

Partial Bowls Using the Haemonetics Cell Saver 5: Does It Produce a Quality Product?

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Abstract: Controversy still exists on the validity of processing a partial bowl during the collection of shed blood lost through surgery during cell salvaging. The purpose of this study was to assess the quality of red blood cells produced from a partial bowl of autologous suctioned blood using the Haemonetics Cell Saver 5. Suctioned blood was collected from 17 patients undergoing cardiac surgery. A partially filled cell saver bowl was washed with 1500 mL of NaCl. Reservoir and processed blood samples were examined for potassium, leukocytes, hematocrit, platelets, and plasma-free hemoglobin and then compared with 22 previously studied full bowls. Results are summarized in the table below:

In conclusion, the Haemonetics Cell Saver 5 can produce a quality product from washing a partial bowl with a better washout of

white blood cells compared with a full bowl. However, there is a reduction in red blood cell recovery. **Keywords:** autotransfusion, cell saver, partial bowl, quality, wash. *JECT. 2005;37:161-164*

	Full Bowl	Partial Bowl	<i>p</i> Value
Platelet removal (%)	86 ± 23	85 ± 6	NS
Potassium removal (%)	91 ± 4	88 ± 4	NS
Leukocyte removal (%)	35 ± 17	50 ± 13	0.006
Plasma-free hemoglobin removal (%)	85 ± 6	85 ± 6	NS
Red blood cell recovery (%)	94 ± 16	84 ± 17	0.02

Controversy still exists on the validity of processing a partial bowl during the collection of shed blood lost through surgery during cell salvaging. Although most companies using bowl technologies do condemn the practice, quoting a poor-quality wash (1,2), the Haemonetics Corporation actually advocates the practice, provided the wash volume is doubled. They state that because the hematocrit of the bowl contents is lower, there is more supernatant in the bowl; therefore, to dilute this supernatant, twice the normal wash solution is needed to provide an adequate wash (3). We wanted to substantiate the claims of the manufacturer as to the quality of washed red blood cells (RBCs) delivered from a partially filled bowl; therefore, the purpose of this study was to assess the quality of washed RBCs produced from partially filling an autotransfusion bowl of autologous suctioned blood using the Haemonetics Cell Saver 5 (Haemonetics Corporation, Braintree, MA).

METHODOLOGY

The Cell Saver 5 autotransfusion device was evaluated using the manufacturer's recommended protocols in the

automatic mode. Operators were limited to those who had been properly trained to use the Haemonetics Cell Saver 5. The same 125-mL Latham bowl was used as in a previous study (4) with a conventional centrifugation speed of 5650 rpm. The autotransfusion machine was set up according to manufacturer's specifications using the recommended fill, wash, and empty rates (300 mL/min, 300 mL/min, and 500 mL/min, respectively) in the automatic mode with a maximum controlled suction of -150 mmHg.

Suctioned blood was collected from patients undergoing cardiac surgery for whom cell salvage was normally required. The cell saver was set-up using a 150-micron reservoir. Two luer connectors with stopcocks were placed 1) after the reservoir and 2) before the blood bag for sampling. Before processing, the reservoir was agitated to ensure adequate mixing. The fill cycle was started, and blood was withdrawn through the stopcock in the reservoir line and placed in appropriate containers without using needles to avoid hemolysis. For the purpose of this study, a partially filled bowl was obtained when the wash process was started before the erythrocyte layer reached the upper curved shoulder of the bowl and before the optical RBC sensor engaged. Thus, the fill cycle was interrupted early as the column of RBCs approached the shoulder of the bowl, at which point the wash cycle was started. The total wash volume used was 1500 mL of normal saline. Once the wash cycle was completed, the blood was withdrawn from the holding bag through the stopcock. Reservoir and pro-

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cess volumes were recorded and samples sent to the lab for analysis. At no time were the erythrocytes from a partially filled bowl reinfused back to the patient.

Analysis of Blood Samples

Complete Blood Count: Blood samples (3 mL) were placed in purple-top ethylene diamine tetraacetic acid vacuum containers and labeled. The blood was then analyzed for platelets, white blood cells (WBC), total RBCs, and hematocrit using a Coulter counter.

Potassium: Blood (3 mL) was collected in a dry heparinized blood gas syringe and analyzed for potassium levels using the Nova pHox (Nova Biomedical, Waltham, MA) blood gas analyzer.

Plasma Hemoglobin: Blood (5 mL) were collected and placed in a green top heparinized tube and centrifuged twice for 20 minutes. Plasma was then taken off and analyzed for plasma-free hemoglobin (PFH) using a spectrometric assay.

RBC Recovery: The RBC recovery in terms of a percentage value was calculated. The starting and ending hematocrits and liquid volumes in the collection reservoir and holding bag were recorded and the recovery calculated using the following equation:

$$\text{RBC recovery (\%)} = \frac{(V_{\text{HB}} \times \text{Hct}_{\text{HB}})}{(V_{\text{R}} \times \text{Hct}_{\text{R}})} \times 100$$

where V_{HB} = holding bag volume; Hct_{HB} = holding bag hematocrit; V_{R} = reservoir volume; and Hct_{R} = reservoir hematocrit.

Statistical Analysis

Statistical analysis of all data was done using the student *t* test. A two-tailed *p* value of less than 0.05 was considered statistically significant.

RESULTS

A total of 17 cardiac operations were entered in the study. All results are summarized in Table 1, which compares the results to a previously published study on a full 125-mL bowl (4).

Table 1. Comparison of the quality of wash between a partial and a full bowl.

	Full Bowl*	Partial Bowl	<i>p</i> Value
No. cases	22	17	
Red blood cell recovery (%)	94 ± 16	84 ± 17	<0.05
Platelet removal (%)	86 ± 23	85 ± 6	NS
Potassium removal (%)	91 ± 4	88 ± 4	NS
Plasma-free hemoglobin removal (%)	85 ± 6	85 ± 6	NS
Leukocyte removal (%)	35 ± 17	50 ± 13	<0.05

*Reprinted with permission Serrick et al. NS, not significant.

RBC Recovery

The average Hct of the partial bowls was 31 ± 4.5% compared with 46 ± 4.6% for a full bowl. When looking at the percentage of RBCs recovered using the above equation, there was a decrease in the amount of RBCs recovered compared to a full bowl (84 ± 17% vs. 94 ± 16%, *p* < 0.05).

Quality of Wash

The quality of the washed blood was assessed by calculating the percent removal of the contaminants of leukocytes, platelets, PFH, and potassium using the following equation.

$$\% \text{ removal} = \frac{[1 - (V_{\text{HB}} \times [\text{Sub}]_{\text{HB}}) / (V_{\text{R}} \times [\text{Sub}]_{\text{R}})]}{\times 100}$$

where V_{HB} = volume in the holding nag; $[\text{Sub}]_{\text{HB}}$ = concentration of substance in the holding bag; V_{R} = processed volume in the reservoir; and $[\text{Sub}]_{\text{R}}$ = concentration of substance in the reservoir.

There were no statistically significant differences between a partial or full bowl when comparing potassium, PFH, or platelet removal. Interestingly, there was a significantly better wash out of leukocytes in the partial bowl compared to the full bowl (50 ± 13% vs. 35 ± 17%, *p* < 0.05).

To access whether the variability in the partial filling affects the quality of the wash of a partial bowl, the Hct of each bowl was plotted against the potassium, PFH, and platelet removal of the partial bowl. As can be seen in Figures 1 through 3, there is no direct correlation with how much blood is used to partially fill a bowl and the quality of the washed product.

DISCUSSION

During the collection of shed autologous blood throughout surgery, a variety of contaminants are aspirated with the blood. Active suctioning and an air to blood interface can cause a high degree of hemolysis, resulting in a very high PFH, and potassium content. In fact PFH can be greater than 400 mg/dL in cardiac cases and several times higher than this in orthopaedic cases. (5) If not ad-

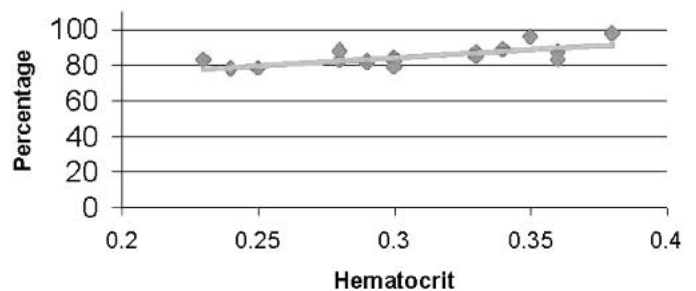


Figure 1. Potassium washout compared with the hematocrit of the partially filled bowls.

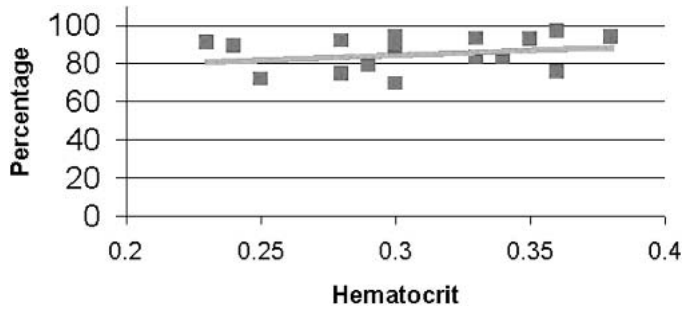


Figure 2. Platelet washout compared with the hematocrit of the partially filled bowls.

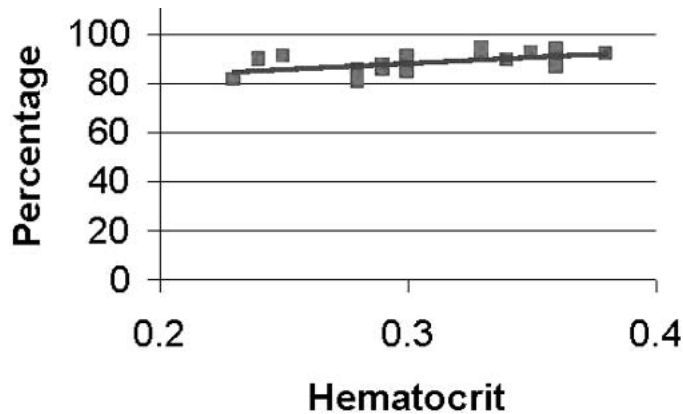


Figure 3. PFH washout compared with the hematocrit of the partially filled bowls.

equately washed, large quantities of this hemolyzed blood can lead to renal compromise. This collected blood also contains a high concentration of activated leukocytes and platelets. Bull et al. (6) claim that these activated cells become trapped on the inner wall of the disposable centrifuge bowl and release leukoattractants and thromboplastic materials, which result in a systemic syndrome called “the salvaged blood syndrome.” This syndrome can involve elements of disseminated intravascular coagulation, capillary leak, and adult respiratory distress syndrome. It is therefore important that salvaged erythrocytes have most of these contaminants removed to safely be transfused back into a patient. This is why partial filled bowls are so controversial. Most companies using bowl technologies condemn the practice, quoting a poor-quality wash. In past training, partial bowl usage was contraindicated because of an inadequate ability to remove unwanted contaminants from the end product (1,2). This inability was a result of the wash volume theoretically failing to infiltrate the RBC layer during a partially filled bowl and instead following the path of least resistance, which resulted in an undesirable product.

However, this does not apply to all bowl technologies. The Haemonetics Cell Saver 5 bowl dynamics ensure that the wash volume directs wash to permeate the RBC layer for a consistently clean result. Despite the controversy

surrounding partial bowl usage, this clinical evaluation has validated that the quality of wash with the Haemonetics Cell Saver 5 system is reproducible. Partial bowl use can be beneficial in cases where returning blood to the patient versus using crystalloid substitutes are necessitated. When concentrating blood is no longer an option, processing a partial bowl ensures all potentially salvageable RBCs are returned to the patient.

This study has demonstrated that the washing of a partially filled bowl with the Haemonetics Cell Saver 5 produces a quality washed RBC product that is comparable with that of a full bowl provided double the normal wash volume is used. The better wash is not only a result of the increased wash volume, but may also be attributable to the “turbo fin” design of the Haemonetics Cell Saver 5 Latham bowl. This particular design has multiple ribs on the bottom of the bowl that increase and improve the mixing of the wash solution with the salvaged RBCs. As a result, the wash solution does not have the tendency to enter the bowl through the central core and exit directly through the waste line or pathway of least resistance without ever passing through the cells as with other designs. The wash solution will be directed to mix with RBCs improving the wash quality.

One study that seems to substantiate our findings is by Tremain et al. (7). Using Baylor bowl technologies, they found that the quality of washed product did not vary significantly regardless of RBC volumes in the bowl or wash volumes. However, when a low volume of erythrocytes was combined with a low wash volume, the quality was compromised.

Despite the fact that there is no difference in the quality of the wash when comparing full to partial bowls, there is a sacrifice in RBC recovery. A 10% reduction in the number of RBCs recovered was noticed when processing a partial bowl, probably attributable to the doubling of the wash volume that is needed to give a quality product. Thus, increasing the wash volume results in more RBCs being pushed out the effluent line and into the waste bag.

One interesting observation was the fact that the processing of a partial bowl resulted in a significantly better washout of leukocytes than a full bowl. Again, this is probably caused by the excessive wash volume. This results in a decreased RBC recovery, however has the beneficial effect of also getting rid of the leukocytes that are only slightly less dense and tends to ride on the top layer of the RBCs.

One limitation of this study is that it only assesses the capability of one particular autotransfusion device that uses bowl technology to produce a good quality partial bowl. Because Haemonetics Corporation is the only autotransfusion company known to the authors that advocates the use of partial bowls, we felt that this claim had to be substantiated before putting it into practice. It is not

the intention of this paper to advocate the washing of partial bowls with other autotransfusion devices.

In conclusion, the Haemonetics Cell Saver 5 can produce a quality product from washing a partial bowl with a better washout of leukocytes compared with a full bowl. This practice can maximize RBC salvaging and would be especially important in situations where a partial bowl of a lower hematocrit is more desirable to use as a volume replacement in surgical patients than just crystalloid.

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