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SCIENTIFIC ARTICLE

Two-year experience with cell salvage in total hip arthroplasty

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Abstract

Background and objective: The aim of this study was to determine the efficacy of the cell salvage system in total hip arthroplasty surgeries and whether the cell salvage system can reduce the allogeneic blood transfusion requirement in total hip arthroplasty patients.

Methods: We reviewed retrospectively the medical records of patients who underwent hip arthroplasty surgeries between 2010 and 2012 in a university hospital. A total of 181 arthroplasty patients were enrolled in our study.

Results: In the cell salvage group, the mean perioperative rate of allogeneic blood transfusion was significantly lower (92.53 ± 111.88 mL) than that in the control group (170.14 ± 116.79 mL; $p < 0.001$). When the mean postoperative transfusion rates were compared, the cell salvage group had lower values (125.37 ± 193.33 mL) than the control group (152.22 ± 208.37 mL), although the difference was not statistically significant. The number of patients receiving allogeneic blood transfusion in the CS group ($n = 29$; 43.2%) was also significantly lower than control group ($n = 56$; 73.6%; $p < 0.05$). In the logistic regression analysis, perioperative amount of transfusion, odds ratio (OR) -4.257 (95% CI -0.502 to 0.184) and operation time, OR: 2.720 (95% CI 0.001–0.004) were independent risk factors for the usage of cell salvage system.

Conclusion: Cell salvage is an effective strategy for reducing the need for allogeneic blood transfusion in the perioperative setting; it provides support to patient blood management interventions. Thus, we recommend the cell salvage system for use in total hip arthroplasty surgeries to reduce the need for allogeneic blood transfusion, if possible.

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Dois anos de experiência com recuperação intraoperatória de sangue em artroplastia total do quadril

Resumo

Justificativa e objetivo: O objetivo deste estudo foi determinar a eficácia do sistema de resgate celular em artroplastia total de quadril e se o sistema de recuperação intraoperatória de sangue pode reduzir a necessidade de transfusão de sangue alogênico em pacientes submetidos à artroplastia total de quadril.

Métodos: Análise retrospectiva dos prontuários de pacientes submetidos a cirurgias de artroplastia de quadril entre 2010 e 2012 em um hospital universitário. No total, 181 pacientes submetidos à artroplastia foram inscritos no estudo.

Resultados: A média da taxa de transfusão de sangue alogênico no período perioperatório foi significativamente inferior no grupo de recuperação intraoperatória de sangue ($92,53 \pm 111,88$ mL) que no grupo controle ($170,14 \pm 116,79$ mL; $p < 0,001$). Quando as médias das taxas de transfusão no pós-operatório foram comparadas, o grupo de recuperação intraoperatória de sangue apresentou valores inferiores ($125,37 \pm 193,33$ mL) aos do grupo controle ($152,22 \pm 208,37$ mL), embora a diferença não tenha sido estatisticamente significativa. O número de pacientes que recebeu transfusão de sangue alogênico no grupo RC ($n = 29$; 43,2%) também foi significativamente inferior ao do grupo controle ($n = 56$; 73,6%; $p < 0,05$). Na análise de regressão logística, a quantidade de transfusão no período perioperatório, a razão de chance (OR) $-4,257$ (95% CI $-0,502-0,184$) e o tempo cirúrgico, OR: 2,720 (IC 95% 0,001-0,004) foram fatores de risco independentes para o uso de sistema de resgate celular.

Conclusão: A recuperação intraoperatória de sangue é uma estratégia eficaz para reduzir a necessidade de transfusão de sangue alogênico no período perioperatório, que auxilia no manejo sanguíneo durante as intervenções. Portanto, recomendamos o sistema de recuperação intraoperatória de sangue para uso em artroplastia total de quadril para diminuir a necessidade de transfusão de sangue alogênico, quando possível.

Introduction

Considerable blood loss is a frequent problem in patients undergoing major orthopedic surgery. Particularly for arthroplasty surgeries, allogeneic red cell transfusion is often necessary.[1] However, the probability of transition of a wide variety of viral diseases such as those caused by hepatitis B and C, human immunodeficiency virus, transmission-transmitted virus, West Nile virus, Cytomegalovirus, Epstein–Barr virus, as well as variant Creutzfeldt–Jakob disease, bacterial contamination, and sepsis are a concern for allogeneic blood transfusion (ABT).[2,3] The incidence of transfusion-transmitted diseases decreased to very low levels in many countries with the modern laboratory techniques (nucleic acid testing) during the past years, but ABT still has considerable risks such as cardiac overload, transfusion-related acute lung injury, and transfusion-related immunomodulation. Medical staff welded incorrect blood transfusion, ABO-Rh mismatch, and allergic reactions also as serious causes of morbidity and mortality.[4] Although the risks for transfusion-transmitted diseases decreased to a very low level in the developed countries, many developing countries where transfusion services are insufficient still experience a high prevalence of such infections.[5] Meanwhile, for the developed countries, the major concern for ABT is the financial cost of providing and preserving a safe blood product rather than transfusion-related infectious diseases.[5]

Consequently, to reduce the need for ABT, different methods are established, including preoperative autologous blood donation, normovolemic hemodilution, iron or erythropoietin based patient blood management, and cell salvage (CS) systems.[1,6,7] CS is the process of collecting and reinfusing autologous blood.[8] Its main target is to reduce and, if possible, eliminate the need for ABT and diminish probable infectious and noninfectious complications.[9]

The aim of this study was to examine the records of patients who had the CS system used in their total hip arthroplasty (THA) surgery and compare them with patients operated without the CS system. In addition, we investigated if the CS method can decrease the need for ABTs.

Methods

This study was conducted with the approval of the local Ethical Committee under approval no. 2013/14, dated 27/12/2012. We searched the database of the medical faculty and retrospectively evaluated patients operated in the Department of Orthopedics and Traumatology. A total of 181 THA patients were enrolled in our study. Of the patients, 38 were excluded from the study because their medical records indicated hematological problems that met our exclusion criteria. We included 67 patients in a CS (cell salvage) group and 76 patients for control groups who underwent hip arthroplasty.
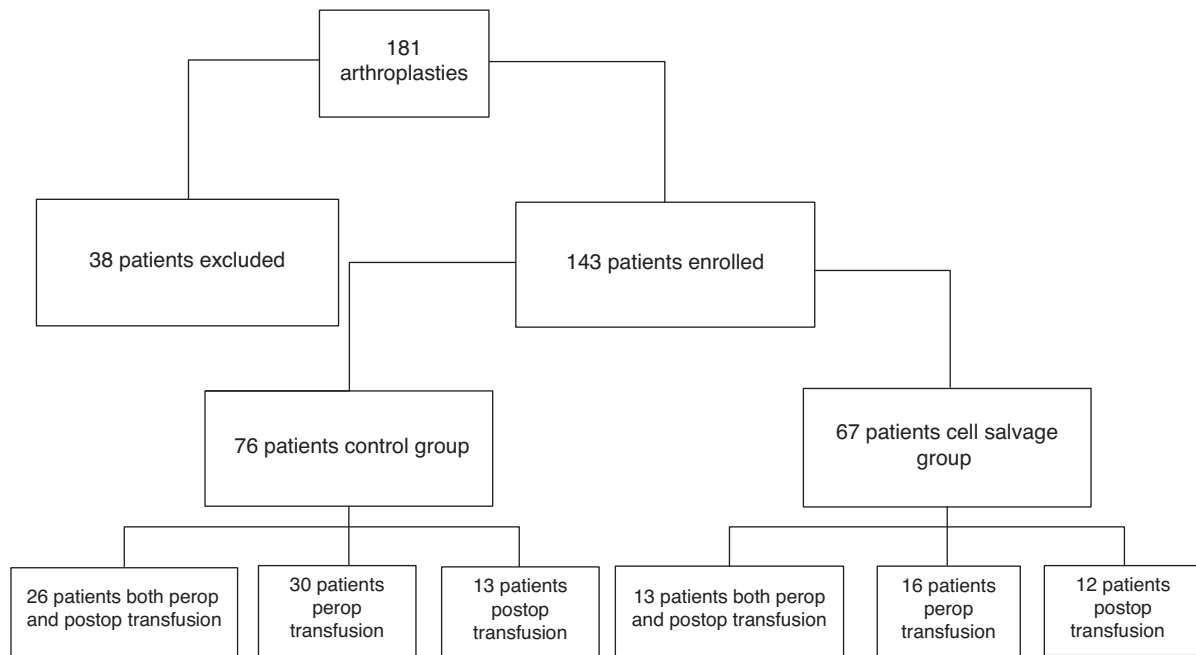
Figure 1   Flowchart of patients.

We reviewed retrospectively the medical records of the patients who had hip arthroplasty operation between 2010 and 2012. We excluded study patients with records of a known history of hematological diseases, bleeding conditions, or thromboembolic events. Low platelet count (plt = 100.000) and any escalation in international normalized ratio (INR > 1.2) were also defined as exclusion criteria. In our institution, we use CS system (Medtronic Autolog, Medtronic inc. Minneapolis, USA) when significant blood loss is estimated or preoperative anemia is present (Hgb < 10 g/dL). We divided our patients into 2 groups. One group consisted of patients for whom the CS system was used during the perioperative setting. CS system was not used before the surgery for any patient in any group. The control group consisted of patients in whom the CS system was not used their operation. The transfusion threshold is 8 g/dL for healthy adults in our institution and between 8 g/dL and 10 g/dL for patients with severe cardiac disease, and severe co-morbidities.

Demographic data, preoperative hemoglobin level, hematocrit and leukocyte values, amount of blood for autologous transfusion during and after the surgery were recorded. Hemoglobin level, hematocrit values, leukocyte values at discharge, highest body temperature during the postoperative period, and C-reactive protein (CRP) levels were noted for both groups. ABTs were also recorded for the 2 groups.

Statistical analysis

Statistical analysis was performed using a computer program NCSS (Number Cruncher Statistical System) 2007&PASS (Power Analysis and Sample Size) 2008 Statistical Software (NCSS LLC, Kaysville, Utah, US). Descriptive statistical methods were used (mean, median, ratio and standard deviation)

to evaluate the study data. Independent samples test was used to compare normally distributed variables between groups. Mann Whitney U test was used for ordinal variables and chi-square test was used for nominal data. For multivariate evaluations, enter logistic regression analysis was used. A p-value < 0.05 was considered as statistically significant.

Results

There were 67 patients in the CS group and 76 patients in the control group (Fig. 1). In the CS group, 41 patients (61.1%) received ABT, and 69 patients (90.7%) in the control group had ABT (preoperative, postoperative, or both).

In terms of sex, type of anesthesia, and age, we did not detect any significant difference between the groups (Table 1). Female patients accounted for 46 patients (68.7%) in the CS group and 56 (73.7%) in the control group. The percentages of neuroaxial and general anesthesia used in the CS group (52.3% and 47.7%, respectively) were close to those used in the control group (51.3% and 48.7%, respectively). The mean age was 55.82 ± 13.20 years in the CS group and 57.82 ± 13.43 years in the control group. Operation time significantly differed between the groups; that is, surgery time was longer in the CS group (152.72 ± 55.08 min) than in the control group (130.13 ± 40.71 min) ($p < 0.05$).

In the CS group, the mean amounts of perioperative allogeneic blood transfused were significantly lower (92.53 ± 111.88 mL) than that in the control group (170.14 ± 116.79 mL; $p < 0.001$). When comparing the mean postoperative transfusion rates, the CS group (125.37 ± 193.33 mL) had lower values than the control group (155.22 ± 208.37 mL), although the difference was not significant. The number of patients receiving allogeneic blood transfusion in the CS group ($n = 29$; 43.2%) was

Table 1 Patients' demographic data.

	Cell salvage group (n = 67)	Control group (n = 76)	p-value
Sex[a]			
Male	21 (31.3%)	20 (26.3%)	>0.05
Female	46 (68.7%)	56 (73.7%)	
Type of anesthesia[a]			
Neuroaxial	35(52.3%)	39 (51.3%)	>0.05
General	32 (47.7%)	37 (48.7%)	
Age (mean ± SD) years[b]	55.82 ± 13.20	57.82 ± 13.43	>0.05
Operation time (mean ± SD) min[b]	152.72 ± 55.08	130.13 ± 40.71	0.016[c]

NS, no significant.
[a] Chi square test.
[b] Independent samples test.
[c] p-value <0.05 statistically significant.

also significantly lower than control group (n = 56; 73.6%; $p < 0.05$) (Table 2).

During the operation of the patients in the CS group, the mean amount of blood transfused from the CS system was 333.61 ± 170.99 mL. The mean preoperative hemoglobin and hematocrit values did not differ significantly from the values at discharge in both groups (Table 3).

The mean CRP level, postoperative body temperature, and preoperative leukocyte levels did not show any significant difference. The postoperative leukocyte level was a little higher, though not significantly, in the CS group (Table 4).

We evaluated the effects of variables for the usage of autologous blood transfusion with enters logistic regression analysis. Variables evaluated were operation time, preoperative hemoglobin and hematocrit levels, perioperative transfusion and postoperative transfusion amounts. Perioperative transfusion and operation time (>140 min) variables were identified as significant ($p < 0.05$). Odds ratio for perioperative transfusion was −4.257 (95% CI −0.502 to −0.184) which means that, 4.257 times less likely ABT was needed during the operation in the CS group. OR for operation time was as 2.720 (95% CI 0.001–0.004); which means that we used CS system in operations longer than 140 min; 2.574 times more likely. Per-op blood transfusion and operation time effects were independent risk factors for Cell Salvage group (Table 5).

Discussion

In major orthopedic surgeries such as total hip arthroplasty surgeries, intraoperative blood loss and associated anemia are frequent. In particular, anemia leads to the need for ABT, declined physical functioning, augmented infection rates, longer hospital stay, and even mortality.[6] In many studies, patient blood management interventions based on postoperative transfusion of salvaged blood cells can provide a significant reduction in ABTs.[6]

In our study, the use of the CS system decreased the need for ABT in the perioperative period. The mean ABT rate was 92.53 mL in the control group and 170.14 mL in the control group. The mean postoperative transfusion rate in the CS group was also lower than that in the control group (125.37 mL vs. 155.22 mL), but the difference in these results did not reach a statistically significant level. In addition, the percentage of the patients who received ABT was also significantly lower in the CS group (n = 29; 43.2%) than in the control group (n = 56; 73.6%). Our results are similar to the results reported in the literature. The results of the study by Ersen et al.[7] are concurrent with ours and indicated a perioperative decrease in ABT rate when the CS system was used in posterior spinal fusion surgery. Their reported mean amount of blood transfused decreased from 2.5 U to 1.04 U when the CS system was used.[7] In a prospective observational cohort study on hip arthroplasty revisions in which

Table 2 Blood transfusion data.

	Cell salvage group	Control group	p-value
Perioperative transfusion; n(%)[a]	29 (43.2%)	56 (73.6%)	0.022[c]
Postoperative transfusion; n(%)[a]	25 (37.3%)	39 (51.3%)	>0.05
Perioperative transfusion (mL); mean ± SD[b]	92.53 ± 111.88	170.14 ± 116.79	0.001[c]
Postoperative transfusion (mL); mean ±SD[b]	125.37 ± 193.33	155.22 ± 208.37	>0.05
Perioperative cell salvage transfusion (mL); mean ± SD	333.61 ± 170.99		

NS, no significant.
[a] Chi square test.
[b] Mann–Whitney U test.
[c] p-value <0.05 statistically significant.

Table 3   Hematological data.

	Cell salvage group (mean ± SD)	Control group (mean ± SD)	p-value
Preoperative hemoglobin (g/dL)	12.84 ± 1.39	12.50 ± 1.52	>0.05
Discharge hemoglobin (g/dL)	11.09 ± 1.61	10.95 ± 1.54	>0.05
Preoperative hematocrit	38.56 ± 3.65	37.43 ± 5.59	>0.05
Discharge hematocrit	33.76 ± 4.92	33.05 ± 4.54	>0.05

Independent samples test.
$p > 0.05$, no significant.

Table 4   Infection markers.

	Cell salvage group (mean ± SD)	Control group (mean ± SD)	p-value
CRP[a]	10.14 ± 15.82	6.57 ± 9.24	>0.05
Body temperature (°C)[b]	37.59 ± 0.52	37.63 ± 0.47	>0.05
Preoperative leukocytes[b]	7620.82 ± 1930.59	7649.53 ± 2686.75	>0.05
Postoperative leukocytes[b]	13007.00 ± 4483.51	12158.00 ± 4567.90	>0.05

[a] Mann–Whitney U test.
[b] Independent samples test.
$p > 0.05$, no significant.

210 cases were included, perioperative CS use decreased the chance of needing an ABT.[1] The results of the study were parallel to our findings. In our logistic regression analysis, perioperative blood transfusion was identified as significant. In the control group, the possibility of having an ABT is almost 4 times (OR = 4.257) more likely than CS group.

The CS system has shown positive evidence for its efficacy in orthopedic surgery.[9] Many studies support the use of the CS system to reduce the necessity for ABTs in hip and knee surgeries.[10–12] In a prospective study by Thomas et al.,[12] which included a total of 231 knee replacement patients, a decrease in allogeneic blood requirement was observed in the CS group.[12] Despite the satisfactory results of knee and hip arthroplasties owing to the CS system, other major orthopedic surgeries show conflicting results. For spinal surgery or acetabular fracture repair, some studies did not report any benefit of the CS system in terms of reduction in the need for ABTs and cost.[13–16] Scannel et al. retrospectively evaluated patients who underwent open reduction internal fixation for acetabular fracture and found no beneficial results for CS.[13] In the retrospective study of Gause et al., the use of the CS system in adult lumbar spinal surgery increased the need for ABTs.[14] Owens et al. also did not report any beneficial results of the CS system in adult lumbar spinal surgery in their retrospective review. [15]

In contrast, Ersen et al.[7] and Bowen et al.[17] demonstrated a decrease in ABTs with the CS system for adolescent scoliosis cases treated with posterior spinal fusion. For adult lumbar fusion, Savvidou et al.[18] reported beneficial results for the CS system in their prospective randomized trial including 50 patients. In their retrospective study on acetabular fracture surgery, Bigsby et al.[3] showed beneficial results for the CS system in terms of cost-effectiveness and reducing the need for ABTs. In their recent study designed for pediatric orthopedic and cardiac surgeries, Samnaliev et al.[19] reported the use of the CS system as cost-effective and cost saving especially when used along with ABT.

Table 5   Logistic regression analysis of risk factors effecting autologous blood transfusion.

	p	ODDS	95% CI	
			Lower	Upper
Perioperative Transfusion	0.001[a]	−4.257	−0.502	−0.184
Postoperative Transfusion	0.094	−1.685	−0.306	0.24
Operation time (>140 min)	0.007[b]	2.720	0.001	0.004
Preop Hgb	0.616	0.502	−0.40	0.068
Preop Hct	0.382	0.877	−0.010	0.026

[a] $p < 0.01$ statistically significant.
[b] p-value <0.05.

In our study, operation time was significantly longer in the CS group. This is because in our institution, the CS system is generally preferred for more complicated cases (estimated blood loss >1000 mL, BMI >30, difficult surgical technique) and the more complicated a case becomes, the longer it takes to complete the surgery. Enter logistic regression analysis, showed us, operation time effect (>140 min) was an independent risk factor for CS group. This points outs, an almost 2.7 times more (OR = 2.720) likely usage of CS system in operations longer than 140 min. Although the operation times were longer in the CS group, less amount of ABT was necessary during the surgery, which seems as a possible benefit for the patient.

The distribution of the male and female populations was similar between the groups. However, the proportion of female patients was higher in both groups. This phenomenon is also specific to our institution; that is, female patients undergo hip arthroplasty surgeries 2 or 3 times more frequently than male patients. An epidemiological study for a Turkish population who had undergone hip arthroplasty surgery should be conducted to validate our results.

In terms of infection markers, we reviewed preoperative CRP levels, leukocyte levels, and body temperatures for both groups. We also reviewed for the highest postoperative leukocyte level, body temperature, and CRP levels. We found no statistical significance in terms of leukocyte level, body temperature, and CRP level between the groups. A prospective observational study of 308 patients found that ABT was associated with an increased incidence of postoperative infections when compared with autologous transfusion.[20]

During the operation of the patients in the CS group, the mean amount of blood transfused from the CS system was 333 mL. Our data are similar to the data obtained by Walsh et al.,[1] who conducted a prospective cohort study for hip arthroplasty revisions in 11 hospitals over a 7-month period and found a mean reinfusion amount of 312 mL.[21] In their retrospective study, Jain and Jain[21] reported a slightly higher amount of salvage blood than that reported in our present study, that is, 527 mL for total knee arthroplasty and 437 mL for total hip arthroplasty.

The main limitation of our study was its design as a retrospective study. Another limitation was the fact that, in our institution, our transfusion threshold is 8 g/dL for allogeneic blood transfusion for healthy adults and between 8 g/dL and 10 g/dL for patients with severe cardiac disease, and severe co-morbidities. But there is an ongoing debate about transfusion thresholds and conflicts are unsolved. As a result different thresholds in different institutions can cause varied results.

Blood transfusion should be avoided whenever possible because of the increased risk for transfusion-transmitted diseases and noninfectious complications. All patient blood management strategies should be considered during major orthopedic surgery to lessen the need for ABTs.

In a Cochrane Database Review, Carless et al.[5] reported that in cardiac and orthopedic surgeries, there is adequate proof of the benefits of the CS system and that it does not cause any adverse events.

Patient blood management is an important issue for orthopedic patients who are candidates for arthroplasty surgeries. In our study, the need for perioperative ABT was diminished significantly. Thus, the CS system may be considered as an effective strategy for reducing the need for ABTs; it provides support to patient blood management. We recommend the use of the CS system for hip arthroplasty surgeries if possible.

Conflicts of interest

The authors declare no conflicts of interest.

References

1. Walsh TS, Palmer J, Watson D, et al. Multicentre cohort study of red blood cell use for revision hip arthroplasty and factors associated with greater risk of allogeneic blood transfusion. Br J Anaesth. 2012;108:63–71.
2. Spiess BD. Risks of transfusion: outcome focus. Transfusion. 2004;44 12 Suppl.:4S–14S.
3. Bigsby E, Acharya MR, Ward AJ, et al. The use of blood cell salvage in acetabular fracture internal fixation surgery. J Orthop Trauma. 2013;27:230–3.
4. Engelbrecht S, Wood EM, Cole-Sinclair MF. Clinical transfusion practice update: haemovigilance, complications, patient blood management and national standards. Med J Aust. 2013;199:397–401.
5. Carless PA, Henry DA, Moxey AJ, et al. Cell salvage for minimising perioperative allogeneic blood transfusion. Cochrane Database Syst Rev. 2006:CD001888.
6. Spahn DR. Anemia and patient blood management in hip and knee surgery: a systematic review of the literature. Anesthesiology. 2010;113:482–95.
7. Ersen O, Kose O, Oguz E. Posterior spinal fusion in adolescent idiopathic scoliosis with or without intraoperative cell salvage system: a retrospective comparison. Musculoskelet Surg. 2012;96:107–10.
8. Waters JH, Yazer M, Chen YF, et al. Blood salvage and cancer surgery: a meta-analysis of available studies. Transfusion. 2012;52:2167–73.
9. Ashworth A, Klein AA. Cell salvage as part of a blood conservation strategy in anaesthesia. Br J Anaesth. 2010;105:401–16.
10. Bridgens JP, Evans CR, Dobson PMS, et al. Intraoperative red blood-cell salvage in revision hip surgery. J Bone Joint Surg. 2007;89:270–5.
11. Zarin J, Grosvenor D, Schurman D, et al. Efficacy of intraoperative blood collection and reinfusion in revision total hip arthroplasty. J Bone Joint Surg Am. 2003;85-A:2147–51.
12. Thomas D, Wareham K, Cohen D, et al. Autologous blood transfusion in total knee replacement surgery. Br J Anaesth. 2000;86:669–73.
13. Scannel BP, Loeffler BJ, Bosse MJ, et al. Efficacy of intraoperative red blood cell salvage and autotransfusion in the treatment of acetabular fractures. J Orthop Trauma. 2009;23:340–5.
14. Gause PR, Siska PA, Westrick ER, et al. Efficacy of intraoperative cell saver in decreasing postoperative blood transfusions in instrumented posterior lumbar fusion patients. Spine. 2008;33:571–5.
15. Owens RK, Crawford CH, Djurasovic M, et al. Predictive factors for the use of autologous cell saver transfusion in lumbar spinal surgery. Spine (Phila Pa 1976). 2013;38:217–22.
16. Weiss JM, Skaggs D, Tanner J, et al. Cell saver: is it beneficial in scoliosis surgery? J Child Orthop. 2007;1:221–7.
17. Bowen RE, Gardner S, Scaduto AA, et al. Efficacy of intraoperative cell salvage systems in pediatric idiopathic scoliosis patients undergoing posterior spinal fusion with segmental spinal instrumentation. Spine (Phila Pa 1976). 2010;35:246–51.

18. Savvidou C, Chatziioannou SN, Pilichou A, et al. Efficacy and cost-effectiveness of cell saving blood autotransfusion in adult lumbar fusion. Transfus Med. 2009;19: 202–6.

19. Samnaliev M, Tran CM, Sloan SR, et al. Economic evaluation of cell salvage in pediatric surgery. Paediatr Anaesth. 2013;23: 1027–34.

20. Innerhofer P, Klingler A, Klimmer C, et al. Risk of postoperative infection after transfusion of white blood cell-filtered allogenic or autologous blood components in orthopedic patients undergoing primary arthoplasty. Transfusion. 2005;45:103–10.

21. Jain R, Jain S. Blood salvage in total hip and knee arthroplasty in a community hospital: a retrospective study. J Orthop Surg (Hong Kong). 2005;13:19–26.