

Is Preoperative Fibrinogen Testing Associated With Total Blood Loss in Adolescent Idiopathic Scoliosis Correction?

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Received 26 October 2016; revised 13 May 2017; accepted 14 May 2017

Abstract

Study Design: Retrospective analysis.

Objective: This study sought to investigate the potential association between preoperative fibrinogen, bleeding, and transfusion requirements in adolescent idiopathic scoliosis (AIS) corrections.

Summary of Background Data: Blood loss after major spinal reconstruction increases the risks and costs of surgery. Preoperative fibrinogen levels may predict intra- and postoperative blood loss.

Methods: Data were collected from clinic charts and hospital medical records of all 110 of a single surgeon's consecutive AIS patients undergoing greater than three-level deformity correction surgeries from January 2011 to December 2013. Pearson test was used to investigate the correlation between bleeding and clinical variables, with level of significance set at $\alpha = 0.05$.

Results: Mean total bleeding volume was 488 (± 356) mL. Overall, mean preoperative fibrinogen concentration was 188.6 ± 32.8 mg/dL. Preoperative platelet counts, prothrombin time (PT), and activated partial thromboplastin time (aPTT) did not correlate significantly with preoperative fibrinogen concentration ($p > .05$). Both packed red cells (PRC) and packed red blood cells (PRBC) correlated significantly with preoperative fibrinogen ($p < .05$). The correlation between PRC and preoperative fibrinogen was -0.042 . There was a negative correlation between PRBC and preoperative fibrinogen ($r = -0.46$). Overall mean thromboelastography (TEG) values were within normal range in both males and females and both had comparable TEG parameter values. All the TEG variables (G, K, and Angle) correlated significantly with preoperative fibrinogen ($p < .05$) but not with total blood volume ($p > .05$). The correlation coefficient between these TEG variables and preoperative fibrinogen were 0.51, 0.59, and 0.54, respectively. The total bleeding volume and % estimated blood volume correlated significantly with both PRC ($r = 0.352$, $r = 0.376$; $p < .05$) and PRBC ($r = 0.621$, $r = 0.614$; $p < .05$).

Conclusions: In our cohort undergoing correction of AIS, preoperative fibrinogen levels exhibited a significant negative logarithmic correlation with total blood loss. TEG variables also correlated significantly with preoperative fibrinogen levels. Efforts should be made to incorporate this measure in perioperative blood management program for AIS corrections.

Level of Evidence: Level IV.

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Keywords: Adolescent Idiopathic Scoliosis; Bleeding; Fibrinogen; Transfusion

Introduction

Intra- and post-bleeding is associated with higher operative morbidity and mortality and greater costs of care

[1-3]. Of course, increased bleeding is associated with increased need for blood transfusion, which carries additional risks such as lung injury and microorganism transmission [4,5]. In order to ameliorate these risks, perioperative blood management programs have been instituted for complex spinal deformity corrections.

To be most effective, these blood management programs require identification of coagulation defects prior to surgery. The most common, routinely collected coagulation markers are activated partial thromboplastin time (aPTT), prothrombin time (PT), and platelet counts. Unfortunately,

Author disclosures: MJG (none); DS (none); HG (none); JKS (none); ET (none).

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these measures are poorly associated with perioperative bleeding [3,6,7].

Fibrinogen, a glycoprotein synthesized in the liver, is a key protein in the coagulation cascade. During coagulation, thrombin lyses the soluble fibrinogen into the insoluble fibrin net onto which clots form. As bleeding continues intraoperatively, fibrinogen is one of the first coagulation factors consumed [8]. In cardiothoracic surgery patients, fibrinogen concentration, even when in the normal range, was predictive of intraoperative blood loss [9].

Thromboelastography (TEG) is a point-of-care test that evaluates whole-clot formation and dissolution. There are three main parameters associated with TEG: G (clot strength, represents the maximum dynamics of fibrin and platelet bonding), K (clot formation time), Angle (kinetics of fibrin formation and cross-linking). More recently, thromboelastography and preoperative fibrinogen levels have been tested for their ability to predict blood loss [10]. In a prospective observational study, Carling and others concluded that preoperative fibrinogen concentration correlated with blood loss [3]. On the other hand, Tomohiro and colleagues concluded that plasma fibrinogen was not associated with perioperative bleeding in adolescent idiopathic scoliosis (AIS) surgery. This study sought to investigate the potential association between preoperative fibrinogen, bleeding, and transfusion requirements in AIS corrections. Our null hypothesis was that preoperative fibrinogen concentration is negatively correlated with the total blood loss in AIS corrections.

Materials and Methods

Institutional review board approval was obtained for this retrospective study. From a single surgeon's practice, data were collected from clinic charts and hospital medical records of all 110 consecutive AIS patients undergoing deformity surgery from January 2011 to December 2013.

The two inclusion criteria for the study were as follows: (1) age at surgery between 8 and 18 years and (2) AIS patients who underwent complex spinal deformity surgical corrections (≥ 3 spinal levels treated) from January 1, 2011, to December 31, 2013. Exclusion criteria included patients younger than 8 years or older than 18 years and patients who did not undergo complex spinal deformity surgical corrections. There was no deliberate exclusion of specific groups.

All surgical procedures were performed by a single surgeon at a university hospital using a uniform surgical approach and fixation strategy. In each case, tranexamic acid (TXA) was administered, total intravenous anesthesia was employed, and the mean arterial pressure was kept above 65 mm Hg. TXA was administered 15 mg/kg load over the first hour followed by an infusion of 1 mg/kg/h for the remainder of the case. A midline incision was employed and a combination of Cobb and electrocautery were used to achieve a subperiosteal dissection of the paravertebral

muscles to the level of the transverse processes. Pedicle screws were used as the chief fixation strategy with occasional, supplementary interlaminar hooks. All patients underwent Smith Petersen osteotomies. Meticulous hemostasis was sought at each stage of surgery using a combination of mono- and bipolar electrocautery, bone wax, thrombin-soaked cottonoids, and hemostatic matrix. A drain was placed deep inside the fascia.

Cell saver was used for all patients. Transfusions of allogeneic blood in our cohort were guided by a clinical protocol designed to keep the hematocrit above 25.

Age, gender, operative time (OT), preoperative Cobb angle, preoperative hemoglobin (Hb), platelet count, PT, aPTT, preoperative fibrinogen, thromboelastography (TEG: G, K, Angle), intraoperative bleeding, postoperative bleeding, total bleeding volume, normalized blood loss, cell saver, and transfusions (packed red cells [PRC]; packed red blood cells [PRBC]) were collected.

Intraoperative estimated blood loss was determined from the blood volume in the suction container minus the volume of irrigant plus an estimate of the blood absorbed by the drapes, gowns, and sponges. The postoperative blood loss was defined as the total amount of drain volume during the first 24 hours. The total blood loss was the sum of intraoperative and postoperative blood loss. The normalized estimated blood loss (estimated blood loss per kilogram [NBL]) was calculated using the equation: $NBL \text{ (mL/kg)} = \text{estimated blood loss (mL)}/\text{body weight (kg)}$. In order to account for the differences in patient size, we also calculated the percentage estimated blood volume (%EBV) using the formula: $EBV = \text{body weight (kg)} \times \text{average blood volume}$. The average blood volume was 65 mL/kg for women and 75 mL/kg for men [11].

Means (standard deviations) were calculated for these parameters. Pearson test was used to investigate the correlation between bleeding and clinical variables with level of significance set at $\alpha = 0.05$. As needed, two-sample *t* test with unequal variances was used to assess for differences between the two groups. The non-normally distributed data were analyzed via the Mann-Whitney *U* test (nonparametric). All the statistical analyses were performed using SPSS software, version 15.0 (SPSS Inc.).

Results

Over the date range, 110 patients met the inclusion criteria. Mean patient age was 14 years (± 3 years), and 83% were female. Both males and females had similar

Table 1
Demographics: mean (\pm standard deviation).

| Patient characteristics | Male | Female |
|-------------------------|----------------------|----------------------|
| Patient sample (n) | 19 | 91 |
| Mean age (y) | 13.8 (± 4.9) | 14.3 (± 2.7) |
| Mean body mass index | 22.43 (± 6.56) | 22.56 (± 5.06) |

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