bleeding persists, repeat viscoelastic test before any further action**, to ensure that the fibrinogen is already corrected. If it is not, administer fibrinogen again. If it is:

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4) **Is there any alteration in coagulation factors?**: Elevated PT / aPTT
   1. EXTEM CT > 75 s or CK-R > 7.6 min → Weight gain > 50 Kg **4 units FFP**.
   2. EXTEM CT > 75 s or CK-R > 7.6 min → Weight gain ≤ 50 Kg **3 units FFP**.

5) **If bleeding persists, check blood platelet count:**
   1. Platelets ≤ 75x10^9/L → **1 platelet pool**.

Conclusions

In cases of PPH, fibrinogen deficiency is very common. Coagulation factor and platelet deficiencies are less frequent.

The current scientific evidence suggests:

- The administration of **tranexamic acid** as first-line treatment for PPH, with POC-VET guidance not required.
- The administration of TCC- or POC-VET-guided **fibrinogen** is recommended. The latter is preferred on account of its early result.
- The administration of **FFP** can be guided by TCC or POC-VET, although evidence for the latter is scarce.
- The administration of **platelets** can be guided by TCC, but there is not enough evidence to guide it by POC-VET, partly because of the low incidence of **thrombocytopenia** in PPH.