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Blood Loss and Intraoperative Salvage Procedure in Patients Underwent Re-operation Coronary Artery Bypass

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Introduction

- Cell saving systems are commonly used during cardiac operations to improve hemoglobin levels and to reduce blood product requirements\(^1\).

- Preoperative patients` characteristics can predict the need for perioperative blood transfusion in cardiac surgery.
  - Use of cardiopulmonary bypass (CPB)
  - Hematocrit <30%, weight < 70 kg
  - Serum creatinin > 100 μmol/L

\(^1\text{Scrascia G et al. Perfusion 2012; 27(4):270-7.}\)
Background

- Currently, a large number of patients with coronary artery diseases are on antiplatelet therapy.
- A group of these patients require reoperative surgery (redo) after coronary artery bypass grafting (CABG).
CPB induces the inflammation

- Open-heart surgery is associated with the inflammatory response, which occurs as a result of
  - the contact of blood and artificial surfaces of the circuit,
  - ischemia-reperfusion damage,
  - surgical trauma,
  - changes in body temperature, and
  - release of endotoxin$^{2,3}$.

Cell salvage procedure

Concentrations of IL-6 in supernatant

CABG    redo CABG

Intraoperative blood management

- Cell saver procedure
  - collecting
  - washing
  - reinfusing
  - return own RBC
- Autologous blood transfusion
Aim

- We analyzed the effects of blood salvage through a cell saver on
  - postoperative hemoglobin levels,
  - the volume of the autologous blood transfusions reinfused after reoperative cardiac surgery
Dideco cell saver (Sorin, Italy) device was used for blood salvage procedure
Patients and Methods

- Fifty-four elective patients were included.
- In 30 patients, CABG was done for the first time in their life (Group 1). These patients have had low ejection fraction (LVEF).
- In the other 24 patients, the reoperative surgery was done several years after the first CABG (Group 2).
Patients and methods (cont.)

- **Fifty-four patients** (16% female, 84% male; aged 60.5 ± 6 vs. 66.2 ± 7 years) were divided in:
  - **Group 1** – CABG (n=30), and
  - **Group 2** – redo CABG (n=24)

- Two patients were excluded in Group 2 intraoperatively due to changed indication
Patients and Methods (cont.)

- Blood samples were collected
  - 24 h prior to the surgery
  - 6 h, and
  - 24 h after initiation of CPB
- Laboratory parameters and coagulation
  - RBC count, Hgb, Hct, Platelets, WBC, etc.
  - MEA (platelets function), Rotem, ACT, ATIII, fibrinogen, etc.
Patients and methods (cont.)

- **Time frame** (November 2010 – May 2011)
- **Outcomes** (clinical and other endpoints)
  - use of transfused blood products
  - blood loss, chest tube drainage
  - rethoracotomy and revision
  - atrial fibrillation rate (AF)
  - tracheal intubation time
  - ICU stay
  - hospital stay
  - mortality
Patients profile

CABG and reoperative CABG surgery

- First CABG
- RedoCABG
- RedoCABG + valve

1 2 3
<table>
<thead>
<tr>
<th>Variable</th>
<th>Group 1</th>
<th>Group 2</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender male (%)</td>
<td>25 (83)</td>
<td>19 (86)</td>
<td>0.9370</td>
</tr>
<tr>
<td>Age (years)</td>
<td>60.5±6.5</td>
<td>66.2±7.36*</td>
<td>0.0216</td>
</tr>
<tr>
<td>Body mass (kg)</td>
<td>82±15.3</td>
<td>81.4±6.24</td>
<td>0.7064</td>
</tr>
<tr>
<td>LVEF (%)</td>
<td>26.08±4.8</td>
<td>35.68±10.72*</td>
<td>0.0004</td>
</tr>
<tr>
<td>EuroSCORE</td>
<td>4.66±1.37</td>
<td>8.1±2.34*</td>
<td>0.0001</td>
</tr>
<tr>
<td>Aspirin (yes/no)</td>
<td>93/7</td>
<td>76/24</td>
<td>0.1163</td>
</tr>
<tr>
<td>Hemoglobin (g/L)</td>
<td>133.37±16.1</td>
<td>137.0±17.2</td>
<td>0.4487</td>
</tr>
<tr>
<td>Leukocytes x10⁹/L</td>
<td>7.83±1.86</td>
<td>7.39±3.23</td>
<td>0.5735</td>
</tr>
<tr>
<td>Thrombocytes x10⁹/L</td>
<td>244.13±62.9</td>
<td>186.86±45.32*</td>
<td>0.0004</td>
</tr>
</tbody>
</table>

*p<0.05
Discussion

CPB-induced alterations in the haemostatic system are multifactorial, pertaining to excessive activation of coagulation and fibrinolytic pathways with interplay of cellular and soluble hemostatic and inflammatory systems;

hypothermia and hemodilution further complicate the situation.

Coagulopathy following CPB represents one extreme on a continuum of coagulation function, with perioperative... (e.g. coronary graft thrombosis, myocardial infarction, stroke and pulmonary embolism) at the other end of the spectrum.


P=0.02

Group 1 Age vs Group 2 Age

* P=0.02
For complicated cardiac surgery, such as re-operation with repeated use of CPB, as a control group in this study we choose the patients with poor LVEF (26% vs. 35%) 

p = 0.0004
## Table 2. Perioperative and lab data

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group 1</th>
<th>Group 2</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPB (minutes)</td>
<td>82.83±21.43</td>
<td>127±57.93*</td>
<td>0.00</td>
</tr>
<tr>
<td>Hemoglobin (g/L)</td>
<td>104.31±10.12</td>
<td>114.0±13.3 *</td>
<td>0.00</td>
</tr>
<tr>
<td>Leukocytes x10⁹/L</td>
<td>13.63±10.42</td>
<td>16.25±4.79 *</td>
<td>0.03</td>
</tr>
<tr>
<td>Thrombocytes x10⁹/L</td>
<td>187.78±196.0</td>
<td>137.4±42.66</td>
<td>0.19</td>
</tr>
<tr>
<td>Autologous RBC (mL)</td>
<td>566.0±146.66</td>
<td>733.4±297.8*</td>
<td>0.05</td>
</tr>
<tr>
<td>Blood loss (mL)</td>
<td>868.5±587.5</td>
<td>1040±823.4</td>
<td>0.42</td>
</tr>
<tr>
<td>Allogenic RBC (mL)</td>
<td>505.5±169.4</td>
<td>556.66±332.04</td>
<td>0.61</td>
</tr>
</tbody>
</table>

* p<0.05
Table 3. Clinical outcomes after primo- and reoperative CABG surgery

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group 1</th>
<th>Group 2</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tracheal intubation time (h)</td>
<td>16.07 (13.9-18.45)</td>
<td>19.20 (12.13-30.18)</td>
<td>0.30</td>
</tr>
<tr>
<td>Revision (%)</td>
<td>3 (10.0%)</td>
<td>2 (9.1%)</td>
<td>0.91</td>
</tr>
<tr>
<td>Arrhythmia (%)</td>
<td>5 (16.7%)</td>
<td>3 (13.6%)</td>
<td>0.76</td>
</tr>
<tr>
<td>ICU stay (days)</td>
<td>3.03 (2.32-3.95)</td>
<td>4.55 (2.76-7.53)</td>
<td>0.14</td>
</tr>
<tr>
<td>Hospital stay (days)</td>
<td>9.86 (7.9-10.4)</td>
<td>14.6* (10.2-20.8)</td>
<td>0.01</td>
</tr>
<tr>
<td>Survival (yes/no)</td>
<td>30/30</td>
<td>21/1</td>
<td>ns</td>
</tr>
</tbody>
</table>

* p<0.05
<table>
<thead>
<tr>
<th>Transfused products (ml)</th>
<th>Mean ±SD</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packed red blood cells transfused intraoperatively</td>
<td>505.5±169.4</td>
<td>556.6±332.0</td>
</tr>
<tr>
<td>Autologous erythrocytes reinfused intraoperatively</td>
<td>566.0±146.6</td>
<td>733.4±297.7</td>
</tr>
<tr>
<td>Fresh frozen plasma transfused</td>
<td>906.5±452.8</td>
<td>829.1±289.0</td>
</tr>
<tr>
<td>Crioprecipitate substitution</td>
<td>400.0±142.2</td>
<td>440.0±242.2</td>
</tr>
<tr>
<td>Packed red blood cells transfused postoperatively</td>
<td>771.1±809.5</td>
<td>1143.0±958.7</td>
</tr>
<tr>
<td>Platelets transfused</td>
<td>466.6±378.6</td>
<td>502.0±292.2</td>
</tr>
</tbody>
</table>
Results

- The two groups of patients had no significantly different hemoglobin levels before open heart surgery
  (133.37±16.1 g/L vs. 137.0±17.2 g/L; 0.44).

- The Group 2 of patients had a significant improvement in hemoglobin levels after operation
  (104.31±10.12 g/L vs. 114.0±13.3 g/L; 0.00).
Results (cont.)

- No differences were found for allogenic red blood cell transfusions intraoperatively (505.5± 169.4 vs. 556 ± 332.04; p: NS).
- The Group 2 of patients had higher amount of the blood loss (868.5± 587.5 vs. 1040 ± 823.4) but p: NS
- The Group 2 of patients had increased amount of the autologous RBC transfusions (566.0±146.6 vs. 733.4±297.8; p:0.05).
Blood transfusions

- Of 52 patients observed, 27 patients (51.92%) received a blood transfusion.
- In the Group 1, 19 (63%) patients received alloproducts:
  - 18 (60%) intraoperatively,
  - 13 (43%) postoperatively, and
  - 12 (40%) patients received alloproducts during and after surgery
- In the Group 2, 13 (59%) patients received alloproducts:
  - 9 (40%) intraoperatively,
  - 4 (18%) postoperatively, and
  - 13 (59%) patients during and after surgery.
Blood component substitution postoperatively

- Platelets transfused ($p = 0.88$),
- fresh frozen plasma ($p = 0.68$), and
- packed red blood cells transfused ($p = 0.32$) have not reached statistical significance.
- ICU stay was not influenced by used blood components transfusion, either allogenic or autologous.
The positive correlation between blood loss and ICU stay $r = 0.49$ ($p = 0.021$)
Discussion

- Blood salvage with a cell saving system improved postoperative hemoglobin levels, but affects coagulative and fibrinolytic systems\(^1\).
- These conditions could generate a consumption coagulopathy.
Bleeding in reoperative surgery

- Due to the re-exploration of chest these patients are at higher risk of perioperative bleeding, and requires consequential substitution of blood products\textsuperscript{6}.

Microvascular bleeding remains a major problem following cardiac surgery with CPB.\textsuperscript{6-7}

Approximately 4\% of patients require reoperation for hemorrhage,\textsuperscript{7-8} which is associated with increased mortality and morbidity\textsuperscript{9}

with up to 5\% of patients receiving more than a 10 unit perioperative blood transfusion.\textsuperscript{8}

\textsuperscript{6} Nuttall et al, Anesthesiology 2001; 94:773-781
\textsuperscript{7} Hall et al, Cardiovasc. Surg. 2002; 10:146-153
\textsuperscript{8} Woodman and Harker, Blood 1990; 76:1680-1697
Conclusions

- We have found that cell salvage procedure is safe and can significantly improve hemoglobin levels in reoperative CABG surgery.
- The use of cell sever could help to reduce the amount of allogenic blood transfusion, and thus,
- to prevent postponing the surgical procedure in patients scheduled for complicated open heart surgery.
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