International Journal of Anesthesiology Sciences
www.anesthesiologyjournals.com
Online ISSN: 2664-9276, Print ISSN: 2664-9268
Received: 30-10-2021, Accepted: 16-11-2021, Published: 01-12-2021
Volume 3, Issue 1, 2021, Page No. 5-8

Analysis of factors responsible for blood loss during scoliosis correction surgeries

Abhilasha Motghare, Vinaya Ghanawat, Vivek Gupta, Rajendra D Patel
Department of Anesthesia, Seth Gordhandas Sunderdas Medical College, Parel, Mumbai, Maharashtra, India

DOI: https://doi.org/10.33545/26649268.2021.v3.i1a.16

Abstract
The present analysis was conducted retrospectively to determine the importance of factors which can affect blood loss in scoliosis surgery. Data of the 30 patients who underwent surgery for correction of scoliosis by using various instrumentation and non-instrumentation techniques with bone grafting in period of one year was collected.
The mean intraoperative blood loss was 424.66 ± 342.07ml which was 21.45 ± 13.37 percent of estimated blood volume. The mean total blood loss (intraoperative + drain output) was 488 ± 361.72 i.e 24.78 ± 14.22 percent of estimated blood volume. The mean total blood administration was 472.82 ± 302.96 ml.
Introperative blood loss was significantly related with duration of surgery (r= 0.845, P< 0.001). When surgery lasted less than 6 hrs the mean intraoperative blood loss was 234.7 ± 171.39 ml and when the duration was more than 6hrs intraoperative blood loss was 673.07 ± 354.5 ml (P < 0.001).
Number of fused vertebrae were related with intraoperative blood loss (r= 0.632, P<0.01) but more significantly related with total blood loss (r= 0.766, P <0.001). When less than seven vertebrae were fused the mean intraoperative blood loss and the mean total blood loss was 236.87 ± 217.36 ml and 277.81 ± 227.91 ml respectively. In case of more than seven vertebral fusion the mean intraopertive blood loss was 639.28±336.94 (P= 0.003) and total blood loss was 728.21 ±336.94 ml (P= 0.001).
A poor correlation was obtained with the mean intraopertive blood loss and Cobb's angle (r=0.468, P<0.02) but a better correlation was observed with the mean total blood loss (r= 0.541, P< 0.01).
There was a significant correlation between the mean intraoperative blood loss (P< 0.005) and total blood loss (P<0.008) with the wake up test when it was performed. Mean arterial blood pressure was not related with intraoperative as well as total blood loss.

Keywords: scoliosis, blood loss

Introduction

Scoliosis surgery is an extensive orthopaedic operative procedure which involves substantial blood loss and thus increases transfusion requirement [1]. Profuse bleeding may occur when the erector spinae muscles are stripped from spinous process, lamina and transverses process of vertebrae. Severe oozing may occur from the large area of cancellous bone and osteoporotic bone.
The following factors can affect blood loss in scoliosis surgery –
Surgical factors: which include surgical technique, duration of surgery, number of vertebrae involved, site and size of bone graft etc.

Anaesthetic factors: which include anaesthesia technique, hypotensive technique and various drugs used to decrease the blood loss.

Postural factors: which include abdominal wall tension and increased intra-abdominal pressure or extrinsic pressure on abdomen causing venous obstruction.

Respiratory factors: include intermittent positive ventilation.

Various methods have been suggested to reduce the blood loss intraoperatively [2]. The surgical technique is of utmost importance to decrease the bleeding. Posterior spinal fusion procedure is associated with more blood loss as compared to anterior procedures[3]. Subperiosteal dissection, pressing the wound edges firmly with approximated fingertips, use of packs whenever feasible and use of retractors all provide a certain degree of hemostasis. Meticulous attention must be given for proper positioning of patient.
In our retrospective study we attempted to determine the relative importance of factors that influence bleeding during intraoperative and postoperative period after spinal fusion for scoliosis surgery in 30 patients.

Methods

A retrospective analysis of the data of 30 ASA grade I & II patients presenting for the correction of scoliosis by various instrumentation technique [4, 5] such as Harrington rod fixation, Mossmiami etc and non-instrumentation technique with harvesting of bone graft from iliac crest was done over a period of one year.
After taking valid informed consent, patients were anesthesised using standard anaesthesia technique. Tab atenolol 0.5 mg/kg was given one hour prior in the preoperative room. Once inside the Operating Room (OR), standard anaesthesia monitors were attached.The patients were premeditated with Inj Midazolam 0.03mg/kg and Inj Buprenorphine 3µg/kg. The endotracheal intubation with flexometallic tube was facilitated with Inj Thiopentone 5-7mg/kg and Inj Succinylcholine2mg/kg. The muscle paralysis was maintained with Inj Vecuronium 0.1

mg/kg/hr. The anaesthesia was maintained with oxygen: nitrous oxide (50:50) with sevoflurane to maintain MAC 1. Intraoperative monitoring was done by pulse oximeter, electrocardiogram (ECG), invasive blood pressure, ABG, Capnograph, temperature & hourly urine output (UO). Heart rate, blood pressure, O2 saturation was recorded before induction, during induction and every 15 min thereafter until the end of anesthesia. UO was maintained 0.5-1 ml/kg/min.

Intraoperative controlled hypotensive anesthesia was maintained. The mean arterial pressure was maintained 15-20% less than the preinduction baseline value which was achieved by Nitroglycerine (NTG) infusion rate at 1-2.5 µg/kg/min. Atenelol, a potent hypotensive drug used as premedication also helped to maintain hypotension as well as heart rate. Sevoflurane 1-2 % was administered continuosly during surgery to maintain depth of anesthesia and hypotension.

Skin and subcutaneous tissue were infiltrated with inj. Adrenaline 1:500000 dilution in normal saline and bupivacaine 15 min before incision. Maximum allowable dose of infiltration (in ml) was approximately 2.5 times of the body weight of the patient. Inj Bupivacaine 0.5% was mixed in adrenaline infiltration in dose 1-1.5ml/kg. Maintainance fluid and third space losses were replaced with 6-10 ml/kg/hr lactated ringer's solution. Intravenous crystalloids were used to replace surgical blood losses in the ratio of 1:3 when estimated blood loss was less than 10-15% of estimated blood volume (EBV). Whole blood was administered when blood loss was more than 15-20% EBV. Estimated blood volume was calculated as 70ml/kg for female patients and 80ml/kg for male patients. Blood loss was estimated by measuring the blood in suction bottle and deducting the amount of any saline wash(if any given), weighing the dry mops before and after being soaked with blood and calculating the difference(considering 1gm=1ml whole blood) and adding amount of blood lost on drapes and in operative field.

Wake up test [6] was performed in case where possible and required. Inhalational anaesthetic agents and neuromuscular blocking agents were discontinued half an hour prior to the expected time of performing wake up test. In few cases half calculated dose of inj Glycopyrolate and inj. Neostigmine were given to reverse the neuromuscular blockade. After performing the wake up test anaesthesia was deepened.

Surgical drain was inserted before closure and was kept in place for duration of 48-72hrs. At end of surgery neuromuscular blockade was reversed and patients were extubated. Post-operative vital parameters were monitored and blood was replaced in postoperative period depending on blood loss in drain output and the haemoglobin level.

For this analysis, following data was collected- age, sex, weight, preoperative cobb's angle, preoperative haemoglobin, number of fusion of vertebrae, duration of surgery, mean arterial blood pressure, type of surgery, position of patient, number of wake up tests performed and duration of wake up test, intraoperative and postoperative blood loss, amount of adrenaline infiltration given and hourly urine output.

Preoperative and postoperative Cobb's angle was noted. Relationship between various factors and intraoperative as well as total (intraoperative+ postoperative) blood loss was analysed by using coefficient of correlation. Statistical analysis was done by using unpaired t test, analysis of variance (ANOVA) and Chi square test as required.

Results

30 patients were analysed in this study whose age range was 1.5 – 16 years. Among these 23 were females and remaining 7 were males (table 1). Twenty three patients underwent instrumentation surgery with bone grafting and remaining 7 underwent non instrumentation surgery with bone grafting. Twenty five patients were operated in prone position and 5 were operated in lateral position. Blood transfusion was required in 22 patients either intraoperatively or in the post-operative period. Intraoperative blood loss, total blood loss and blood administered intraoperatively as well as postoperatively are given in table 2 as whole percent of estimated blood volume and per fused vertebrae.

Preoperative and postoperative haemoglobin values were found to be 10.24 ± 0.90 gm% and 10.52 ± 0.62 gm% respectively (Table 3). The mean duration of surgery was 6.03 ± 2.96 hrs in all patients. Intraoperative blood loss was 426.66 ± 342.09 ml as an absolute and 21.45 ± 13.37 as percent of estimated blood volume. A strong positive correlation was obtained with intraoperative blood loss and duration of surgery ($r=0.845$, $P < 0.001$). Total blood loss (intraoperatively and drain output) was 488 ± 361.72ml as a whole and 24.78 ± 14.22 as percent of estimated blood volume. There was a strong correlation ($r=0.821$, $P < 0.001$) between total blood loss and duration of surgery.

Out of 30 cases, in 17 cases surgical time was less than 6 hours while in 13 cases it was more than 6 hours. In one case surgical time was 14 hours. When the surgery lasted less than 6 hours the average intraoperative blood loss was 234 ± 171.39 ml and total blood loss was 255.88 ± 200.95 ml compared with more than 6 hours surgery time group with an intraoperative blood loss of 673.07 ± 354.5ml and total blood loss 739.23 ± 376.42 ml, significant correlation was obtained ($P < 0.001$) (Table 4).

Number of fused vertebrae ranged from 5-9(6.6 ± 1.328). There was positive correlation with number of fused vertebrae with intraopertive blood loss ($r = 0.632$, $P < 0.01$) and with total blood loss ($r= 0.766$, $P < 0.001$).

When less than seven vertebrae were fused the mean intraoperative blood loss was 236.87 ± 217.36 ml and total blood was 277.81 ± 227.91 ml. In the remaining 14 cases with more than seven vertebral fusion the mean intraoperative blood loss was 639.28 ± 336.94 ml and average total blood loss was 728.21 ± 339.74 ml (table 5).

The mean arterial blood pressure ranged from 58 – 82 mm of Hg (67.3 ± 5.16) intraoperatively. The intraoperative and total blood loss was poorly correlated ($r = 0.4030$, $P < 0.02$) and ($r = 0.5089$, $P< 0.01$) respectively with mean arterial blood pressure.

17 patients had mean arterial pressure less than 60 mm of Hg and 13 patients had mean arterial pressure of more than 60 mm of Hg. Intraoperative blood loss was more in less than 68 mm of Hg MAP group (522.35 ± 388.29) than MAP more than 68 mm of Hg (296.92 ± 231.74). Preoperative cobb's angle ranged from 10^o - 60^o (39.2 ± 9.94). Intraoperative blood loss was poorly correlated ($r = 0.54$, $P< 0.01$) with preoperative cobb's angle. Out of 30 cases 14 cases had Cobb's angle < 40^o, rest 16 cases had Cobb's angle > 40^o, no significant difference was obtained in the blood loss in these 2 groups.

Out of 30 cases in our analysis wake up test was performed in 20 cases. In most of the cases wake up test was performed once, wake up test was performed thrice in only one patient. Positive correlation was obtained using Chi square test with

the mean intraoperative and average total blood loss with the cases where wake up test was performed. The mean intraoperative blood loss was 545 ± 344.08 ml where the wake up test was performed and 184 ± 179.44 ml where the wake test was not performed. Out of 20 cases where the wake up test was performed, only 7 cases had mean duration of wake up test more than 20 minutes, in one case where the wake up test was performed thrice total duration of wake up test was 50 minutes. The mean intropeative blood loss in less than 20 minutes group was 434 ± 259.53 ml while in more than 20 min group it was 750 ±371.93 ml (P< 0.01). The average total blood loss in less than 20 min group was 499.61 ± 259.53 ml while in more than 20 minutes group it was 828.57 ± 388.83 ml (P< 0.004).

25 patients operated in prone position had mean intraoperative blood loss 457.6 ± 354.96 ml and mean total blood loss 519 ± 377.18 ml. Remaining 5 patients operated in either right or left lateral position had mean intraoperative blood loss 260± 227.48 ml and mean total blood loss 333 ± 242.83 ml. A positive correlation was obtained between intraoperative blood loss and position (P< 0.05) and total blood loss with the position of the patient (P< 0.05) on applying unpaired t test. Out of 30 cases in this analysis 23 underwent various instrumentation techniques (Harrington rod fixation, Mossmiami etc with bone graft) and seven patients were for non-instrumentation technique (anterior transthoracic fusion, epiphysiotomy etc) with bone grafting. The mean intraoperative and total blood loss in instrumentation group was found to be 513.47 ± 342.71 ml and 580.86 ± 355.94 ml respectively. While in non-instrumentation group the mean intraoperative blood loss was 132.85 ± 73.41 ml and total blood loss was 182.85 ± 125. 16 ml. Positive correlation was obtained with type of surgery and the mean intraoperative blood loss (P < 0.01) & total blood loss (P < 0.01).

Table 1: General Data of Patient

	Mean ± SD	Range
Age (years)	10.716 ± 4.186	(1.5 – 16)
Sex	23 F : 7 M	
Weight (kg)	26.2 ± 11.02	(6 – 52)
Cobb's angle (°)		
Pre-operative	39.2 ± 9.94	(10 – 60)
Post-operative	14.93 ± 5.02	(6 – 32)
Number of fused vertebrae	6.6 ± 1.328	(5 – 9)
Adrenaline (1:500000) with bupivacaine infiltration (ml)	64.23 ± 26.88 2.57± 1.08	(15 – 125) (0.6 – 5)
Duration of surgery	6.03 ± 2.96	(2.25 – 14)
Mean arterial blood pressure (mm of Hg)	67.83 ± 5.16	(58- 82)
Duration of drain (hours)	45.1 ± 4.92	(36 – 60)

Table 2: Blood Loss and Replacement

Study Parameter	Mean ± SD
Intraoperative blood loss (ml)	424.66 ± 342.09
Intraoperative blood loss (%EBV)	21.45 ± 13.37
Intraoperative blood loss per fused vertebra (ml)	59.43 ± 43.01
Blood administered during surgery	377.66 ± 209.93
Postoperative blood loss (ml)	63.33 ± 40.52
Postoperative blood loss (%EBV)	3.346 ± 1.849
Postoperative blood loss per fused verterbra (ml)	8.822 ± 5.103
Blood administered postoperatively	336 ± 101.44
Total blood loss (ml)	488 ± 361.72
Total blood loss (% EBV)	24.78 ± 14.22
Total blood loss per fused vertebra(ml)	68.26 ± 45.29
Total blood administered	472.82 ± 302.96

Table 3: Preoperative and Postoperative Hemoglobin

All Patient (n = 30)	Preoperative (Mean ± SD)	Postoperative (Mean ± SD)
Hemoglobin (gm/dl)	11.24± 0.90	10.52 ± 0.662

Table 4: Duration of Surgery and Blood Loss

Duration of Surgery (Hours)	Number of cases	Blood Loss (ml) mean ± SD	
		Perioperative	Total
<6	17	234.7 ± 171.39	295.88 ± 200.45
≥ 6	13	673.07 ± 354.5	739.23± 376.42

Highly significant relation obtained between duration of surgery with per operative and total blood loss (P < 0.001)

Table 5: Number of Fused Vertebra and Blood Loss

Number of Fused Vertebra	Number of Cases	Blood Loss (ml) (Mean ± SD)	
		Perioperative	Total
< 7	16	236.87 ± 217.36	277.81 ± 227.91
≥ 7	14	639.28 ± 336.94	728.21 ± 339.74

P = 0.003 for perioperative blood loss and P = 0.001 for total blood loss

Discussion

In our study 30 patients were analysed who underwent surgical correction for scoliosis using various techniques of instrumentation with bone grafting and non-instrumentation with bone grafting. We tried to determine the relative importance of various factors that influence the bleeding in the intraoperative and postoperative period using similar anaesthesia techniques and hypotensive anaesthesia.

The mean intraoperative blood loss was 424.66 ± 342.09 ml which was 21.45 ± 13.37 percent of estimated blood volume. Total blood loss was 488 ± 361.72 which was 24.78 ± 14.22 percent of estimated blood volume. Total blood administered was 472 ± 302.96 ml.

Guay *et al* found mean intraoperative blood loss 1971 ±831 ml which was 61.5 ± 27.6 percent of EBV, the total blood loss was 3347 ± 920 ml was 104.2 ± 30.6 percent of estimated blood volume. Total blood administered was 2231 ± 801ml [7].

In our analysis there was a strong positive correlation between the mean intraoperative blood loss and duration of surgery (r = 0.845 P< 0.001), strong positive correlation was also obtained with average total blood loss and duration of surgery (r = 0.821, P < 0.01). Blood loss was significantly

more in the cases where surgery lasted more than 6 hours ($P< 0.001$).

A positive correlation was obtained with intraoperative blood loss and number of vertebrae fused ($r = 0.632$, $P < 0.01$). A strong positive correlation was observed with average total blood loss and number of fused vertebrae ($r = 0.766$, $P < 0.001$). This value shows that number of fusion of vertebrae is important factor of intraoperative as well as post-operative blood loss. Blood loss was significantly more in the intraoperative as well post-operative period when more than seven vertebrae fusion was done. A weak correlation was obtained with Cobb's angle and intraoperative as well as total blood loss. But no significant difference in mean was obtained in cases where cobb's angle was less than 40^o and where it was more than 40^o. Mc Neil [8] *et al* did not find difference in blood loss in patients with cobb's angle less than 60^o, between 60^o - 79^o or greater than 79^o

The intraoperative blood loss had no correlation to mean arterial pressure mentioned intraoperatively in the range of 58 – 82 mm of Hg. A weak correlation was obtained with intraoperative mean arterial blood pressure with total blood loss ($r = 0.5089$, $P < 0.01$). Out of 30 patients 17 patients had MAP < 60 mm of Hg and 13 had MAP > 60 mm of Hg. No significant difference in mean was obtained in two groups on applicable of analysis of variance.

Intraoperative blood loss was significantly more in the cases with wake up test performed ($t = 3.10$, $P< 0.05$) but this will require further evaluation because most of the cases in the group wake up test was not performed were operated with non-instrumentation techniques.

Duration of wake up test is definitely significant which can affect blood loss in intraoperative period, out of 20 patients where wake up test was performed, 13 patients had duration of wake up test less than 20 minutes and 7 patients had duration of wake up test more than 20 minutes. On applying analysis of variance, significant difference in mean was observed with intra operative blood loss and duration of wake up test ($P = 0.01$)

In our study 25 patients were operated in prone position and 5 patients were operated in lateral position. Blood loss was significant more in prone position in the intra operative period ($p < 0.05$) but total blood loss was not significantly related with position of patient. Since there was a large number of difference in the two groups of the patients so interpretation of results will require a further evaluation to prevent the bias. Boston O *et al* [9] studied patients undergoing lumbar disc herniation surgery in prone versus kneeling position and found significantly less blood loss with kneeling position.

In our analysis 23 patients underwent various instrumentation techniques with bone grafting and seven patients underwent non instrumentation techniques with bone grafting. A significant relation was observed with intraoperative blood loss and instrumentation surgery ($P < 0.01$), but total blood loss was not significant difference in two groups of patients so a further evaluation will be required. We found significant correlation between duration and blood loss similar to study by Murat *et al* [10].

We conclude that number of fused vertebra is the one of the most important factor in the intraoperative as well as postoperative blood loss. The duration of surgery has significant relationship with intraoperative blood loss. Cobb's angle has poor correlation with intraoperative blood loss but has better correlation with blood loss in postoperative period. Duration of wake up test has significant relationship with intraoperative blood loss.

References

1. Goldstein LA. Surgical management of Scoliosis. Journal of Bone and Joint surgery (Am)48A:167,1966
2. illiam AP and Robert HN. Control of blood loss during scoliosis surgery.Clinical orthopedic and related research,1998:229:88-94.
3. Modi H N, Seung-Woo Sun, Jae-Young Hong, Sang-Heon Song, Jae-Hyuk Yang : Intraoperative blood loss during different stages of scoliosis surgery: A prospective study. Scoliosis,2010:5:16
4. Anderson M. Posterior spinal fusion with Harrington instrumentation using balanced anaesthesia. Southern Medical Journal,1978:71(6):660-1.
5. Harrington PR. Treatment of scoliosis correction and internal fixation by spinal instrumentation. Journal of bone and joint surgery (Am),1974:56:218.
6. Abott TR, Bentley G. Intraopertive awakening during scoliosis surgery. Anaesthesia,1980:35:298-302.
7. Guay J, Haig M, Lortie L, Guertin M. Predicting blood loss in surgery for idiopathic scoliosis. Can J Anaesth,1994:41:9:775-81
8. McNeil TW, Dewald RL, Kvo KN, Ben net EJ, Salem MR. Controlled Hypotensive Ansthesia in Scoliosis surgery. Journal of Bone and Joint surgery (Am),1974:56(A):1167-72.
9. Bostman O, Hyrkas J Hirvensalo, Kallio E. Blood loss operating time and positioning of patient in lumbar disc surgery. Spine,1989:15:5.
10. Murat I, Delleur MM, Loose JP, Saint Maurice C. Controlled hypotension during posterior vertebral arthrodesis; value of an isoflurane nitroglycerin combination. Cah Anesthesiol,1986:34(2):117-24