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How accurate is visual estimation of perioperative blood loss in adolescent idiopathic scoliosis surgery?

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ABSTRACT

Objective: The aim of this study was to assess whether the visual estimation method for perioperative blood loss is accurate in adolescent idiopathic scoliosis surgery.
Methods: Sixty-five consecutive patients, who were operated on from 2012 to 2015 and had a diagnosis of AIS, were included into the study. Gender, age, preoperative weight and height, preoperative major curve magnitude and T5–T12 kyphosis angles, the fusion level, and the time of surgery were recorded. Perioperative blood loss was estimated by the same anesthesiologist for all patients. Then, an experienced surgeon estimated the perioperative blood loss by a gravimetric method, and the results were compared.
Results: Seventeen (26.2%) of the patients were male and 48 (73.8%) were female. The mean age was 15.8 ± 1.9. The mean height of the patients was 162.1 ± 8.9 cm and the mean weight was 52.6 ± 8.9 kg. The mean preoperative major curve magnitude and kyphosis angles were 49.5 ± 9.2 and 47.1 ± 12.7 respectively. The mean estimate of the surgeon was 1009 ± 404.5 ml and the mean estimate of the anesthesiologist was 434 ± 217.6 ml and the difference was statistically significant ($p < 0.05$). Moreover, if blood loss was high during the operation, the difference between the estimates of the surgeon and anesthesiologist was also higher.
Conclusions: Even in operations where most of the blood goes into a suction canister, such as for AIS, a visual estimation method is not accurate. A short training regarding optimizing the amount of blood contained in sponges that are not fully soaked may be sufficient to improve this method.

Introduction

Adolescent idiopathic scoliosis (AIS) is the most common type of spinal deformity. It affects individuals between 10 and 20 years of age, and multilevel posterior instrumentation and fusion is the primary surgical option for correction of the deformity.[1] Although AIS surgery is associated with less blood loss than other types of scoliosis surgery, the mean blood loss can reach 1500 ml; this lost blood should be replaced to an adequate level.[2] Underestimation may lead to inadequate fluid and blood replenishment, which may be associated with shock, organ damage, and impaired tissue oxygenation.[3,4] Meanwhile, overestimation may lead to an unnecessary transfusion and, as a result, increased complications and mortality.[5,6] Thus, for adequate replacement of blood loss, a reliable estimation of perioperative blood loss (PBL) is essential.

Although there are several methods for estimating PBL, all have limitations and estimating PBL remains a challenge. It may be especially difficult for long-duration operations and when much bleeding is expected, as in scoliosis surgery. The most commonly used method, as at our institution, is visual estimation by anesthesiologists, although several studies have shown its inadequacies.[7,8] In this method, the anesthesiologist estimates PBL by visually examining blood collected in suction canisters, surgical sponges, drapes, towels, and on other surfaces; it has been reported that large losses are typically underestimated, while smaller losses tend to be overestimated.[9]

The Manuscript submitted does not contain information about medical device(s)/drug(s).

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Other methods, like gravimetric techniques and photometry, are not used widely. Although they are more objective, they are not always practical and are also time-consuming. As a result, there is no reliable and routinely applicable method for estimating PBL.

One reason for inaccurate estimates using visual estimation method (VEM) is the inability to determine the exact amount of blood not in the suction canister and sponges, or on drapes and other surfaces.[10] Most of the studies in the literature about the inaccuracy of VEM are related to obstetric operations, which typically involve bleeding out of the surgical site on to sponges and drapes.

We hypothesized that VEM would be accurate for AIS surgeries. Because of the characteristics of the operation site in scoliosis surgery, which is deep and has a distinct border, like a pool, only a small amount of blood leaks away, and most of the blood is suctioned into the canister. Thus, this should result in an accurate estimation. In summary, this study was designed to assess whether estimates of PBL were reliable in spinal fusion surgery when compared with the more objective gravimetric method.

Materials and methods

This was a prospective clinical study approved by the Institutional Ethics Committee/Review Board. Sixty-five consecutive patients, who were operated on from 2012 to 2015 and were diagnosed with AIS between the age of 10 and 20 years, were included in the study. The surgical indication was a deformity with a Cobb angle >40°. Patients with abnormal preoperative laboratory findings, a history of spinal surgery, or congenital anomalies on preoperative spinal magnetic resonance imaging (MRI) were excluded. Patients' gender, age, and preoperative weight and height were recorded. Preoperative major curve magnitude and T5–T12 kyphosis angles were measured according to the Cobb method. The fusion level and time of surgery were also recorded. PBL was estimated by the same anesthesiologist for all patients. Then, an experienced surgeon estimated the PBL independently by a gravimetric method and the estimates were compared.

Posterior instrumentation and fusion was performed for all patients. All of the surgeries were performed by the same senior spine surgeon from the beginning to the end. Patients were placed in the prone position on a radiolucent table. After a standard midline incision, subperiosteal dissection of the posterior soft tissue was done, to the tips of the transverse processes, by electrocautery. Surgicel, padding, bone wax and electrocautery were used to maintain homeostasis as required. Pedicle screws were placed bilaterally and parallel at each level using a free-hand technique. The posterior release was performed with partial facetectomies at all instrumented levels by using osteotome and hammer. There was no need to perform major osteotomy in any patient. Titanium rods, 6.0 mm in diameter, were contoured to correct deformities. The rods were attached to screws, initially at the top of construct, bilaterally. Deformity were corrected using a direct derotation technique. Then, fluoroscopic control of the coronal and sagittal alignment was performed and compression, distraction and in situ bending maneuvers were added if necessary. The laminae and transverse processes were thoroughly decorticated by rongeur to facilitate the fusion. Allograft bone material was used for fusion. Double hemovac drain was used without activation and they were removed on the second day after surgery. All patients practiced ambulation within the first day after surgery. Stressful activities were avoided for at least 2 months after surgery.

The anesthesiologist was informed about the study and estimated the PBL clinically, i.e., by VEM, and maintained normovolemia by replacing the lost blood with appropriate crystalloids, colloids, or blood products. To estimate the blood loss, they multiplied the number of blood-soaked gauze pieces by 20 cc, and the mopping pads by 100 cc, and then summed them with the blood estimated to be in the suction bottle and around the surgical area. Surgeons estimated the blood loss by weighing all of the soaked gauze pieces and mopping pads postoperatively with a sensitive balance, and summing those data with the amount of blood and irrigation solution mixture in the suction bottle. Then, total dry weight of items and the weight of the irrigation solution in the suction canister (which was calculated by a nurse), were subtracted from the total of stained weight of the items and mixture of suction canister. The difference in weight was noted. This method is called the gravimetric method. As a result, the blood loss estimated by the anesthesiologist and the surgeon could be compared.

Descriptive statistics were used to describe continuous variables. Spearman's rho correlation analysis was used to analyze the relationship between two continuous variables with non-normal distributions, and Pearson correlation analysis was used to analyze the relationship between two continuous variables with normal distributions. Student's *t*-test was used to compare two independent and normally distributed variables, and the Mann–Whitney U test was used to compare two independent variables with non-normal distributions. Statistical significance was set at $p < 0.05$. Analyses were performed using MedCalc software (ver. 12.7.7; MedCalc Software bvba, Ostend, Belgium).

Results

In total, 65 patients with AIS, who were treated with posterior segmental instrumentation and fusion from 2013 to 2015, were included in the analysis. Table 1 lists the demographic information,

Table 1
Preoperative demographics, scoliosis and kyphosis angles and fusion levels.

Variable	Number (65)	Mean	Median	Standard deviation	Minimum	Maximum
Age		15,8	16	1,9	12	20
Height		162,1	162	8,9	144	193
Weight		52,6	51	8,9	35	77
FL		13,1	13	0,7	11	15
PMCA		49,5	47	9,2	40	83
PKA		47,1	47	12,7	17	74

FL: Fusion level, PMCA: Preoperative major Cobb angle, PKA: Preoperative kyphosis angle.

Table 2
Perioperative blood loss estimates.

Variable	Number	Mean	Median	Standard deviation	Minimum	Maximum	P value
Estimated by Surgeon (ml)	65	1009	941	404,5	93	2385	<**0,05**[a]
Estimated by Anesthesiologist (ml)	65	434	350	217,6	150	1100	

[a] Mann-Whitney U p.

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