Platelet Dysfunction in Major Pediatric Scoliosis Surgery: A Cause of Common Surgical Bleeding Phenotypes

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Objectives: Spinal fusion is often complicated by high blood loss and the clinically observed phenomenon of increased bleeding times throughout the case. Although the pathophysiology of this phenomenon involves hyperfibrinolysis and occurs to a lesser extent in the presence of antifibrinolytics (e.g., TXA), we hypothesize that perioperative changes in platelet function also contribute to this continued observation.

Methods: Blood samples were acquired from patients undergoing posterior spinal fusion for correcting scoliosis (five neuromuscular, three idiopathic). Samples were obtained immediately before the procedure, at 2, 4, and 6 hours post-incision, and the subsequent morning (POD1). Platelet activation in response to stimulation with an intravascular agonist, thrombin, and an extravascular agonist, convulxin, was measured by flow cytometry. Activation of the fibrin-binding integrin glycoprotein IIb/IIIa (GpIIb/IIIa) was reported by PAC-1 binding and expression of the alpha-granule component P-selectin was reported by CD62p binding. CBCs and Thromboelastography (TEG) were performed on samples in parallel. Estimated blood loss (EBL) was calculated using a hematocrit-based analysis of red cell mass.

Results: All five neuromuscular patients exhibited a marked and progressive decline in platelet count and activity throughout surgery and early postoperative period. Reductions were most notable for thrombin-stimulated GpIIb/IIIa activation (Th PAC1) at 4 hrs (mean 41.7%, p=0.0056) and 6 hrs (50.9%, p=0.0096). Similar trends in mean reductions were observed for thrombin stimulated P-selectin expression (Th P-selectin) at 6 hrs (22.5%, p=0.0112) and on POD1 (39.2%, p=0.0274). Patients with idiopathic scoliosis demonstrated significant reductions in convulxin-stimulated GpIIb/IIIa activation (32.8%, p=0.0087) and P-selectin expression (35.1%, p=0.0147) at 2 hrs, which recovered to or increased beyond baseline thereafter. These trends also manifested on TEG for all neuromuscular patients as the average time to maximum clot strength increased by 48.8% at 6 hrs (p=0.0058). Furthermore, platelet activity correlated with the calculated EBL for all eight patients (Th PAC1 at 4 hrs R= -0.673, p=0.146 and 6 hrs: R= -0.623, p=0.099; Th P-selectin at 6 hrs: R= -0.694 p = 0.056 and POD1: R= -0.713, p=0.047). EBL also significantly correlated with reductions in platelet count at 6 hrs (R= -0.919, p=0.010) and absolute platelet count on POD1 (R= -0.858, p=0.006).

Conclusions: We have observed a progressive reduction in platelet activation and fibrin-dependent clot formation throughout scoliosis surgery, particularly in patients with neuromuscular disease. High endothelial injury related to achieving surgical exposure may account for the early drop in response to the extravascular collagen receptor agonist, convulxin. Measures associated with secondary hemostasis, such as the thrombin-stimulated platelet activation and time to maximum clot strength, both demonstrated exhaustion towards the postoperative period. These data suggest that surgically induced disruption in platelet function may be a key component of the coagulopathic phenomenon described and closely associated with blood loss.

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