Is Intraoperative Blood Cell Salvage Effective in Hip Surgery?*

A recuperação intraoperatória de células sanguíneas é eficaz em cirurgias de quadril?

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Abstract

Objective The present study aims to evaluate the efficacy of blood cell salvage (CS) as a method of reducing allogeneic blood transfusion in patients submitted to transtrochanteric femoral and hip surgeries due to injury.

Methods Prospective cohort of 38 patients from a school hospital submitted to hip or trochanteric surgeries and divided into two groups from August 2015 to February 2017. Patients with any malignancy or infectious condition were excluded from the study. Cell savage group (19 patients) received autologous blood using cell saver, whereas control group (19 patients) received just allogeneic blood, if needed. Red blood cell parameters, blood transfusion requirements, and clinical and surgical characteristics, such as age, gender, ASA scale and type of surgery, were compared both preoperatively and postoperatively. Data was processed in SPSS 20.0.

Results There were no differences in the clinical parameters studied (age, gender and ASA scale). Red blood cell parameters on the first day postoperative were higher in the cell savage group ($p < 0.05$). No significant reduction of intraoperative and postoperative allogeneic blood transfusion requirements was found.

Conclusion This study found that CS was not effective in reducing intraoperative and postoperative allogeneic blood transfusion requirements in patients submitted to transtrochanteric femoral and hip surgery.

Keywords

- hip/surgery
- femoral fractures
- blood transfusion, autologous
- blood transfusion

Resumo

Objetivo O estudo visa avaliar a eficácia da RIOS na redução hemotransfusão alogênica em pacientes submetidos à cirurgia por fratura de fêmur e quadril.

Métodos Coorte prospectiva com 38 pacientes submetidos à cirurgia traumatológica para fraturas em quadril e transtrocantérica de fêmur, divididos em dois grupos em um hospital de ensino de agosto de 2015 a fevereiro de 2017. Utilizou-se a RIOS em 19

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pacientes e não em 19. Grupos comparados em relação ao sexo, idade na cirurgia, escala ASA (I, II ou III), uso intraoperatório da RIOS, volume sanguíneo reinfundido pela RIOS, parâmetros hematimétricos pré e pós-operatórios, volume intra e pós-operatório de sangue alogênico transfundido. Dados processados no SPSS 20.0.

Resultados Sem diferenças significativas entre os grupos com as variáveis: idade, sexo e ASA. Percebeu-se que os valores finais de hemoglobina e hematócrito (no 1° dia de pós-operatório) foram mais elevados no grupo que utilizou o dispositivo ($p < 0,05$). Não houve redução significativa da transfusão alogênica intra e pós-operatória no grupo RIOS em comparação ao controle.

Conclusões Esse estudo constatou que a RIOS não foi eficaz em reduzir a transfusão alogênica no intra e pós-operatório de pacientes submetidos à cirurgia de fêmur transtrocantérica e quadril.

Palavras-chave
- quadril/cirurgia
- fraturas do fêmur
- transfusão de sangue autóloga
- transfusão sanguínea

Introduction

One of the main causes of morbidity in surgeries such as total hip replacement (THR) and transtrochanteric femoral fracture repair is high blood loss.[1–3] According to some studies, this blood loss may exceed 500 mL at the intraoperatively and 750 mL postoperatively.[4]

Homologous blood is cold, acidic, potassium-rich, and presents low rates of 2,3-diphosphoglyceric acid (2,3-DPG), failing to carry oxygen adequately for up to 24 hours.[5] Thus, it is associated with the risk of immunological and non-immunological adverse effects, such as higher postoperative infection rate, contamination issues, disease transmission (cytomegalovirus [CMV], human immunodeficiency virus [HIV], hepatitis), hypersensitivity reactions, intravascular hemolysis, transfusion-induced coagulopathy, renal failure, development of autoantibodies impairing subsequent compatibility, increased length of hospital stay and higher mortality.[1,5–7]

In order to reduce the need for this type of transfusion in surgeries with high expected blood loss, several blood management techniques are used, including preoperative autologous blood donation, normovolemic hemodilution, hypotensive anesthesia, aminocaproic acid, tranexamic acid, preoperative erythropoietin administration and use of blood cell rescue systems with intraoperative reinfusion.[8,9]

Blood cell salvage (CS) is an intraoperative cell rescue system that collects blood from the operative field by aspiration, washes it and filters residues, such as cellular and biochemical debris. After the filtration process, the patient's red cells are reinfused.[10]

Despite the advantages of this method, it is unclear whether its use reduces the need for allogeneic blood transfusion in hip and proximal femur surgeries.

The present study aims to evaluate the effectiveness of Cell Saver as a method of reducing allogeneic blood transfusion in patients submitted to elective post-traumatic proximal femoral and hip surgeries.

Materials and Methods

This is a prospective cohort study with a sample composed of 38 patients submitted to surgery for transtrochanteric femoral or hip fracture at the traumatology and orthopedics department of our institution between August 2015 and February 2017.

Only one intraoperative blood recovery system, the Medtronic Autolog (Medtronic Inc. Minneapolis, USA), was used in the study. The device was used in 19 patients, but not in the other 19 individuals (control group). The sample number was determined by similar previous studies found at the literature.[1,7,11,12]

Patients who presented pre-operative history of hemostasis disorders, low platelet count (<100,000), changes in prothrombin time (PTT)/international normalized ratio (INR) or partially activated thromboplastin time (APTT), thromboembolic events prior to surgery or family history of thromboembolism, American Society of Anesthesiologists (ASA) score > 3, whose religious beliefs (Jehovah's Witnesses) do not allow allogeneic blood transfusion, or those afflicted by neoplasms and/or systemic infectious disease were excluded from the sample.

No patient received previously donated autologous blood, or pre/postoperatively erythropoietin (EPO) administration; similarly, no patient was submitted to intraoperative isovolumetric hemodilution. At anesthesia induction, regarding antifibrinolytic drugs, aminocaproic acid (in a 4 g dose) was used in three patients from the cell saver group and in one patient from the control group and tranexamic acid (in a 1 g dose) was given to another four patients from each group.

The patients were placed on the operating table in lateral recumbency for Kocher Langenbeck access for hip surgeries or in dorsal recumbency for proximal femoral surgeries. For total hip replacements, the proximal femur conformation (A, B, C) and the cortical index described by Dorr et al. apud Semkiw et al.[11] were used for cementation or not of the femoral component. Anesthesia with neuroaxis blockade (spinal or epidural anesthesia) in volume established by the anesthesiologist was performed according to surgical requirements, associated or not with general anesthesia.

The parameters for blood transfusion included signs and symptoms of anemia, including urinary volume reduction to less than 30 mL/h as measured by bladder catheterization, tachycardia (>100 beats/minute), hypotension (systolic

blood pressure < 100 mm Hg) refractory to volume expansion and a hemoglobin level of less than 8 g/dL by blood gases analysis associated with signs or symptoms of anemia, or a hemoglobin level below 7 g/dL regardless of signs or symptoms of anemia. The decision of allogeneic blood transfusion during the surgery was a consensual decision taken by the surgeon and the anesthesiologist.

In the postoperative period, the patients remained in a postanesthetic recovery unit for approximately two hours. During this time, the same parameters for blood transfusion were adopted, and the decision to transfuse was taken jointly by the surgeon and the anesthesiologist. After this period, the patient was discharged to the infirmary, and the decision to transfuse was taken by the surgeon. It is worth noting that all operative wounds were closed without the use of suction drains.

The groups were compared according to the following medical records data: gender; age at surgery; ASA scale (I, II or III); intraoperative SC use; blood volume reinfused by SC; pre and postoperative hemoglobin (Hb) and packed cell volume (PCV) levels; intra and postoperative red blood cells volume of transfused allogeneic blood.

Data were processed in SPSS 20.0 software, license # 10101131007, calculating mean and standard deviation values. Averages from SC and non-SC groups were compared by Student's T test according to general characteristics, red blood cells parameters (Hb and PCV) and blood transfusion requirement (intra and postoperative). The confidence level was set at 0.05.

According to the Resolution 466/2012 from the National Health Council, the present study was approved by the Research Ethics Committee of the referred institution under number 1,702,480 and all participants signed the informed consent form.

Results

A descriptive analysis summarized patient characteristics and surgical procedures. Nineteen (50%) patients were operated using the intraoperative cell rescue system and 19 (50%) were operated without this device, constituting the control group (►**Table 1**).

The mean age of the patients was 58.21 ± 20.03 years in the non-SC group and 46.89 ± 18.92 years in the SC group ($p > 0.05$). There were no significant differences between the groups regarding gender and ASA score. The mean blood volume recovered intraoperatively and reinfused to the patient was 335.47 ± 255.86 mL in the group in which the device was used (►**Table 1**).

When evaluating red blood cells parameters from both groups, the final hemoglobin and packed cell volume values (on the 1st postoperative day) were higher in the SC group ($p < 0.05$) (►**Table 2**).

There was no intraoperative difference in the volume of allogeneic red blood cells transfused in both groups ($p > 0.05$). In the postoperative period, there was a smaller amount of transfusion in the SC group, but this difference was not significant ($p > 0.05$). Considering the sum of the periods (intra and postoperative), there was no evidence of a reduction in the

Table 1 Comparison of clinical and surgical characteristics from both groups

	Non-SC (n = 19/50%)	SC (n = 19/50%)	p
Age (years)	58.21 ± 20.03	46.89 ± 18.92	> 0.05
Gender			> 0.05
Female	6 (60.00%)	4 (40.00%)	
Male	13 (46.42%)	15 (53.58%)	
ASA			> 0.05
I	8 (50%)	8(50%)	
II	6 (46.15%)	7(53.85%)	
III	5 (55.55%)	4(44.45%)	
Intraoperatively recovered volume (mL)	–	335.47 ± 255.86	
Surgeries			
Femoral Osteosynthesis	7 (36.84%)	1(5.26%)	
Acetabular Osteosynthesis	4 (21.05%)	5 (26.32%)	
Total Hip Replacement	6 (31.58%)	10 (52.63%)	
Total Hip Replacement (bipolar)	2 (10.53%)	–	
Revision of Hip Replacement	–	3 (15.79%)	

Table 2 Comparison of pre and postoperative hemoglobin and packed cell volume levels in both groups

	Non-SC (n = 19/50%)	SC (n = 19/50%)	p^*
Hemoglobin (g/dL)			
Preoperative	11.17 ± 1.33	12.21 ± 1.98	p > 0.05
1st Postoperative	8.20 ± 1.40	9.78 ± 1.74	$p = 0.004$
Packed Cell Volume (%)			
Preoperative	33.95 ± 4.60	37.07 ± 5.84	p > 0.05
1st Postoperative	25.36 ± 4.08	29.90 ± 5.05	$p = 0.004$

p^* per Student's T test.

Table 3 Comparison of allogeneic packed red blood cells transfusion in both groups

	Non-SC (n = 19/50%)	SC (n = 19/50%)	p^*
Transfusion (mL)			
Intraoperative	17.31 ± 75.47	23.94 ± 73.38	$p = 0.78$
Postoperative	153.94 ± 275.13	67.00 ± 163.16	$p = 0.24$
Total	171.26 ± 275.26	90.94 ± 169.17	$p = 0.28$

p^* per Student's T test.

total volume of transfused allogeneic blood cell products in SC patients compared to the control group ($p > 0.05$) (►**Table 3**).

Discussion

Although blood bags screening has improved safety considerably in recent years, there are still known risks such as potential transfusion and alloimmunization reactions, as well as associated risk of contracting infectious diseases, including HIV (1:1,930,000), hepatitis B (1:137,000), hepatitis C (1:1,000,000) and bacterial sepsis.[9]

Autologous blood collection techniques have been the subject of discussion since their introduction, more than 30 years ago.[13] There are still doubts, however, about the efficiency and costs related to these techniques in some surgeries and the discrimination of their use.[13,14]

Indications for SC use include anticipation of blood loss $>$ 1000 mL, average of one or more allogeneic blood transfusion units in the postoperative period, religious refusals, low preoperative hemoglobin level, risk factors for bleeding or if more than 10% of patients require transfusion in that type of surgery.[13]

Absolute contraindications for SC use include hemolysis situations (blood mixed with water, alcohol or hydrogen peroxide), erythrocyte abnormalities (for instance, sickle cell anemia) or procedures with fecal or urinary contamination. Other reported contraindications are malignancy, presence of very small particles for filter and systemic infections with dissemination risk.[4,13]

In general, the results of the present study did not reveal a significant reduction in the total volume transfused in the SC group. The mean recovered volume was 335 mL, consistent with authors such as Leigheb et al.,[4] Hawi et al.[15] and Buget et al.,[16] who also showed similar perioperative transfused blood volumes in both groups (average volume at SC Group, 170.14 mL, average volume at control group, 92.53 mL), but this difference between groups was significant, perhaps due to the larger sample (143 patients).

SC is a complex procedure, requiring a qualified team, both for device operation and blood aspiration ability; in addition, it has the disadvantage of not being always available.[4] According to Herd et al.,[13] SC use reduced perioperative transfusion rates over the years in the same hospital service, an effect attributed to the increased competence and experience with the device, resulting in the recovery of a greater blood volume.

There are several types of femoral and hip surgery leading to different volumes of blood loss.[13] The risk of perioperative blood loss increases with the degree of procedural difficulty, especially in cases of revision.[15] In our study, despite the random selection of the groups, the SC group presented a greater number of hip replacement revision surgeries (known for their greater possibility of bleeding).

In the present study, there were no reports of complications, such as air embolism, dilutional coagulopathy, bacteremia, hypervolemia, anticoagulant overdose and hemoglobinuria.

Some data were not recorded, as which acetabular component was used, whether it was single-stage arthroplasty or not, cementation use or not, etc.; this reduced the effectiveness in proving the homogeneity of the surgical procedures. As such, it is possible to inquire whether the SC group was submitted to more complex surgeries, with significantly higher intraoperative bleeding, thus presenting a confounding factor for the results, as in the study conducted Garvin et al.[17] Another variable from our study that may have affected the results was the use of antifibrinolytic agents in both groups.

Conclusion

The present study found that intraoperative recovery of blood was not effective in reducing allogeneic blood transfusion intraoperatively, postoperatively, or in the total period of patients submitted to proximal femoral and hip surgeries for trauma. However, although the number of transfusions did not decrease, the mean values of Hb and PCV in the 1st postoperative period were better in the SC group. Perhaps a study with more patients could reach significant values, according to the literature.

This study did not evaluate operational costs nor length of hospital stay. The authors believe that more prospective, randomized studies are needed to assess not only the effectiveness of the cell saver, but also its cost-effectiveness.

Conflicts of interest

The authors declare that there is no conflict of interest.

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