

## Minimal invasive Extracorporeal Circulation and reduced anticoagulation strategies - less bleeding after coronary surgery?

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### Introduction

Excessive postoperative bleeding is still a common complication after heart surgery with extracorporeal circulation (ECC). Studies show that the use of minimally invasive extracorporeal circulation (MiECC) can improve perioperative hemostasis and reduce postoperative bleeding complications. Further studies also found a positive effect of reduced heparin doses on the incidence and amount of postoperative bleeding. In the present study we combined MiECC and reduced ACT targets (reduced anticoagulation: 300 seconds) vs. Full\_AC (full anticoagulation: 450 seconds) and hypothesized that reduced anticoagulation intensity reduces the amount and occurrence of excessive postoperative bleeding.

### Methods

In this prospective randomized study we examined 106 patients undergoing aortocoronary bypass surgery. The ACT target was controlled by the Haemostasis Management System (Medtronic International, Tolothenaz, CH). The primary endpoint "postoperative bleeding" was measured with the electronic chest drainage system Thopaz + <sup>TM</sup> (Medela, Switzerland) and digitally processed for the study. As secondary endpoint hemostasis was investigated by endogenous thrombin potential (ETP) and thromboclastography (TEG). In addition, thromboembolic complications and serious adverse events were monitored.

### Results

ACT values and heparin/protamine doses were significantly lower in the study group. The study group had significantly less bleeding (Diff\_Median 24 h: -92 ml [290-4478] p = 0.026) and 403 ml less over the entire drainage period (851 ml [372 - 1869] vs. 1275 ml [445 - 4886] p = 0.003). Both TEG and ETP showed improved postoperative coagulation characteristics, but no signs of hypercoagulopathy or hyperfibrinolysis. There were no differences between the groups in terms of thromboembolic complications or increased incidence of re-operations and serious adverse event.

### Conclusion

Since bleeding volumes were significantly reduced and no negative side effects associated with lower heparin levels occurred, we consider the reduction of ACT in combination with MiECC as a measure to reduce postoperative bleeding in ACVB surgery.

## Optimized mechanical rinsing to improve packed red blood cells

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### Introduction

Transfusion of packed red blood cells (PRBC) is associated with side effects, some of these are caused by storage lesions others result from their foreign origin. Non-physiological storage alters cell function and reduces metabolism. The cellular structure is changed, and some cells are destroyed, thus causing an accumulation of potassium and lactate. Mechanical rinsing can minimize these effects.

### Methods

The Present in-vitro study compares 30 differently treated PRBC concentrates. PRBC were either washed with standard physiological saline solution 0.9% (n= 15, NaCl-group) or with a hemofiltration solution containing 4 mmol/l potassium (n= 15, HF-group) using a mechanical rinsing device (Xtra, LivaNova, Italy). A subgroup analysis was performed based on the storage duration of the RBCs (7, 14, 37 days). Samples were taken from the PRBCs before washing (M1), immediately after washing (M2) and 10 h later after storage in the "new" storage solution (M3). The concentration of ATP, lactate and electrolytes was tested. The effect of the selected washing solution as well as of the age of the RBCs was determined using a 2-sample t-test or paired t-test.

### Results

ATP concentrations increased from M1 to M2 (n= 30; M1 vs. M2:  $3.1 \pm 0.7$  vs  $3.8 \pm 0.7$   $\mu\text{mol} / \text{gHb}$ ;  $p < 0.05$ ). The subgroup of 37-day-old PRBCs showed increased ATP concentrations in the HF-group compared to the NaCl-group (M2 vs. M3:  $3.7 \pm 0.4$  vs  $4.0 \pm 0.5$   $\mu\text{mol} / \text{gHb}$ ;  $p < 0.05$ ). The test provides evidence that mechanical rinsing leads to a significant reduction of potassium, lactate and glucose.

### Conclusion

Mechanical rinsing treatment of PRBCs improves pretransfusion quality. PRBC washing with a hemofiltration solution results in a more physiological electrolyte composition. Even after a 10h-storage of 37-days old PRBCs RRBC-pre-transfusion-quality of the erythrocytes after mechanical rinsing with hemofiltration solution is nearly equally as good as fresh PRBC.

## Monitoring of myocardial microcirculation in ex vivo machine perfusion of donor hearts

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### Introduction

Preservation of cardiac allografts is crucial for heart transplantation. A novel preservation strategy is of high importance for heart preservation is ex vivo machine perfusion (EVMP) with warm oxygenated blood. During EVMP the quality of perfusion is only estimated by surrogate parameters, but the effective perfusion is unmonitored.

### Methods

In a pig model of heart donation, donor hearts were explanted and underwent EVMP. To evaluate effective perfusion of the heart, myocardial microcirculation (mLDP) was monitored with a laser doppler perfusion (LDP) needle probe. The impact of different coronary perfusion pressures (CPP) and left ventricular preload volumes (LVV) on mLDP was investigated.

### Results

An increase of CPP in EVMP from 20 to 40 mmHg and from 20 to 60 mmHg drastically increased mLDP by  $16\pm 9\%$  and by  $29\pm 10\%$ . By increasing CPP from 20 to 80 mmHg and from 20 to 100 mmHg, mLDP is increased relatively less radical by  $32\pm 14\%$  and by  $36\pm 18\%$ .

A LVV of 5, 10, 15 and 20 mL at a constant CPP of 60 mmHg leads to a  $8\pm 1\%$ ,  $12\pm 2\%$ ,  $3\pm 3\%$  and  $1\pm 5\%$  increased mLDP, each compared to a baseline-LVV of 0 mL.

### Conclusion

Increasing CPP's show a non-linear increase of mLDP with logarithmic tendency. Our results support the suggestion, that high CPP's do not equally improve the effective perfusion and tissue supply. Our results also indicate, that a medium LVV may improve myocardial microcirculation in EVMP. In future experiments we will increase the sample size, to verify our conclusions.