The Effects of Platelet Transfusions Evaluated Using Rotational Thromboelastometry

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BACKGROUND: In this study, we assessed the immediate effects of platelet transfusion on whole blood coagulation.

METHODS: Ten thrombocytopenic patients given a single unit platelet transfusion of 200–300 $\times$ 10^9 platelets had their coagulation status assessed before and immediately after transfusion using rotational thromboelastometry.

RESULTS: Transfusion increased the median platelet count from 31.5 to 43.5 $\times$ 10^9/L. Clot formation time decreased by 32% ($P = 0.005$), whereas maximum clot strength increased by 47% ($P = 0.005$).

CONCLUSION: Statistically significant improvements in rotational thromboelastometry-measured parameters were observed in association with a mean increase of 12 $\times$ 109/L in platelet count after platelet transfusion in these patients.

(Anesth Analg 2009;108:1430–2)

Thrombocytopenia is common in patients with hematological malignancies but may also complicate management of other patient populations, such as trauma patients. Platelet transfusions are often administered to patients with thrombocytopenia, despite knowledge that such transfusions are complicated by adverse events.[1]

In an effort to avoid unnecessary transfusions, appropriate transfusion triggers and the efficacy of platelet transfusions have been debated for many years.[2] With respect to efficacy, most studies have focused on the posttransfusion increase in platelet count or on posttransfusion platelet viability.[3] The hemostatic effect of the platelet transfusion is an important end point. Few studies have tried to evaluate the effect of the transfusion on bleeding and coagulation, probably because this is a difficult outcome to study. Platelet aggregometry and thromboelastography have been used to study *in vitro* effects of a reduction in platelet count.[4–6]

Thromboelastography and thromboelastometry are gaining increasing popularity as tools for coagulation monitoring now that the techniques are more robust and user-friendly. Thromboelastography appears to be more sensitive and specific than routine laboratory coagulation tests in detecting defects of the coagulation system.[7–9] Rotational thromboelastometry (ROTEM®) is a thromboelastometric method, based on similar principles to the older method of thromboelastography.

To address the immediate effects of a platelet transfusion on the hemostatic system, we performed a thromboelastometric study in thrombocytopenic patients who were scheduled to receive a platelet transfusion before insertion of a tunneled central venous catheter (CVC).

METHODS

The study was approved by the Swedish Central Ethics Committee. Ten patients with thrombocytopenia because of a hematological malignancy and scheduled to receive central venous access through a subcutaneously tunneled CVC were included. Patient informed and written consent was obtained.

According to hospital practice, 1 U of platelets was transfused before insertion of a tunneled CVC in patients with a platelet count below 50 $\times$ 10^9/L. None of the study patients had received anticoagulation medication for at least 7 days before the platelet transfusion. The CVC was placed in either the subclavian vein or internal jugular vein at the discretion of the anesthesiologist. The procedure was performed under local anesthesia using mepivacaine 20 mg/mL (Astra Sodertalje, Sweden), supplemented with incremental doses of IV midazolam for sedation if deemed necessary.

Each platelet transfusion was performed using buffy coat platelets from four donors in a single unit. One transfusion unit contained 200–300 $\times$ 10^9 platelets in a platelet additive solution containing NaCl, Na-acetate, Na-citrate, and 100 mL of plasma.

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Accepted for publication November 17, 2008.

Supported by a research grant from the Laerdal Foundation for Acute Medicine.

None of the authors have any conflict of interest to disclose regarding the present study.

Reprints will not be available from the author.

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DOI: 10.1213/ane.0b013e31819bccb7

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Immediately before the platelet infusion, venous blood samples were collected to measure prothrombin time (PT), activated partial thromboplastin time (aPTT), and platelet count. One sample was collected in a 4.5 mL citrate tube containing 0.129 M citrate (BD Vacutainer systems, Plymouth, UK) for assessment using ROTEM analysis. The platelet infusion was given and the CVC insertion accomplished within 1 h. A second set of samples were collected immediately after insertion of the CVC for assessment of PT, aPTT, platelet count, and for ROTEM analysis. All PT, aPTT, and platelet count measurements were performed at the hospital laboratory according to standard procedures.

The ROTEM analyses were performed at 37°C using a ROTEM analyzer (Pentapharm GmbH, Munich, Germany) 30 min after blood had been drawn. Coagulation was initiated by adding 20 μL 0.2 M $CaCl_2$ and 20 μL ellagic acid to 320 μL of blood, according to the standard INTEM procedure described by the manufacturer.

ROTEM parameters analyzed were clotting time, clot formation time (CFT), and maximum clot firmness (MCF). Clotting time is the time from the start of the analysis until the clot strength is 2 mm and measures the initiation of coagulation, which is affected primarily by humoral coagulation factors. CFT is the time from the start of coagulation until the clot strength is 20 mm and reflects the rate of clot formation. CFT is primarily not only affected by fibrinogen to fibrin conversion, but also by platelet activity. MCF reflects the maximum clot strength and is primarily determined by platelet activity. The elastic modulus (G) can be calculated as a derivative of MCF and describes the actual clot strength in dynes/cm^2.

The results are described using median and range. Nonparametric statistical analyses were performed using SPSS 15.0 (SPSS, IL). The differences between groups before and after platelet transfusion were tested using the Wilcoxon's rank order test. A P value of <0.05 was considered statistically significant.

RESULTS

Data were obtained from all 10 patients. We included six male patients and four female patients with an age between 22 and 75 yr. All CVCs were placed without complication.

The results are shown in Table 1. The most important findings were that the median platelet count increased significantly from 31.5 (20–44) to 43.5 (38–71) $\times$ 10^9/L after the platelet transfusion ($P = 0.005$), and the hemoglobin concentration decreased from 91 (88–101) to 88.5 (83–94) g/L ($P = 0.005$). The PT and aPTT remained unchanged. The CFT decreased significantly from 181.5 (108–347) to 123 (89–233) s ($P = 0.005$) and the elastic modulus increased significantly by 47% ($P = 0.005$).

Table 1. Results of the Analyses Performed Before and After Platelet Transfusions

	Before Transfusion	After Transfusion
Hb (g/L)	91 (88–101)	88.5 (83–94)
PT (INR)	1.2 (0.9–1.4)	1.2 (0.9–1.3)
aPTT (s)	35.5 (27–54)	37 (27–61)
Platelet count ($\times 10^9$/L)	31.5 (20–44)	43.5 (38–71)*
Clotting time (s)	103.5 (81–215)	108.5 (51–158)
Clot formation time (s)	181.5 (108–347)	123 (89–233)*
Maximum clot firmness (mm)	42 (38–50)	51.5 (45–56)*
G (dynes/cm^2)	3623 (2353–6111)	5319 (3333–7500)*

PT = prothrombin time; aPTT = activated partial thromboplastin time; Hb = hemoglobin.
* $P = 0.005$, when compared with before transfusion.

DISCUSSION

To our knowledge, this is the first study primarily designed to evaluate the effects of a platelet transfusion given to a thrombocytopenic patient using ROTEM. We found that platelet infusions given to patients with a platelet count below 50 $\times$ 10^9/L increased the maximum clot strength measured within 1 h of infusion. Platelet transfusion also increased the rate at which clot strength improved, a finding which we find unlikely to be related to the 100 mL of plasma transfused with the platelets. These findings are relevant to the discussion of the efficacy of a platelet transfusion before an invasive procedure. Previous research has focused on increases in platelet count and the viability of transfused platelets, whereas *in vivo* evaluations of hemostatic function are lacking. Our results indicate that platelets are hemostatically active soon after transfusion, although the clinical significance of this activity is unclear. Not only does the platelet count increase but the speed and strength of clot formation is also increased. An important limitation of the study was the absence of any clinical evaluation, so further studies are needed to investigate clinical outcomes after platelet transfusion.

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