tions is about 2.15%. (4) Compared with TEE, sensitivity and specificity of TTE using second harmonic imaging is greater than 90% for the diagnosis of PFO. (2) It may even be more sensitive than TEE in certain circumstances, such as in heavily sedated patients unable to undergo a proper Valsalva maneuver or in patients who cannot tolerate esophageal intubation for a long time. (5)

Its extensive availability and low cost should also be pointed out. In patients with CS, a possible etiological cause is the presence of aortic plaques, which could be very difficult to visualize with TTE, especially when located in the descending thoracic aorta. However, plaques should be searched mainly in patients >50 years of age since their prevalence in younger patients is very low. (6)

When planning the percutaneous closure of atrial septal defects, the use of TEE is recommended to assess the feasibility of such approach. This includes interatrial shunting, the need to determine the size of the defect, the proper edges for implantation, and to rule out associated lesions. (3) However, the anatomical variability is less remarkable in PFO.

The anatomical features compared in our study are those that mainly influence the choice of device size at the time of implantation (e.g., the need to cover the atrial septal aneurysm (ASA), or the size of the device not larger than the size of the septum due to risk of erosion) or the septum approach (through the PFO tunnel or by transseptal puncture in very long tunnels).

Our study had a limited number of patients and was carried out in a single center; however, we believe that this strategy can be employed, since TTE with agitated saline solution is a low-complexity diagnostic test, which is performed in most echocardiography laboratories with positive cost/benefit ratio and no negative influence at the time of percutaneous closure device implantation.

Conflicts of interest
None declared.
(See authors’ conflicts of interest forms on the website/Supplementary material).

Ethical approval
Not applicable.

Table 2. Anatomical features of the septum, size of implanted devices, and implantation strategy.

<table>
<thead>
<tr>
<th></th>
<th>Group 1 (TEE)</th>
<th>Group 2 (TTE)</th>
<th>Pvalue</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASA (%)</td>
<td>55</td>
<td>75</td>
<td>0.40</td>
</tr>
<tr>
<td>Tunnel size (mm)</td>
<td>7</td>
<td>7</td>
<td>0.55</td>
</tr>
<tr>
<td>Aortic edge (mm)</td>
<td>8.5</td>
<td>7.5</td>
<td>0.49</td>
</tr>
<tr>
<td>Septum size (mm)</td>
<td>19</td>
<td>17</td>
<td>0.55</td>
</tr>
<tr>
<td>Device size (mm)</td>
<td>30</td>
<td>30</td>
<td>0.23</td>
</tr>
<tr>
<td>Transseptal puncture (%)</td>
<td>0</td>
<td>8</td>
<td>0.99</td>
</tr>
</tbody>
</table>

ASA: Atrial septal aneurysm

REFERENCES

Alejandro E. Contreras1, Eduardo J. Brenna1, Marcos Amuchastegui (h)1,2, Adolfo Ferrero Guadagnoli2, Alejandro R. Peirone3
1 Department of Cardiology. Hospital Privado Universitario de Córdoba. 2 Interventional Cardiology. Hospital Privado Universitario de Córdoba. 3 Department of Cardiology. Hospital Privado Universitario de Córdoba. Instituto Universitario de Ciencias Biomédicas de Córdoba Naciones Unidas 346. Barrio Parque Vélez Sarsfield (5016). Córdoba, Argentina. Phone: 54 351 4688220. e-mail: aleeterras@hotmail.com

Routine Blood Salvage with Cell Saver During Elective Cardiac Surgery

In cardiac surgery, different approaches have been developed to reduce allogeneic transfusions. Operative recovery of blood with cell saver is one of these approaches, despite its routine use is still questioned. (1-4)

The purpose of this study was to confirm whether the routine use of cell saver during elective cardiac surgery can improve hematocrit and hemoglobin levels at discharge, and also reduce blood product consumption. An intervention study with a quasi-experimental design was conducted on a series of adult patients who underwent cardiac surgery in a community hospital in 2017 and 2018. Patients undergoing any type of elective cardiac surgery with cardiopulmonary bypass
were included, divided into two consecutive series of 43 and 45 subjects each. In the first series, intraoperative blood salvage with cell saver was used routinely, but it was not used in the following time series (“non-cell saver” group).

The cell-saver group underwent intraoperative cell salvage with autologous transfusion of red blood cells at the end of the procedure, and external transfusion as required. Blood loss from skin incision to skin closure was salvaged with a single-lumen suction tube and washed with heparinized 0.9% saline (10 U/ml infused at 83 ml/h) connected to a closed collection reservoir (Dideco®).

Salvaged blood was washed, and red blood cells were suspended in saline until a hematocrit of about 60% was achieved. The suspension was transferred to a sterile collection bag, and was administered with a standard blood infusion set. Salvaged red blood cells were transfused upon skin closure.

In the control group without cell saver, bleeding from the skin incision to its closure was either aspirated and discarded or salvaged with the heart-lung machine during perfusion.

The defined threshold for homologous red blood cell transfusion was hemoglobin < 8 g/dl or hematocrit < 23%. In patients with excessive blood loss and hemodynamic instability, blood was administered at the discretion of the attending team. Platelets and coagulation products were transfused at discretion and by thromboelastometry (ROTEM®) test support. A comparative analysis based on the use—or not—of cell saver was carried out, evaluating the basal hematometric variables (hematocrit and hemoglobin) before surgery and before hospital discharge, as well as blood product consumption. The protocol was approved by the Institutional Review Board, and all patients consented to the use of cell saver.

A total of 88 patients were included, 43 with cell saver and 45 without cell saver. Mean age was 67.2 (SD: 12.8) years, and 70% were men. Baseline clinical characteristics were similar in both groups (Table 1).

Thirty-day mortality was 4.7% and 4.4% (p = 1.000) for cell-saver and non-cell-saver groups, respectively. The rate of reoperation for bleeding was similar in both groups: cell saver 2.3% versus non-cell saver 4.4% (p = 1.000). The average volume of salvaged red blood cells with the cell saver was 473 ml (SD: 264). Table 2 compares the data on bank blood product consumption and blood values at discharge for each group.

In this quasi-experimental study, no benefit was found with the use of cell saver to reduce the average volume of red blood cells transfused during elective cardiac surgery in adults, or to reduce platelet consumption. On the contrary, a higher consumption of fresh frozen plasma was found in the group of operated patients using cell saver. This finding supports the theory of some authors who argue that cell saver would generate dilutional coagulopathy secondary to the removal of platelets, plasma, and coagulation factors. (5)

A recently published systematic review (2019) concluded that the use of cell saver would not have an impact on the rates of red blood cell, platelet and fresh frozen plasma transfusion; however, this should be interpreted taking into account the substantial heterogeneity between the results of the included studies (I² = 60%). (6)

In conclusion, the use of cell saver as a routine strategy to reduce red blood cell consumption during elective cardiac surgery showed no benefit in optimizing hematometric values at discharge or in the consumption of blood products during hospitalization.

### Conflicts of interest
None declared.

(See authors’ conflicts of interest forms on the website/Supplementary material).

### Ethical approval
Not applicable.

#### Table 1. Baseline characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Cell-saver group (n: 43)</th>
<th>Non-cell-saver group (n: 45)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years, mean (SD)</td>
<td>68.0 (12.4)</td>
<td>65.4 (11.0)</td>
<td>0.301</td>
</tr>
<tr>
<td>Male subjects, n (%)</td>
<td>31 (72)</td>
<td>34 (76)</td>
<td>0.712</td>
</tr>
<tr>
<td>EuroSCORE II (%), mean (SD)</td>
<td>2.8 (6.4)</td>
<td>2.8 (8.2)</td>
<td>0.978</td>
</tr>
<tr>
<td>Hematocrit (%), mean (SD)*</td>
<td>40.8 (4.2)</td>
<td>40.3 (5.3)</td>
<td>0.623</td>
</tr>
<tr>
<td>Hemoglobin (g%), mean (SD)*</td>
<td>13.5 (2.0)</td>
<td>13.7 (1.6)</td>
<td>0.649</td>
</tr>
<tr>
<td>Coronary surgery, n (%)</td>
<td>22 (51)</td>
<td>25 (56)</td>
<td>0.680</td>
</tr>
<tr>
<td>Valve surgery, n (%)</td>
<td>18 (42)</td>
<td>15 (33)</td>
<td>0.267</td>
</tr>
<tr>
<td>Other surgeries, n (%)</td>
<td>3 (7)</td>
<td>5 (11)</td>
<td>0.632</td>
</tr>
</tbody>
</table>

SD: Standard deviation. *Correspond to hematocrit and hemoglobin values before surgery.

#### Table 2. Bank blood product consumption and hematometric values at discharge

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cell-saver group (n: 43)</th>
<th>Non-cell-saver group (n: 45)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume of transfused red blood cells in ml, median (IQR)</td>
<td>300 (0-600)</td>
<td>300 (0-300)</td>
<td>0.562</td>
</tr>
<tr>
<td>Volume of transfused fresh frozen plasma in ml, mean (SD)</td>
<td>130 (329)</td>
<td>5 (30)</td>
<td>0.022</td>
</tr>
<tr>
<td>Transfused platelet units, mean (SD)</td>
<td>1 (1.9)</td>
<td>0.3 (1.5)</td>
<td>0.150</td>
</tr>
<tr>
<td>Hematocrit (%), mean (SD)</td>
<td>30.4 (3.1)</td>
<td>31.4 (3.7)</td>
<td>0.168</td>
</tr>
<tr>
<td>Hemoglobin (g%), mean (SD)</td>
<td>10.0 (1.1)</td>
<td>10.2 (1.4)</td>
<td>0.368</td>
</tr>
</tbody>
</table>

SD: Standard deviation. *Correspond to hematocrit and hemoglobin values before surgery.
José M. Álvarez Gallesio1, Tomás Bertolino2, Miriam M. Méndez3, Michel David4, Osvaldo M. Tenorio Núñez5, Raúl A. Borracci6

Department of 1 Cardiac Surgery, 2 Department of Cardiology, and 3 Hemotherapy Service, Herzzentrum, Hospital Alemán, Buenos Aires, Argentina. Av. Pueyrredón 1640, (C1118AAP), CABA, Argentina. e-mail: jalvarezgallesio@gmail.com

REFERENCES


Effect of Antiplatelet Therapy on Suboptimal Reperfusion

In ST-segment elevation acute coronary syndrome (STE-ACS), the main purpose is restoration of blood flow in the responsible artery and microvascular reperfusion as soon as possible, thus limiting the extent of irreversible injury.

Suboptimal reperfusion (SOR) is associated with greater infarct size, increased rate of left ventricular dysfunction, and increased mortality rate. (1) It is defined by partial ST-segment depression (< 50%) after pharmacological or mechanical reperfusion.

The causes of SOR are persistent stenosis or thrombosis, dissection or coronary spasm, distal microembolism, acute stent thrombosis, no-reflow phenomenon, reperfusion injury, endothelial cell edema, and myocyte inflammation. (1-4)

We recently published an analysis (4) in which we observed that SOR incidence in a STE-ACS registry was 8.6%, with significantly increased in-hospital mortality in this subgroup of patients [17.6 vs 1.8%, SOR vs optimal reperfusion (OR), p = 0.007].

Furthermore, in the multivariate analysis, we observed that high leuko-glycemic index (LGI) and history of prior revascularization were significantly associated with SOR. Other authors observed that in a series of 1,005 consecutive patients with STE-ACS undergoing primary angioplasty, the independent predictors of SOR were prior infarction, Killip and Kimball (KK) 3-4, diabetes, TIMI flow < 2 pre-angioplasty, and TIMI < 3 post-angioplasty.

In turn, Mahmoud et al. (2019) (5) found that the independent predictors of SOR were pre-angioplasty hyperglycemia and increased white blood cells (similar to our findings) associated with technical variables related to the angioplasty procedure, such as thrombus formation and number of balloon inflations.

The present analysis evaluated the antiplatelet therapy received, both on admission and maintenance doses, among patients who presented SOR and OR. A cohort of 197 patients with STE-ACS and angioplasty presented 180 cases with OR, and 17 with SOR.

Table 1 shows patient baseline characteristics. All patients in both groups received some antiplatelet therapy, receiving aspirin in 95% of the SOR group, and in 98% of the OR group. The mean loading dose of aspirin in the SOR group was 280 ± 28.0 mg vs. 325 ± 9.9 mg in the OR group (p = 0.11).

Regarding the use of clopidogrel, the mean loading dose was 356 ± 35.6 mg in the SOR group versus 460 ± 11 mg in the OR group (p = 0.0023). There is little evidence of a relationship between the type and dose of the antiplatelet regimen used and the incidence of SOR, but based on our findings we believe there is an association with greater incidence of SOR in patients receiving a less potent antiplatelet regimen prior to reperfusion treatment.

Platelet aggregation would play a key role. Roule et al. (6) found that patients who were associated with SOR continued to have residual platelet reactivity after ticagrelor loading doses. We believe that our findings provide an alternative or additional explanation to the classical concept that higher doses of P2 and 12 are associated with a lower rate of myocardial infarction or death, due to a reduction in thrombotic events associated with the antiplatelet effect of thienopyridines.

Our study has the limitation of insufficient data to analyze the effect of new antiplatelet drugs, such as prasugrel or ticagrelor, so further studies will be necessary to test this hypothesis in order to clarify these results and those mentioned and published by other researchers; (2-4) that is, the occurrence of SOR is associated with a significant increase of in-hospital mortality. However, the hypotheses on SOR diagnosis are still controversial.

Conflicts of interest
None declared.

Ethical approval
Not applicable.