



The efficacy of cell saver method in the surgical treatment of adolescent idiopathic scoliosis

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Objective: The aim of the study was to evaluate the efficacy of the intraoperative blood salvage cell saver method for allogeneic blood transfusion in the surgical treatment of adolescent idiopathic scoliosis with pedicle screw and rod combination.

Methods: The study included 33 patients (5 males and 28 females) who underwent surgery due to adolescent idiopathic scoliosis. Patients were divided into 2 groups; 16 patients (mean age: 17.1±3.9 years) in Group A were operated using the cell saver (Medtronic Autolog; autologous cell saver machine) method and the 17 patients (mean age 18.7±6.8 years) in Group B (control group) were treated without cell saver. The Cobb angle, levels of pedicle fixation, operation time, postoperative bleeding, hemoglobin change, allogeneic blood replacement and the amount of autologous erythrocytes were recorded.

Results: Mean level of pedicle fixation was 12.9±1.54 vertebra using a mean of 21.1±3.21 screws in Group A and 12.8±1.47 vertebra using 18.7±3.59 screws in Group B ($p>0.05$). The mean operation time was 224 (Group A: 228±58; Group B: 221±60) minutes. There were no statistically significant differences in the demographic characteristics of both groups ($p>0.05$). The preoperative mean hemoglobin levels were 12.2±1.47 mg/dl in Group A and 13.1±1.56 mg/dl in Group B. Postoperative mean hemoglobin level was 11.3±1.62 mg/dl in Group A and 9.86±0.93 mg/dl in Group B ($p=0.004$). The mean amount of autologous erythrocyte replacement was 284±139 ml. The mean postoperative bleeding was 834±253 ml in Group A and 759±380 ml in Group B ($p>0.05$). The mean allogeneic blood replacement was 1.88±0.88 units in Group A and 1.94±1.34 in Group B ($p>0.05$).

Conclusion: Autologous erythrocyte replacement was possible using the cell saver method. However, there was no decrement in allogeneic blood replacement using cell saver in the surgical treatment of adolescent idiopathic scoliosis.

Key words: Adolescent idiopathic scoliosis; allogeneic blood transfusion; cell saver; erythrocyte replacement.

One of the major causes of morbidity in the surgical treatment of adolescent idiopathic scoliosis is bleeding. Blood loss is estimated by fusion level (65 to 193 ml for

each level) in posterior instrumentation and constitutes 16 to 30% of the total blood reserve.^[1,2] In posterior instrumentation of idiopathic scoliosis patients, blood

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transfusion is needed in 37 to 85% of patients.^[3-6] With allogeneic blood replacement, complications such as allergic reactions and blood-borne infections can be encountered.^[7,8] To decrease allogeneic blood replacement, many methods such as patient positioning, hypotensive anesthesia, normovolemic hemodilution, autologous donor blood, and cell saver had been used in the literature.^[1-9] A decrease in the required allogeneic blood replacement has been reported with these methods.

The cell saver method spares the erythrocytes by filtering the blood, debris, and irrigation fluid that are collected during surgery. No consensus has been made on the use of cell saver in the surgical treatment of adolescent spine disorders and complications such as hematuria, homeostasis and electrolyte disturbances had been reported.^[2,10-15]

The aim of this study was to evaluate the efficacy of the cell saver method on blood replacement in the surgical treatment of the adolescent idiopathic scoliosis with pedicle screw and rod combination.

Patients and methods

This study retrospectively evaluated 33 patients who underwent surgery for adolescent idiopathic scoliosis between 2010 and 2013. The 16 patients (mean age: 17.1 ± 3.9 years) who were operated using the cell saver method with an autologous blood transfusion machine (Medtronic Autolog; Medtronic Inc., Minneapolis, IN, USA) were enrolled in Group A and the 17 patients (mean age: 18.7 ± 6.8 years) treated without the cell saver method were enrolled in Group B (control group). Patients with thrombophilia or who needed osteotomy were excluded from the study.

Operations were performed by surgeons experienced in spine surgery. Patients were positioned in the prone position to prevent increased abdominal pressure. Hypotensive anesthesia was administered. Mean perioperative systolic and diastolic blood pressures were calculated and accepted as 70-80 mmHg. All patients were operated via a posterior approach with a pedicle screw and rod combination. Blood transfusion was decided by both the surgeon and anesthesiologist. Hemoglobin levels of ≤ 8 mg/dl in patients with clinical findings of anemia and ≤ 7 mg/dl in those without any clinical finding were accepted as the hemoglobin limit for transfusion. In Group A patients, Medtronic Autolog device salvaging erythrocytes according to their weight density by centrifuge was used. After 400 cc of blood was collected in the reservoir of the cell saver machine, the erythrocyte concentrate was transfused to the patient through a closed network.

All patients were followed in the intensive care unit for the first postoperative 24 hours. Patient demographic characteristics, body mass indexes (BMI), preoperative and postoperative hemoglobin levels, thrombocyte levels and Cobb angles were recorded. Instrumentation levels, number of pedicle screws, operation time, drainage in the first postoperative day, number of allogeneic transfusion and the amount of spared erythrocytes with cell saver were evaluated.

SPSS v.20.0 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. The t-test was used for numeric value comparison and the chi-square for non-numeric comparison for both groups. P values of less than 0.05 were considered significant.

Results

The mean age of the patients was 17.1 ± 3.9 years in Group A and 18.7 ± 6.8 years in Group B. The mean Cobb angle was $55.3^\circ \pm 10.8^\circ$ in Group A and $68.6^\circ \pm 17.3^\circ$ in Group B. According to age, there were no statistically significant differences between groups ($p > 0.05$). There were no statistically significant differences in demographic characteristics of both groups ($p > 0.05$) (Table 1).

Cobb angles were statistically higher in Group B ($p = 0.013$). Preoperative BMI was 20.7 ± 3.5 kg/m² in Group A and 20.8 ± 2.6 kg/m² in Group B and there were no statistically significant differences between groups ($p = 0.92$). Preoperative mean hemoglobin level was 12.2 ± 1.47 mg/dl in Group A and 13.1 ± 1.56 mg/dl in Group B. There were no statistically significant differences between groups ($p > 0.05$). The mean arterial pressure during surgery was 88 ± 6.0 mmHg in Group A and 92.6 ± 6.3 mmHg in Group B. The mean arterial pressure was higher in Group B and this difference was significant ($p = 0.035$).

The mean level of pedicle fixation was 12.9 ± 1.54 vertebrae with a mean of 21.1 ± 3.21 screws in Group A. In Group B, the mean level of pedicle fixation was 12.8 ± 1.47 vertebrae with 18.7 ± 3.59 screws ($p > 0.05$). The mean operation time was 224 (Group A: 228 ± 58 ; Group B: 221 ± 60) minutes. Mean autologous erythrocyte replacement was 284 ± 139 ml. Operation time and the amount of autologous erythrocyte replacement were correlated and was statistically significant ($p = 0.0072$).

Mean drainage in the 1st postoperative day was 834 ± 253 ml in Group A and 759 ± 380 in Group B ($p > 0.05$). Mean allogeneic blood replacement was 1.88 ± 0.88 units in Group A and 1.94 ± 1.34 units in Group B ($p > 0.05$). Patients required 7.90 ± 3.7 ml/kg of intraoperative blood replacement in Group A and

Table 1. Demographic characteristics and the statistical analysis of the patients.

Parameters	Cell saver Group (Group A)	Control Group (Group B)	p
	Mean±SD	Mean±SD	
Age (year)	17.1±3.9	18.7±6.8	0.17
Cobb angle	55.3±10.8	68.6±17.3	0.013
Body Mass Index (kg/m ²)	20.7±3.5	20.8±2.6	0.92
Instrumentation level	12.9±1.54	12.8±1.47	0.922
Number of screws	21.1±3.21	18.7±3.59	0.055
Preoperative hemoglobin level (mg/dl)	12.2±1.47	13.1±1.56	0.720
Mean arterial pressure (mmHg)	88±6.0	92.6±6.3	0.035
Postoperative hemoglobin level (mg/dl)	11.3±1.62	9.86±0.93	0.004
Operation time (min)	228±58	221±60.1	0.750
Postoperative 1st day bleeding (First 24 hours) (ml)	834±420	759±380	0.591
Perioperative blood replacement (unit)	1.25±0.57	1.0±0.612	0.237
Perioperative blood replacement (ml/kg)	7.9±3.7	6.93±5.23	0.57
Postoperative blood replacement (unit)	0.625±0.806	1.06±1.09	0.205
Total blood replacement (unit)	1.88±0.885	1.94±1.34	0.869
Total blood replacement (ml/kg)	11.68±4.82	15.2±12.3	0.30
Postoperative thrombocyte count (x1000/mm ³)	217±48.1	216±48.8	0.941
Preoperative and postoperative change of hemoglobin levels	p=0.07	p=0.000	

Significant p values are written in bold. SD: Standard deviation.

6.93±5.23 ml/kg in Group B (p=0.57). Total allogeneic blood replacement of 11.68±4.82 ml/kg was transfused in Group A and 15.2±12.3 ml/kg in Group B (p=0.30). There were no statistical differences in intra- and postoperative blood transfusion between groups (p>0.05).

A statistically higher postoperative hemoglobin level was determined in the cell saver group (mean: 11.3±1.62 mg/dl in Group A and 9.86±0.93 mg/dl in Group B) (p=0.004). In addition, there were no statistically significant differences between pre- and postoperative hemoglobin levels in patients in the cell saver group (Group A) (p=0.07). However, hemoglobin levels decreased significantly in the control group (Group B) (p=0.000).

No allergic reactions during or after the operation with transfusion of allogeneic blood or autologous erythrocytes were encountered.

Discussion

Posterior instrumentation and fusion is accepted as the gold standard in the surgical treatment of adolescent idiopathic scoliosis. The length of the fusion level, operation time, and the amount of bleeding increases morbidity. To decrease bleeding and reduce allogeneic blood transfusion, successful methods such as aminocaproic acid, tranexamic acid, hypotensive anesthesia, autologous erythrocyte transfusion and patient positioning have been defined in the literature.^[2,7-17]

Allogeneic blood transfusion can be reduced using the cell saver system in surgical procedures, including innominate osteotomy and cranial surgery, in a pediatric patient population.^[10,12] Some controversy remains over cell saver use in spinal surgery. Weiss et al. could not demonstrate the efficacy of the cell saver method in their study.^[14] Copley et al. reported that hemodilution was more effective than cell saver in reducing allogeneic blood transfusion.^[4]

Lennon et al. reported a significant decrease in allogeneic blood transfusion using the cell saver method in spinal surgery in a pediatric population.^[13] In addition, while Bowen et al. reported an intraoperative decrement in the rate of allogeneic blood transfusion and overall transfusion number using the cell saver system, there were no difference in the postoperative allogeneic blood transfusions.^[17] Ersen et al. stated that the cell saver method did not reset the requirement of allogeneic blood transfusion, but decreased the need of allogeneic blood transfusion in the perioperative and postoperative periods.^[11] In our study, perioperative allogeneic blood transfusion was 7.5±4.37 ml/kg and there were no statistical difference between groups (p= 0.57). Hemoglobin level changes were statistically lower in the cell saver group than in the control group. While this can be attributed to the positive effect of erythrocyte replacement, we could not find any statistical differences in the periopera-

tive allogeneic blood replacement between groups.

In a study by Bowen et al., the mean operation time of the patients was 360 (range: 228 to 540) minutes and they recommended the use of the cell saver method in operations longer than 6 hours.^[17] In our series, the mean operation time was 224 (range: 120 to 405) minutes. Ersen et al. reported a mean erythrocyte suspension of 382.1 ± 175 ml in their patients.^[11] In comparison, our mean operation time and the amount of erythrocyte suspension (284 ± 139 ml) was lower. Additionally, we found a correlation between operation time and perioperative bleeding ($p=0.0072$). Hypotensive anesthesia was used in all patients in our series and we believe that its use and the shorter operation time may decrease the efficacy of the cell saver machine in our patients.

Behrman and Keim reported that use of the cell saver system in the peri- and postoperative periods produced more successful results.^[15] In our study, there was no difference between the 2 groups in the assessment of postoperative bleeding (834 ± 253 ml in Group A, 759 ± 380 ml in Group B) or allogeneic blood transfusion. The mean postoperative blood requirement was 330 (range: 0 to 1000) ml in all patients. Postoperative cell saver use may decrease the requirement of allogeneic blood replacement.

Reitman et al. evaluated the cost effectiveness of the cell saver method in comparison to allogeneic blood replacement and reported that cell saver was more expensive.^[18] In our study, we did not evaluate the cost effectiveness of the method.

In conclusion, although autologous erythrocyte transfusion using the cell saver system was obtained, the method did not lower the required amount of allogeneic blood replacement in the surgical treatment of adolescent idiopathic scoliosis.

Conflicts of Interest: No conflicts declared.

References

- Shapiro F, Sethna N. Blood loss in pediatric spine surgery. *Eur Spine J* 2004;13 Suppl 1:S6-17. [CrossRef](#)
- Carey PA, Schoenfeld AJ, Cordill RD, Tompkins BJ, Caskey PM. A Comparison of Cell Salvage Strategies in Posterior Spinal Fusion for Adolescent Idiopathic Scoliosis. *J Spinal Disord Tech* 2013 Nov 8. [CrossRef](#)
- Bess RS, Lenke LG, Bridwell KH, Steger-May K, Hensley M. Wasting of preoperatively donated autologous blood in the surgical treatment of adolescent idiopathic scoliosis. *Spine* 2006;31:2375-80. [CrossRef](#)
- Copley LA, Richards BS, Safavi FZ, Newton PO. Hemodilution as a method to reduce transfusion requirements in adolescent spine fusion surgery. *Spine* 1999;24:219-24.
- Joseph SA Jr, Berekashvili K, Mariller MM, Rivlin M, Sharma K, Casden A, et al. Blood conservation techniques in spinal deformity surgery: a retrospective review of patients refusing blood transfusion. *Spine* 2008;33:2310-5.
- Thompson GH, Florentino-Pineda I, Poe-Kochert C. The role of amicar in decreasing perioperative blood loss in idiopathic scoliosis. *Spine* 2005;30(17 Suppl):S94-9. [CrossRef](#)
- Kuklo TR, Owens BD, Polly DW Jr. Perioperative blood and blood product management for spinal deformity surgery. *Spine J* 2003;3:388-93. [CrossRef](#)
- Ridgeway S, Tai C, Alton P, Barnardo P, Harrison DJ. Pre-donated autologous blood transfusion in scoliosis surgery. *J Bone Joint Surg Br* 2003;85:1032-6. [CrossRef](#)
- Neilipovitz DT1, Murto K, Hall L, Barrowman NJ, Splinter WM. A randomized trial of tranexamic acid to reduce blood transfusion for scoliosis surgery. *Anesth Analg* 2001;93:82-7.
- Dahmani S, Orliaguet GA, Meyer PG, Blanot S, Renier D, Carli PA. Perioperative blood salvage during surgical correction of craniosynostosis in infants. *Br J Anaesth* 2000;85:550-5. [CrossRef](#)
- Ersen O, Ekinci S, Bilgic S, Kose O, Oguz E, Sehirlioglu A. Posterior spinal fusion in adolescent idiopathic scoliosis with or without intraoperative cell salvage system: a retrospective comparison. *Musculoskelet Surg* 2012;96:107-10. [CrossRef](#)
- Nicolai P, Leggetter PP, Glithero PR, Bhimarasetty CR. Autologous transfusion in acetabuloplasty in children. *J Bone Joint Surg Br* 2004;86:110-2.
- Lennon RL, Hosking MP, Gray JR, Klassen RA, Popovsky MA, Warner MA. The effects of intraoperative blood salvage and induced hypotension on transfusion requirements during spinal surgical procedures. *Mayo Clin Proc* 1987;62:1090-4. [CrossRef](#)
- Weiss JM, Skaggs D, Tanner J, Tolo V. Cell Saver: is it beneficial in scoliosis surgery? *J Child Orthop* 2007;1:221-7.
- Behrman MJ, Keim HA. Perioperative red blood cell salvage in spine surgery. A prospective analysis. *Clin Orthop Relat Res* 1992;278:51-7.
- Malcolm-Smith NA, McMaster MJ. The use of induced hypotension to control bleeding during posterior fusion for scoliosis. *J Bone Joint Surg Br* 1983;65:255-8.
- Bowen RE, Gardner S, Scaduto AA, Eagan M, Beckstead J. Efficacy of intraoperative cell salvage systems in pediatric idiopathic scoliosis patients undergoing posterior spinal fusion with segmental spinal instrumentation. *Spine* 2010;35:246-51. [CrossRef](#)
- Reitman CA, Watters WC 3rd, Sassard WR. The Cell Saver in adult lumbar fusion surgery: a cost-benefit outcomes study. *Spine* 2004;29:1580-4. [CrossRef](#)