



Is Autologous Blood Transfusion cost effective in Adolescent Idiopathic Scoliosis?

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The purpose of this study has been to evaluate the use of preoperative autologous blood donation (PABD) in the surgical treatment of adolescent idiopathic scoliosis (AIS).

The surgical records of 37 AIS patients, Lenke type 1, were reviewed. Patients were classified according to whether they had entered the PABD (Program of Autologous Blood Donation) (25 patients) or had been rejected to join (12 patients non-donors). Both groups were comparable.

All but one of the PABD patients (96%) as compared to only 2 non-donors patients (16.7%) required postoperative transfusion. Moreover, 12 of the PABD patients (48%) did not require the whole stored blood. At discharge both groups had similar haemoglobin levels.

The risk of transfusion was much higher in the PABD group. The patients in this group received blood even with high haemoglobin levels (>8 g/dl). Furthermore, 31.4% of the collected blood was never used. Therefore, PABD resulted in an increase in procedure costs and lead to unnecessary blood transfusions.

Keywords : adolescent idiopathic scoliosis; blood transfusion; autologous blood donation.

INTRODUCTION

The use of preoperative autologous blood donation (PABD) in the surgical treatment of adolescent

idiopathic scoliosis (AIS) remains highly controversial. The advantages of PABD include risk reduction in virus transmission and antibody formation as compared to allogeneic blood transfusion (ALBT). Moreover, there is some evidence that ALBT may be associated with higher chances of postoperative infection (22). Despite this, ALBT complications are extremely rare, not representing a major concern in blood transfusion safety (12). Meta-analyses on

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PABD have shown to: (i) reduce the use of allogeneic blood transfusion by 63%; (ii) increase overall red blood cell (RBC) transfusions (i.e., allogeneic and autologous RBC units) by 30%; and (iii) cause a decline in patients' haemoglobin (Hb) concentration by more than 1 g/dL from the time before starting PABD to immediately prior to surgery (1,9,14,19). However, all the meta-analyses studies do stress the weak design of most of the clinical studies (1,9,19).

Controversy has recently grown over the use of PABD in elective surgery (3,7,9,20). Criticisms to PABD includes: blood over-collection leading to a preoperative reduced haematocrit level, waste of autologous units, high cost of preparation and storage, and a lower threshold for transfusing autologous blood causing unnecessary transfusions. Recent studies have reported that the most important predictor for blood transfusions following elective orthopaedic surgery is PABD (3,15,21).

In a recent large population-based analysis of trends in spinal fusion for paediatric patients with adolescent idiopathic scoliosis (AIS) in the USA, a total number of 43,983 cases were analysed (25). Blood transfusion of any type was only required in 30.4% of patients. During the 10-year period studied, PABD decreased from 9.7% in 2000 to 2.6% in 2009, whereas perioperative autologous blood transfusion using cell-saver increased over time (from 6.0 to 17.3%). The ALBT rate remained relatively stable (from 13.6 to 23.0%). Therefore, in recent times, there has been a trend towards declining PABD, while the use of ALBT has remained stable. The objective of this study has been to analyse the blood requirements and the waste of autologous blood in a group of patients undergoing surgery for AIS. This was tested for a group that participated in PABD, against a group that had rejected blood donation.

MATERIAL AND METHODS

This was a retrospective, case-control study in which institutional review board approval was obtained. The medical records of 37 non-consecutive girls treated for Lenke type 1 AIS between January 2010 and December 2012 were reviewed. The sample was made out of 25 patients who had been

included in a program for PABD, and 12 patients who had rejected to join the same program, and hence constitute the non-donors group.

Patients were reviewed by age, diagnosis, major curve size and location, and number of fused levels. The pre- and perioperative haematocrits obtained during their stay at the hospital, along with the haematocrit whenever the patient was transfused at any other stage were also analysed. The amount of transfused autologous or allogeneic blood units were evaluated. Finally, the number of autologous blood units wasted were recorded.

All patients received primary surgical correction via a posterior approach using all pedicle screw constructs. The vertebral coplanar alignment technique was applied in all cases (23).

Data has been analysed with SPSS statistical software (version 20). The distribution of the quantitative variables is shown as the mean, standard deviation, and range. Data has been sub-divided into groups and analysed using the ANOVA test. The 2-tailed independent t-test has been used to compare pre-operative data with post-operative data, whilst Pearson correlation has been used to compare parametric data and the Spearman Rank correlation test has been used to compare nonparametric data. To assess the changes between the pre-operative to immediate post-operative data and the immediate to final post-operative data, the Fisher's exact was used. P values of less than 0.05 were considered statistically significant.

RESULTS

The anthropometric and radiological data of the patients included in the series are shown in Table I. No differences between the two groups of girls regarding age, major curve size and fused levels existed, although the PABD group was slightly younger. The post-operative radiographic evaluation of the curve correction is presented in Table II. The duration of the surgery, number of fused levels and hospital stay are also included in Table II.

Before donation, the mean haemoglobin level among PABD patients was 14.2 ± 1.1 mg/ml (range: 13-15.8). Six PABD patients donated 2 units (24%), 18 donated 3 units (72%), and one donated 4 units

Table I. — Patients profile

	PADB (n=25)	Non-donors (n=12)	P value
Age (years)	12.9± 1.3 (11-15)	14.6 ± 1.6 (11-16)	0.011*
Weight (Kg)	46.0± 8.8 (35-77)	50.8 ±14.6 (33-83)	0.383
BMI	19.2± 2.5 (16.6-28.1)	20.7 ±7.1 (14.7-38.9)	0.530
Risser <2/>2	14/5	4/6	0.006**
Major curve (Cobb)	58.6 ± 10,7 (43-79)	56.9 ± 6.4 (49-69)	0.885
T5-T12 kyphosis (Cobb)	19.2± 19.2 (-5-42)	32.7 ± 15.5 (14-55)	0.033*
Rotation (Pedriolle)	14.8 ± 6.3 (7-35)	18.0 ± 5.4 (10-25)	0.105

Values in Means ± SD (Standard deviation) (minimum-maximum). * (p<0.05; Mann-Whitney test); ** (p< 0.01; Chi-square test)

Table II. — Clinical and Radiological Results

	PADB (n=25)	Non-donors (n=12)
MT curve Preop	58.6 ± 10.7	56.9 ± 6.4
MT curve postop	8.4 ± 4.5	11.6 ± 5.6
Correction %	85.6%	79.6%
Surgical time	231.1 ± 35.1	226.9 ± 44.7
Fused Levels	12.6 ± 0.8	12.5 ± 1.0
Hospital stay	7.3 ± 1.1	7.8 ± 1.3

MT Preop: Mean Thoracic Curve Pre-operative measured in degrees (Cobb± SD)

MT Postop: Mean Thoracic Curve post-operative in degrees (Cobb± SD)

Correction%: Percentage of correction achieved

Surgical time: measured in minutes ± SD

Hospital stay: expressed in days ± SD

(4%); comprising a total of 70 autologous units donated at an average of 2.3 ± 0.8 units per patient (Figure 1). Average preoperative haemoglobin, as expected, was lower in PABD than in non-donors (12.2 vs. 13.5 g/dl; $P<0.05$).

In order to identify when the transfusion took place, 3 different moments were studied; Intra-operatively; where only 1 PABD patient (4%) did not require transfusion, in contrast with 11 of the non-donors (91.6%) that did not. Altogether, during surgery 1.5 blood units were given in the PABD group.

In the ICU (Intensive Care Unit), again only 1 of the non-donor patients received allogeneic blood, while 9 patients in the PABD blood had 1 or more units. The average blood unit transfused between PABD patients were 0.5 units. Finally, no patients required transfusion in the wards.

If we look at the total number of blood units transfused during the patients' stay, only 1 (4%) of the PABD patients received no blood, whilst 10 (83,3%) out of 12 of the non-donors left the hospital with no transfusions (Figure 2). On the other hand, in 12 (48%) of the PABD patients one or more stored blood unit (total: 22 RBC units) was not used.

The evolution of the haemoglobin levels during the whole surgical process is shown in Figure 3. Statistically significant differences between the two groups were only found in the mean pre-operative Haemoglobin levels (PABD, Hb 12.2 ; Non-donors 13.5 ; $p<0.01$). The mean intra-operative haemoglobin level was lower in the PABD group than in the non-donor group, but this was not statistically significant. The same applies to the Hb at ICU (9.5 versus 9.6), ward and at the moment of discharge.

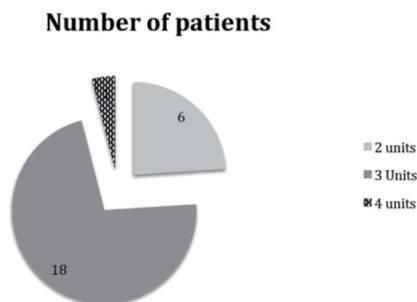


Fig. 1. — Number of donated units by the patients in the PABD (Program of Autologous Blood Donation).

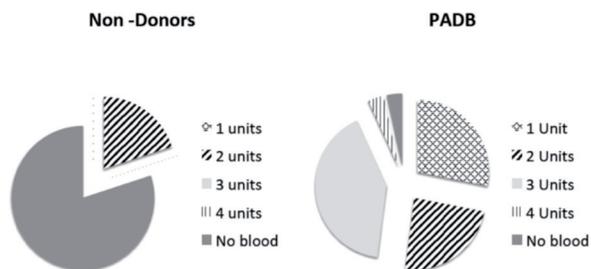


Fig. 2. — Total of Blood Units Transfused: The graphic, on the left, shows the number of blood units that each patient on the donor group, received during his hospital stay. The graphic on the right reflects the same data referring to the non donors (NPABD) patients.

DISCUSSION

A large number of reports have documented a reduction in the need of ALBT amongst patients participating in PABD for elective surgery (1,8-11,16,17,19). Most of these reports have been founded on the premise that the patients were transfused autologous blood instead of allogeneic blood. However, more recently, new literature critically evaluating the use of PABD for elective surgery has raised a number of concerns with PABD, including: high cost, increased transfusion rates, and wasted resources (3,7,9,18,20). PABD in surgery for scoliosis has also been previously studied (1,8,16,17,19) and despite the studies have documented a reduction in

allogeneic blood when using PABD, most of them include mixed scoliosis aetiologies and different correction techniques, resulting in a confusing comparison between PABD and NPABD groups.

One recent study of a large series of AIS in young patients undergoing posterior instrumented spinal fusion in a single institution, compared the use of the PABD program against non-donors, and showed that the overall transfusion rate (both autologous and allogeneic) was of 77.5% (21). The PABD strategy reduced the needs for ALBT to less than 13% (18 out 148), as compared to 65% (98 out of 151) in the non-PABD group. However, the overall (autologous and allogeneic) transfusion rate was significantly higher for patients included in the PABD group (89.9% vs. 64.9%). Factors used as predictors of transfusion were: to be in a PABD program, and the number of autologous RBC donated, therefore implying that being in the program increased significantly the chances to be transfused (15).

In the last decade 30% of all AIS paediatric patients surgically treated have received at least one blood transfusion, in the United States. On the other hand, there is also a trend towards a progressive decrease in the use of PABD, whilst promoting the use of cell-saver techniques together with ALBT. However, there is also controversy regarding the efficacy of the cell-saver approach in AIS surgery and its ability to save ALBT. There is also controversy regarding the necessary amount of blood that needs to be collected for the system to be efficient (4,6,24). Nevertheless, different proposals to reduce both autologous and allogeneic peri-operative transfusion are now being introduced worldwide, including intra-operative antifibrinolytic drugs, local haemostatic gels, and so on (12).

Our findings from this study are more focused on supporting the association between PABD and unnecessary blood transfusions and the increased costs that take place as a result. We found increased transfusion rates, and heterogeneous transfusion criteria amongst the AIS patients that participated in the PABD program. This discrepant criteria for blood transfusion has been reported previously by other authors. In a retrospective study of paediatric patients that underwent posterior spinal fusion for scoliosis, Meert et al. reported that the only variable

that independently predicted the administration of autologous red blood cells after surgery for AIS was the amount of autologous blood donated (15).

Moreover, according to the rules of our National Society of Haematology and Haemotherapy, indicators of transfusion include haematocrit below 30% and haemoglobin below 7 g/dl (13), tempered by the “context of the patient’s general clinical condition”. In our series the mean haemoglobin before intraoperative transfusion in PABD patients was 8.2 ± 0.7 (range 7.1-9.9). The only patient that was intraoperatively transfused in the non-donor group had a haemoglobin pre-transfusion of 9.0. This data indicates that the guidelines were not followed in the majority of cases. Bess (2) also noted that only 28% of their patients were transfused with a haematocrit lower than 30%. Similarly, Solves (21) admitted that medical staff typically have a more liberal attitude for transfusion in patients on PABD. However, we cannot ignore the fact that the patients in our PABD sample had, as expected, a lower preoperative Hb, and this may have prompted a lower threshold for transfusion.

Yet, not only the unnecessary autologous blood transfusion made PABD look less attractive, also the high amount of blood wasted (2,17) did. In the current series of PABD patients, 22 units out of 70 were wasted (31,4%). Over-collection may be a factor to account for this wastage; because, even though the mean number of units collected was relatively low,

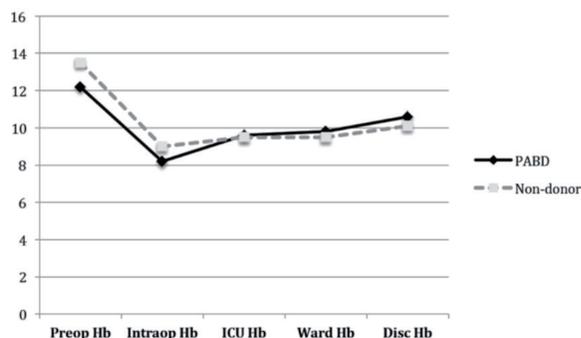


Fig. 3. — Haemoglobin (Hb) evolution during hospital Stay for both groups. The Hb expressed in g/dl is show for the different groups at preoperative stage, during surgery (Intraoperative), at ICU (Intensive Care Unit), at ward and at the moment of Hospital discharge.

the mean blood units collected per patient were 2.8, while the average units transfused, between PABD patients, were only 1,92 units.

Some authors suggest (5) that PABD may not only be unnecessary but also be associated with to pre-operative phlebotomy risk. Finally, we should not forget, that the inclusion of patients in a PABD program does not exclude the risk of allogeneic transfusion, which for AIS patients has been reported to be of 0 to 7.4% (1,17,19).

Limitations of the current study include the retrospective design and the lack of randomisation for the inclusion of patients in the study. Although the demographics and operative data for patients in the PABD and NPABD groups were similar, we cannot exclude the possibility that differences between the two groups can account for the differences in transfusion practices.

CONCLUSION

The risk for transfusion was much higher in PABD patients, resulting probably in avoidable transfusions, along with the unnecessary wastage of the stored blood. This data supports the fact that autologous blood donation is unnecessary at least in Lenke Type 1 AIS patients.

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