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Original contribution

Massive blood loss in elective spinal and orthopedic surgery: Retrospective review of intraoperative transfusion strategy☆

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ABSTRACT

Objective: To evaluate the perioperative dynamics of hematologic changes and transfusion ratio in patients undergoing a major spinal surgery accompanied with massive bleeding defined as blood loss >5 liters.
Design: Retrospective cohort study.
Setting: Operating room of a university-affiliated hospital.
Patients: Adult patients who underwent elective neurosurgical, orthopedic, or combined spinal surgical procedure between 2008 and 2012.
Methods: Patients who underwent a major spinal or orthopedic surgery and who experienced major bleeding (>5 L) during surgery were identified and selected for final analysis. The following information was analyzed: demographics, clinical diagnoses, hematologic parameters, estimated intraoperative blood loss, blood product transfusions, and survival 1 year after surgery.
Results: During the study period, 25 patients, who underwent 28 spinal procedures, experienced intraoperative blood loss >5 L. Mean patient age was 50.5 years and 56.4% were males. The majority of patients underwent procedures to manage spinal metastases. Median estimated intraoperative blood loss was 11.25 L (IQR 6.35-22 L) and median number of units (U) transfused was 24.5 U (IQR 14.0-32.5 U) of packed red blood cells (RBCs), 24.5 U (IQR 14.0-34.0 U) of fresh frozen plasma (FFP), and 4.5 U (IQR 3.0-11.5 U) of platelets (PLTs). The blood product transfusion ratio was 1 and 4 for RBC:FFP, and RBC:PLT, respectively. Hematocrit, hemoglobin, PLTs, partial thromboplastin, prothrombin time, INR, and, fibrinogen varied significantly throughout the procedures. However, acid-base status did not change significantly during surgery. Patients' survival at 1 year was 79.17%.
Conclusion: Our results indicate that a 1:1 RBC:FFP and 4:1 RBC:PLT transfusion ratio was associated with significant intraoperative variations in coagulation variables but stable intraoperative acid-base parameters. This transfusion ratio helped clinicians to achieve postoperative coagulation parameters not significantly different to those at baseline. Future studies should assess if more liberal transfusion strategies or point of care monitoring might be warranted in patients undergoing spinal surgery at risk of major blood loss.

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1. Introduction

In 2013, approximately 23 130 new cases of malignant tumors of the central nervous system were diagnosed in the United States [1]. Metastatic disease was the most frequent neoplastic pathology of the spine accounting for 83 000 admissions during the period between 2006 and 2010. Spinal metastases develop in 5% to 10% of all cancer patients. In the majority of these cases, the metastasis originate from lung, breast, prostate, renal tumors, or bone marrow malignancies [2,3]. The primary tumors of the spine represent <5% of all bone neoplasms, and <2% of all spinal tumors. The most common primary lesions of the spine include chordoma, Ewing's sarcoma, osteosarcoma, enostosis, osteoid sarcoma, osteoblastoma, giant cell tumor, and aneurysmal bone cyst [4].

Patchell et al (2005) showed that decompressive surgery combined with postoperative radiotherapy was the preferred method of treatment for spinal metastatic disease [5]. The rate of surgical interventions to treat spinal metastases has increased by 22% in recent years [3,5]. These procedures are frequently long in duration and can be associated with significant blood loss that may exceed 5 L (in 12% of patients). Blood transfusions may be required in 50% to 81% of cases [6-8].

Such massive blood loss represents a challenge to the coagulation system. Furthermore, massive transfusion (MT) of blood products, colloids, and crystalloids creates an imbalance between antagonistic procoagulant and anticoagulant mechanisms, triggering systemic coagulation with consumption of coagulation factors, hyperfibrinolysis, acid-base imbalance, hypothermia, hemodilution, and end organ damage. Finally, self-perpetuating coagulopathy may take place [9-11].

Foresight and planning of a transfusion strategy is paramount to maintain a normal blood profile and coagulation response in patients at risk of intraoperative major blood loss (>40% blood volume) or massive bleeding (loss of one blood volume within a 24 h period) [7,12,13]. Currently, there is no universal protocol for massive hemotransfusion in neurosurgical patients undergoing semi-elective procedures. The existing MT practices are derived from studies performed in trauma and general surgical populations and have not been clearly demonstrated to be applicable to this subset of patients. In an elective case, the mechanism of intentional surgical injury combined with the ability to rapidly replace lost blood based upon frequent hematologic data may influence transfusion practice.

The purpose of our study was to evaluate the perioperative hematologic profile and transfusion ratio of patients undergoing elective neurosurgical, orthopedic or combined procedures, who experienced greater than 5 L of intraoperative blood loss. We hypothesized that the transfusion ratio, given to patients that lost greater than 5 L of blood intraoperatively, impacts the incidence of postoperative coagulopathy in patients undergoing elective spinal or complex spinal/orthopedic surgeries.

The primary objectives of the study were to assess the extent of massive intraoperative blood loss and transfusion during spinal orthopedic and neurosurgical procedures. We sought to characterize the hematological changes and changes in blood coagulation parameters at the following time points: baseline, during surgery, and upon procedure completion. Additionally, we aimed to describe the infusion and transfusion therapy for this patient group, length of procedure, and assess the patients' survival after surgery.

The secondary exploratory outcomes included describing the patients' demographic data, types of cancer, intraoperative changes in hemodynamic parameters, and relationship between perioperative medications and blood loss.

2. Methods

After obtaining the approval of the local Institutional Review Board, we performed a retrospective database analysis to identify patients who underwent a major spinal or orthopedic surgery and who experienced major bleeding (>5 L) during surgery. Patients were included if they were diagnosed with cancer, underwent an elective neurosurgical, orthopedic, or combined procedure. Twenty-five patients were identified between January 2008 and February 2012 who met the inclusion criteria.

Screening the paper and electronic medical records to identify the patients meeting inclusion criteria was performed by the principal investigator and the surgeon. Patients' demographics, past medical history, pathology, laboratory results, and details of intraoperative patient management were retrieved for analysis. The coagulation parameters measured included hemoglobin (HB), hematocrit (HCT), platelets (PLT), prothrombin time (PT), partial prothrombin time (PTT), international normalized ratio (INR), and fibrinogen (FIB). Measurements were obtained at baseline and were followed in the first 24 hours after completion of the procedure. Intraoperative data such as patient hemodynamics, arterial blood gases (pH, base excess and deficits), fluid infusion volumes (crystalloids, colloids, and albumin), urinary output (mL), intraoperative blood loss (mL), and blood product transfusion (type, units) were also documented. Additionally, inpatient mortality at 30 days, 3, 6, 9 months, and 1 year after surgery was analyzed.

The estimated blood volume loss included the exact suction volume and visual assessment of the gauze and dressing absorbed volume. Although no specific transfusion protocol was identified by the study, blood product administration was performed according to institutional guidelines. According to this institution protocol, packed red blood cell transfusions were indicated in the presence of life threatening bleeding with hemorrhagic shock, in which case no specific hemoglobin value was required and the massive transfusion protocol was activated (2 PRBC, 2FFP and 1 PLT apheresis is provided every 30 min). PRBC transfusion with no HB threshold was also indicated in the presence of acute/symptomatic blood loss manifested by tachycardia, hypotension, or any other indicator of inappropriate oxygen delivery. Active bleeding with consumption and/or dilution of coagulation factors, INR >1.5, and fibrinogen <100 mg/dL warranted the transfusion of FFP. Platelets transfusion was indicated in actively bleeding neurosurgical patients with PLT counts <100 000 μL. Certain clinical conditions, such as, anticipated intraoperative life-threatening bleeding or oncologic cases might have warranted high hemoglobin levels (>10 g/dL) with transfusion thresholds dictated by clinical rationale. One PRBC unit contains about 300 to 350 mL.

Table 1
Patient demographics

Variable	Mean (SD)	N = 25* 95% Confidence interval
Age	50.5 (14.5)	(44.5-56.4)
BMI	28.9 (6.5)	(26.2-31.6)
Sex		Frequency
	Female	11 (44%)
	Male	14 (56%)
Race		
	Asian	1 (4%)
	Caucasian	22 (88%)
	Other	2 (8%)
ASA		
	2	1 (4%)
	3	17 (68%)
	4	7 (28%)
Diagnosis/Procedures		
	Primary tumor	8 (32%)
	Metastatic tumor	15 (60%)
	Orthopedic procedures	2 (8%)

Patient Demographics. There were 28 procedures performed on 25 patients. *Parameter (percentage) for categorical data. *Mean ± standard deviation (SD). ASA - denotes American Society of Anesthesiologists Physical Status Classification System; BMI - Body Mass Index. SD Standard deviation.