Benefits of early haemofiltration during aorto-bifemural bypass with mesenteric revascularization – a case report

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Abstract
The intraoperative vs postoperative initiation of haemofiltration procedures in patients submitted for major vascular surgery is a controversial issue and a subject of debate in recent literature. We report the case of a 50 yr old patient scheduled for aorto-bifemoral bypass with mesenteric revascularization in whom the haemofiltration procedure (Prismaflex with Onix filter) was installed intraoperatively. Known to have non-insulin-dependent type 2 diabetes, the patient was admitted for Leriche syndrome, abdominal aorta thrombosis, superior and inferior mesenteric artery occlusion, celiac trunk occlusion, bilateral critical limb ischemia and mild renal impairment. The filtration rate was 25 ml/kg/h, ultrafiltration rate of 50 ml/h and 2 h clamping time. Haemofiltration was continued postoperatively in the ICU for another 48 h. The patient had a favorable evolution with restoration of renal function and a significant improvement of the biochemical parameters.
In conclusion the early haemofiltration applied in this case provided clear beneficial effects, probably preventing the evolution towards multiple organ dysfunction syndrome.
Keywords: intraoperative haemofiltration, aorto-bifemoral bypass, ischemia-reperfusion syndrome

Introduction
The issue regarding the use of intraoperative versus postoperative haemofiltration, applied in the intensive care unit, while multiple organ failure is already present, is still controversial [1-6]. We present a patient in whom the early intraoperative use of haemofiltration procedures contributed to the favorable outcome after a major vascular surgery.

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Case report
Having obtained the patient’s consent, we describe the case of a 50 year-old Caucasian male patient, 163 cm in height, 64 kg weight, body mass index of 24.1, heavy smoker (30 cigarettes per day). The patient was admitted to the Vascular Surgery Ward of the Emergency County Hospital Timișoara, with bilateral lower limb rest pain of recent onset (2 months prior to his admission), arterial ulcer on the left leg (10/15 cm) and with a recently installed diarrhea, abdominal pain and distension, weight loss and fatigue. Following clinical examination, biochemical and hematological blood tests, electrocardiography, and CT angiography, the established diagnosis was peripheral arterial disease stage IV, type III Leriche syndrome, abdominal aorta thrombosis, superior and inferior mesenteric artery occlusion, celiac trunk occlusion, left lower limb critical ischemia and right lower limb chronic ischemia, arterial
ulcer on the left anterior calf, coronary heart disease, non-insulin dependent type 2 diabetes mellitus, recently installed gluten intolerance interpreted as “celiac disease” and renal impairment.

Haemofiltration was chosen as the intraoperative extra-corporeal therapy that provides a rigorous fluid balance, electrolytes and acid-base management and also the efficient removal of the pro-inflammatory cytokines that are released as a consequence of the reversible ischemia consecutive to surgical aortic clamping. A Prismaflex device (Gambro® Lundia AB, Lund, Sweden) with an Osirix filter (Gambro® Lundia AB, Lund, Sweden) was used, which allowed the simultaneous execution of haemofiltration and removal of the pro-inflammatory cytokines.

The surgical procedure consisted of: infrarenal aortic bypass with a 12/6 mm Dacron synthetic prosthesis, and the ligation of the aorta’s distal end, aorto-bifemoral tic clamping with trombendarterectomy of the aorta was also used.

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The blood volume of the entire circuit was 168 mL. The procedure was initiated intraoperatively, before aortic clamping and was performed in the veno-venous method, through a right internal jugular vein approach taking approximately 48 hours. The medium blood flow into the device was 180 mL/min, filtration rate 25 mL/kg/h, 50 mL/h ultra-filtration, 800 mL/h dialysis, substitution before the filter 160 mL/h and after the filter 640 mL/h. During the procedure, 7500 UI heparin were administered to obtain an APTT of 50-70 seconds. The substitution solution contained potassium 2 mEq/L (Primasol 2) and the aortic clamping was maintained for 2 hours.

The anesthetic management of this patient consisted of combined general anesthesia with Sevoflurane, and epidural anesthesia with 0.5% bupivacaine, through a catheter inserted preoperatively at L2-L3. The vascular access comprised both peripheral and central venous approach (12 F catheter for the haemofiltration on the right jugular vein, a 7 F catheter for volemic repletion and central venous pressure monitoring on the left subclavian vein).

The arterial approach was made on the left radial artery with a Seldinger catheter, used for invasive monitoring of the arterial pressure and arterial blood gas parameters.

Intraoperative monitoring included: ECG in DII and V5, invasive blood pressure, $\text{SpO}_2$, $\text{EtCO}_2$, cutaneous and esophageal temperature, diuresis. The hemodynamic monitoring platform, non-invasive LIDCO type (LiDCO Group Plc, London, England) offered real-time monitoring of the cardiac output and systemic vascular resistance. The INVOS (Regional Oximetry System), (Covidien, Minneapolis, USA) for cerebral real time monitoring of the regional oxygen saturation was also used.

The surgical procedure consisted of: infrarenal aortic clamping with trombendarterectomy of the aorta and the ligation of the aorta’s distal end, aorto-bifemoral bypass with a 12/6 mm Dacron synthetic prosthesis, superior mesenteric artery revascularization through a 6 mm reinforced PTFE prosthesis (bypass between the Dacron prosthesis and the superior mesenteric artery). The de-clamping of the left prosthetic arm was done after 1 h 20 min and of the right prosthetic arm after 2 h 10 min, with a total blood loss of about 2000 ml.

The volume therapy addressed the blood and fluids loss during the surgical intervention (7 hours duration). A volume of 7000 ml crystalloid solutions (NaCl0.9%), five units of packed red cells, two units of fresh plasma and 250 ml of manitol 20% were administered.

After surgery, still intubated and on a ventilator the patient was transferred to the intensive care unit. The ventilatory support continued for 2 hours on SIMV ventilation, followed by CPAP with 14 cm H$_2$O pressure support. After extubation the patient continued to present a good oxygenation ($\text{SpO}_2$ of 100%) with oxygen support on a facial mask (4 L/min).

Postoperative management included administration of antibiotics (vancomycin 1g i.v. every 12 hours), gastric protection (nexitum 40 mg i.v. every 24 hours) and prokinetics (metoclopramid 10 mg i.v. every 8 hours). A multimodal analgesia regimen was installed: paracetamol i.v. 1 g every 8 hours, tador 50 mg i.v. every 8 hours and epidural analgesia with 0.125% bupivacaine – 7 ml/h. For thromboembolism prophylaxis, fractionated heparin (clexane 40 mg every 12 h) was administered.

The haemofiltration was stopped after 48 hours. The patient’s evolution was favorable, haemodynamic and respiratory stable, with an efficient diuresis (100 mL/h) and restoration of bowel function at 24 hours postoperatively. He was transferred into the surgical ward in a stable condition showing complete restoration of the arterial circulation of the lower limbs (normal skin color and peripheral pulses).

The main biochemical parameters recorded pre-, intra- and postoperatively improved after surgery (Table 1).

**Discussion**

Currently two opinions are sustained, through different studies, regarding timing of haemofiltration. Satish, Bauers and Guntars [1-3] are in favor of the early haemofiltration, the purpose being to prevent the ischemia – reperfusion syndrome, which can lead to multiple organ failure and death. On the other hand, there are authors that consider that this kind of haemo-filtration together with cytokines adsorption is too invasive and puts the patient at high risk and it is not justified to use it so early during the surgical procedure [4, 5]. These authors recommend application of the
Table 1. The evolution of the biochemical parameters intra- and postoperatively

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Preclamping and at haemofiltration initiation</th>
<th>At the end of surgery</th>
<th>1st postoperative day and at the end of haemofiltration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total CK</td>
<td>220 U/L</td>
<td>112 U/L</td>
<td>2010 U/L</td>
</tr>
<tr>
<td>LDH</td>
<td>242 U/L</td>
<td>710 U/L</td>
<td>268 U/L</td>
</tr>
<tr>
<td>ALAT</td>
<td>16 U/L</td>
<td>40 U/L</td>
<td>23 U/L</td>
</tr>
<tr>
<td>ASAT</td>
<td>45 U/L</td>
<td>71 U/L</td>
<td>52 U/L</td>
</tr>
<tr>
<td>Lactate</td>
<td>1.3 mmol/L</td>
<td>4 mmol/L</td>
<td>1.7 mmol/L</td>
</tr>
<tr>
<td>Urea</td>
<td>72 mg/dL</td>
<td>61 mg/dL</td>
<td>14 mg/dL</td>
</tr>
<tr>
<td>Creatinine</td>
<td>1.6 mg/dL</td>
<td>1.5 mg/dL</td>
<td>0.98 mg/dL</td>
</tr>
<tr>
<td>Potassium</td>
<td>5.2 mmol/dL</td>
<td>4.3 mmol/dL</td>
<td>3.8 mmol/dL</td>
</tr>
<tr>
<td>IL-6</td>
<td>14.2 pg/mL</td>
<td>16.8 pg/mL</td>
<td>81 pg/mL</td>
</tr>
</tbody>
</table>

CK – creatine kinase; ALAT – alanine aminotransferase; ASAT – aspartate aminotransferase; LDH – lactate dehydrogenase; IL – interleukine

procedure postoperatively, after the diagnosis of systemic inflammatory syndrome is established. This approach appears to be safer because it does not put the patient through a series of invasive procedures, but it needs a close monitoring for early determination of the biological features of ischemia-reperfusion syndrome.

A recent case report showed good results of EHF started before revascularization in two cases of acute limb ischemia with myonephropathic metabolic syndrome [7].

In our patient, the type III Leriche limb ischemia carried a high risk of severe acid-base and other metabolic disturbances consecutive ischemia-reperfusion syndrome associated with surgical intervention. For this patient with numerous comorbidities, without a haemofiltration protocol an unfavorable postoperative evolution was predictable, and we considered that to apply this method early during the surgical intervention before the patient met the recommended criteria, was justified.

The benefits of EHF were also reported, in a pilot trial on patients with renal impairment during cardiopulmonary bypass surgery, such as reducing ICU length of stay, days of mechanical ventilation and important economical savings (about 150,000 pounds/year) for their unit [8].

In our patient, the benefits of the intraoperative initiation of haemofiltration were reflected in the improvement of biochemical parameters. As concerning the major enzymes released in the settings of prolonged ischemia/reperfusion injury, we noticed that LDH showed a steep decrease first day after surgery, approaching the pre-intervention values. As for total CK, the values recorded in the 1st day postoperatively, albeit high, were far below those reported by other authors [9, 10], pointing to a clear protective effect of the haemofiltration protocol when initiated prior to surgery. A similar beneficial evolution was reported for the transaminases.

Laboratory investigations showed that the patient presented at admission with mild renal impairment (urea = 72 mg/dL and creatinine = 1.6 mg/dL), values that were expected to further deteriorate due to the prolonged aortic clamping and the subsequent severe ischemia/reperfusion injury syndrome. Haemofiltration clearly improved the renal function as shown by the values of creatinine, urea and potassium that decreased immediately after surgery and normalized in the next day. It has to be emphasized that the aggravation of renal failure is the rule rather than the exception in these conditions.

As expected, IL-6 showed no important changes in the first hour after surgery but significantly increased in the postoperative first day. These changes are in agreement with the literature data reporting a delayed dynamics for the pro-inflammatory cytokines [11]. For this patient, an unfavorable evolution after surgery was predictable in view of the prolonged aortic clamping and the potential severity of the reperfusion injury. Therefore, we decided to apply the extrarenal filtration protocol early during the surgical procedure, even though the patient did not meet the standard laboratory criteria [12].

The criteria considered for an early intraoperative haemofiltration were: the acute ischemia of the lower limbs, the estimated long aortic clamping time and the presence of renal impairment. None of these situations would present per se an indication for the intraoperative haemofiltration, but their association led us to its application in this case.

Diarrhea, initially interpreted as “celiac disease”, proved to be the consequence of the mesenteric ischemia and completely remitted in two weeks after discharge. It represents a particularity of this case.

In conclusion, the early application of haemofiltration in this patient, with a severe initial prognosis, proved beneficial and allowed prevention of multiple organ failure.
It should be considered when elaborating guidelines and therapeutic protocols, having as final endpoints a reduced morbidity and mortality.

Conflict of interest
Nothing to declare

References

Beneficiile hemofiltrării precoce în cursul bypass-ului aorto-bifemural cu revascularizare mezenterică – un caz clinic

Rezumat

Problematica aplicării procedurilor de hemodiafiltrare intraoperatorie versus postoperatorie este controversată şi face obiectul a numeroase studii de specialitate.

Am descris efectele iniţierii precoce a hemodiafiltrării în cazul unui pacient în vârstă de 50 de ani, cu diabet zaharat de tip 2, non-insulino-dependent care s-a prezentat cu sindrom Leriche, tromboză de aortă abdominală, ocluzie de trunchi celiac şi de artere mezenterice şi ischemie severă la nivelul membrelor inferioare. Pacientul a fost propus pentru bypass aorto-bifemural şi aorto-mezenteric, iar hemofiltrarea a fost demarată intraoperator utilizând un aparat Prismaflex prevăzut cu filtru tip Oxiris şi continuată apoi timp de 48 de ore în terapie intensivă. Rata de filtrare utilizată a fost de 25 ml/kg/h, ultrafiltrat de 50 ml/h şi un timp de clampare aortic de 2 ore. Am obţinut îmbunătăţirea postoperatorie a parametrilor biochimici (enzime de citoliză, acid lactic) şi a funcţiei renale, iar evoluţia pacientului a fost favorabilă.

În concluzie, aplicarea procedurii de hemodiafiltrare precoce, intraoperator, în cazul acestui pacient, a fost benefică, cu suprimarea mecanismelor fiziopatologice care ar fi putut determina insuficienţa multiplă de organ.

Cuvinte cheie: hemodiafiltrare intraoperatorie, bypass aorto-bifemural, sindrom ischemie-reperfuzie