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Clinical Study

Predicting excessive hemorrhage in adolescent idiopathic scoliosis patients undergoing posterior spinal instrumentation and fusion

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Abstract

BACKGROUND CONTEXT: Blood loss in patients with adolescent idiopathic scoliosis (AIS) who are undergoing posterior spinal instrumentation and fusion (PSIF) varies greatly. The reason for this wide range is not clear. There are reports of unexpected massive hemorrhage during these surgeries. Many studies reflect authors' preferences for describing blood loss in terms of levels fused, weight, or percent blood volume.

PURPOSE: We sought to define excessive blood loss clinically, determine its incidence in our study population, and identify associated variables. Results are intended to inform perioperative preparation for these cases. Results may be used to inform prospective study designs.

STUDY DESIGN: This was a retrospective uncontrolled case series.

PATIENT SAMPLE: A total of 311 consecutive AIS PSIF cases during the years 2005–2010 performed at Children's Hospital Colorado were studied.

OUTCOME MEASURES: We measured estimated blood loss (EBL) and its association with multiple patient, surgical, and anesthetic variables.

METHODS: Thirty-one variables potentially related to blood loss were collected retrospectively from electronic medical records for analysis. When no cases of clearly excessive blood loss were identified on the basis of visual examination of EBL distribution, we chose to use the top 10% of blood loss cases as an arbitrary determinant of excessive blood loss. Three cut-off strategies captured the top 10% of EBL cases with little variation in who was selected: 1) >1,700 mL of EBL, 2) >50% EBL/estimated blood volume, and 3) >150 mL/level fused EBL. Variables were compared with the χ^2 test, Fisher exact, or *t*-tests, when appropriate. A generalized linear mixed logistic model was used to determine the probability of excessive blood loss based on the number of levels fused.

RESULTS: The average EBL was 89.17 mL/level fused (range, 45–133 mL). EBL fit a progressively wider distribution as surgical complexity (number of levels fused) increased. Number of levels fused ($p<.0001$), operative time ($p=.0139$), number of screws ($p<.0001$), and maximal preoperative Cobb angle ($p=.0491$) were significantly associated with excessive blood loss. The variable that was most strongly associated with excessive blood loss was the number of levels fused, with ≥12 levels having a probability of >10% of excessive hemorrhage.

CONCLUSION: Excessive blood loss may be an arbitrary number until future research suggests otherwise. We show that the probability of exceeding one of our arbitrary definitions is approximately 10% when 12 or more levels are fused. If a 10% incidence of excessive blood loss is

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determined to be clinically relevant, teams might wish to pursue hematologic consultation and maximal blood conservation strategy when 12 or more levels are planned for fusion.

Keywords: Scoliosis; Spinal fusion; Surgical hemorrhage; Estimated blood loss; Hemostatic disorder

Introduction

Excessive surgical hemorrhage resulting in acute and severe complications occurs in 2% to 3% of elective pediatric ear-nose-throat procedures [1]. Another group with reports of excessive hemorrhage is patients with adolescent idiopathic scoliosis (AIS) who are undergoing posterior spinal instrumentation and fusion (PSIF).

In 2004 Shapiro and Sethna [2] reviewed the literature to quantify published rates of estimated blood loss (EBL) in pediatric spine surgery. Reviewed papers were diverse and included comparisons of surgical technique, blood conservation methods, and patient specific factors. Although blood loss was not reported identically between reviewed papers, the authors were able to publish useful ranges of EBL on the basis of types of scoliosis. They found that patients with AIS lost 65 to 150 mL/level, spastic neuromuscular patients lost 100 to 190 mL/level, and paralytic neuromuscular patients lost 200 to 280 mL/level fused. More recent studies show similar rates for patients with AIS [3,4].

To our knowledge, a clear definition of what constitutes excessive hemorrhage in this population does not exist. In one case series of 168 patients with neuromuscular and idiopathic cases, authors define ''extensive blood loss'' as a loss of more than 50% of estimated blood volume (EBV) without describing how this was derived [5]. Another group has defined ''moderate blood loss'' as a loss of greater than 25% EBV [6]. In Shapiro and Sethna's review, neuromuscular scoliosis patients routinely had 80% to 100% EBL/EBV, whereas patients with AIS undergoing PSIF had 25% to 30% EBL/EBV.

Centers differ on their preference for performing detailed bleeding histories, preoperative laboratory testing, focused hematology consultation, and intraoperative blood conservation strategies. If excessive hemorrhage could be predicted, it might guide targeted preoperative testing and intraoperative blood conservation strategy preparation. As a research question, targeted evaluation of patients at greatest risk for excessive hemorrhage might yield more specific clues to the wide variation in EBL as surgical complexity increases.

Materials and methods

A chart review was conducted after approval from the local institutional research board. No consent was required. No funding was provided or requested.

Data

Preoperative variables collected included age, sex, weight, height, maximal Cobb angle, autologous predonation, medical and surgical history including any significant episodes of bleeding, and results of preoperative laboratory or hematology consultations, if ordered. Intraoperative data collected included surgeon, anesthesiologist, operative time, levels fused, screws placed, blood conservation techniques used, EBL (visual method), blood products infused, intraoperative laboratory tests and values studied, lowest temperature recorded, and any adverse events such as cardiopulmonary resuscitation or neuromonitoring changes. Postoperative data collected included daily hematocrit, drain output, and blood products transfused. Calculated variables included body mass index and EBV based on Nadler's formula [7]. If a preoperative hematocrit had not been drawn, the initial intraoperative hematocrit was used as a surrogate for a baseline value.

Of 311 identified cases, we were able to obtain data on all. The only missing data fields were maximal Cobb angle for 14 (4.5%), preoperative hematocrit in 13 (4.2%), and postoperative day one hematocrit in 3 (1%).

Local conduct of care 2005 to 2010

Patients with AIS were preoperatively evaluated through the orthopedic surgical service including an extensive neuromuscular examination, radiographs, and spinal magnetic resonance imaging scans (per surgeon preference) to ensure the idiopathic nature of the scoliotic deformity. Patients are not routinely screened with a bleeding questionnaire or coagulation laboratory tests unless deemed appropriate by the primary surgeon. Approximately 30% of patients predonated autologous units during the years 2005 to 2010. Within the operating room, cell saver was used infrequently, and antifibrinolytic medications were rarely used. Blood products were transfused at the discretion of the anesthesiologist in consultation with the surgeon. Postsurgical drains were used often and continued until the third postoperative day.

A total of nine surgeons within a single tertiary care pediatric hospital operated collaboratively, with two operative surgeons per case. This made variation from individual surgeon technique unlikely. Surgical technique was relatively uniform, that is, a single stage, posterior spinal approach with implant hardware of dual rod, and pedicle screw fixation were used.