Combined preoperative autologous blood donation and intra-operative cell salvage for hip surgery

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ABSTRACT

Purpose. To review records of 161 consecutive hip surgery patients for whom preoperative autologous blood donation (PABD) was used in combination with intra-operative cell salvage (ICS).

Methods. 114 women and 14 men aged 41 to 86 (mean, 64) years underwent 135 primary total hip arthroplasties (THAs), whereas 19 women and 7 men aged 16 to 52 (mean, 35) years underwent 26 rotational acetabular osteotomies (RAOs). Two or 3 weeks before the operation, patients deposited one unit (400 ml) of blood weekly, so long as their haemoglobin levels exceeded 110 g/l (if they had osteoarthritis) or 100 g/l (if they had rheumatoid arthritis). Patients were given oral ferrous sulphate, lactated Ringer’s solution, and recombinant human erythropoietin. 800 and 1200 ml of blood were deposited for patients undergoing THA and RAO, respectively. Intra-operatively, ICS was carried out using a continuous autotransfusion system. The blood from ICS was transfused first, and then the blood from PABD was transfused during the latter half of the operation.

Results. By combining PABD and ICS, homologous blood transfusion was avoided in all patients, even in those with unexpected massive bleeding during surgery. In 3 patients, one unit of deposited autologous blood was discarded, because they showed no sign of anaemia. The mean total blood loss was almost 1.5 times higher in RAO than in THA patients (1095 vs 1550 ml). In the THA and RAO patients respectively, the mean amount of ICS was 181 and 210 ml, whereas the mean total blood transfusion volume was 975 and 1394 ml. No complications (including infection) related to autologous blood transfusion were observed during PABD, the surgery or the postoperative period.

Conclusion. Homologous blood transfusion was avoided with the use of PABD and ICS. Preoperative donation of 800 and 1200 ml of blood (combined with ICS) seemed optimal, as only 3 units of blood were discarded.

Key words: arthroplasty, replacement, hip; blood transfusion, autologous

INTRODUCTION

Transfusion-related infections have decreased...
after stricter donor selection and donated blood screening. Although allogeneic blood transfusion is safe, its avoidance may minimise any infections and immunological risks. Transfusion-related immunomodulation has been implicated in infections, as patients receiving homologous blood transfusion have higher infection rates than those not receiving any. The likelihood of contracting a blood-borne infection (such as human immunodeficiency virus or hepatitis) from donated blood is very low in Japan, but not negligible. Blood transfusion can also stimulate the formation of alloantibodies against red cells, platelets, white cells, and plasma proteins. Transfusion-related acute lung injury is a rare complication in which donor anti-leukocyte antibodies cause severe pulmonary damage in the recipient. Use of autologous blood avoids all of these potential complications. We reviewed the records of 161 consecutive hip surgery patients who underwent preoperative autologous blood donation (PABD) combined with intra-operative cell salvage (ICS).

**MATERIALS AND METHODS**

Records of 133 women and 21 men who underwent 161 consecutive hip surgery procedures with the use of PABD and ICS between July 2005 and September 2007 were reviewed. 114 women and 14 men aged 41 to 86 (mean, 64) years underwent 135 primary total hip arthroplasties (THAs) for osteoarthritis (n=118), osteonecrosis of the femoral head (n=10), and rheumatoid arthritis (n=7). 19 women and 7 men aged 16 to 52 (mean, 35) years underwent 26 rotational acetabular osteotomies (RAOs) for osteoarthritis (n=22) and osteonecrosis of the femoral head (n=4). General anaesthesia combined with epidural anaesthesia was used. In 9 women, both hips were operated on separately. Seven patients whose anaemia (a haemoglobin level of <100 g/l) did not improve despite iron administration were excluded. As RAO was performed for younger patients, the transfusion threshold may differ in patients having THA versus RAO.

Two or 3 weeks before the operation, patients deposited one unit (400 ml) of blood weekly so long as their haemoglobin level exceeded 110 g/l (if they had osteoarthritis) or 100 g/l (if they had rheumatoid arthritis). To prevent dizziness, nausea, and syncope caused by hypovolaemia, patients were given oral ferrous sulphate (50 mg twice daily), lactated Ringer’s solution (500 ml), and recombinant human erythropoietin (24 000 U). 800 and 1200 ml of blood were deposited for patients undergoing THA and RAO, respectively. The blood was stored in a separate, designated refrigerator, and was cross-matched and subjected to the same handling and checks as donated homologous blood. Exclusion criteria for PABD were anaemia, poor venous access, active infection, cardiovascular disorders (such as critical valvular stenosis, cyanotic heart disease, or arrhythmia), severe restrictive or obstructive airways disease, neurological disorders (such as epilepsy, brain tumours, or transient ischaemic attacks), and viral infections.

ICS was carried out using a continuous autotransfusion system (Fresenius Haemotechnology, Redmond [WA], USA). Blood was retrieved from the operating field using a single specific suction catheter. The processed red blood cells were collected in sterile bags for autotransfusion by the anaesthetist. Intra-operatively, blood from ICS was transfused first, and then the blood from PABD was transfused during the latter half of the operation. The postoperative blood loss tended to be greater in cementless hip surgery.

**RESULTS**

By combining PABD and ICS, homologous blood transfusion was avoided in all patients, even in those with unexpected massive bleeding during surgery. In 3 patients, one unit (400 ml) of deposited autologous blood was discarded, because they showed no sign of anaemia (with a haemoglobin level of >115 g/l). The mean total blood loss was almost 1.5 times higher in patients having RAO versus THA (1095 vs 1550 ml, Table). In the THA and RAO patients respectively, the mean amount of ICS was 181 and 210 ml, whereas the mean total blood transfusion volume was 975 and 1394 ml (Table). Prophylactic anticoagulants such as Xa inhibitor or low molecular heparin were administered postoperatively to prevent deep vein thrombosis. All drains were removed within 48 hours. No complications (including infections) related to autologous blood transfusion were observed during PABD, the surgery, or the postoperative period.

**DISCUSSION**

Autologous blood transfusion can be performed in 4 ways: (1) PABD and retransfusion intra- and post-operatively, (2) artificial haemodilution with immediate preoperative phlebotomy and postoperative retransfusion, (3) intra-operative autotransfusion.
blood salvage, and (4) postoperative blood salvage. PABD, combined with oral iron supplementation, is beneficial for orthopaedic surgeries, but the short shelf life of blood limits the amount that can be collected preoperatively. The use of ICS for patients undergoing revision hip arthroplasty has been reported. ICS should be used (in addition to PABD) when the preoperative haemoglobin level falls below 120 g/l in primary or revision hip arthroplasty.

In patients undergoing hip or knee arthroplasties, the absence of pre-donated autologous blood and a low haemoglobin level are the most common predictors of homologous blood transfusion. Infections (particularly urinary tract infection) occur more frequently in patients receiving a homologous blood transfusion than those not receiving any. Autologous blood has a higher incremental cost than allogenic blood because of the discard of unused autologous units and the more labour-intensive process (collect, identify, and store). Nonetheless, in our series, the amount of discarded autologous blood was not excessive.

The continuous autotransfusion system can handle the blood continuously at a high speed regardless of the amount of bleeding. Nonetheless, care is necessary when heavy bleeding occurs, because protein and clotting factors are depleted by washing shed blood. In our series, no patient had increased bleeding (related to lack of clotting factors) and received a protein infusion.

Combination of PABD and ICS involves higher costs and more staff than PABD or ICS alone. The postoperative haemoglobin levels should be maintained between 100 to 110 g/l in THA patients. Maintaining the postoperative haemoglobin level is beneficial for rehabilitation.

### REFERENCES


### Table

Comparison of patients undergoing total hip arthroplasty (THA) versus rotational acetabular osteotomy (RAO)

<table>
<thead>
<tr>
<th>Variable</th>
<th>THA (n=135)</th>
<th>RAO (n=26)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preoperative autologous blood donation (ml)</td>
<td>800</td>
<td>1200</td>
</tr>
<tr>
<td>Mean±SD (range) intra-operative cell salvage (ml)</td>
<td>181±95 (78–522)</td>
<td>210±83 (88–540)</td>
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<tr>
<td>Mean±SD (range) blood loss (ml)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intra-operation</td>
<td>542±285 (117–2178)</td>
<td>629±249 (234–1227)</td>
</tr>
<tr>
<td>Postoperation</td>
<td>553±343 (55–1680)</td>
<td>921±277 (323–1495)</td>
</tr>
<tr>
<td>Total</td>
<td>1095±462 (343–3413)</td>
<td>1550±374 (725–2187)</td>
</tr>
<tr>
<td>Mean±SD haemoglobin level (g/l)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predonation</td>
<td>132±11 (100–167)</td>
<td>137±12 (109–161)</td>
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<tr>
<td>Preoperation</td>
<td>117±12 (9.8–150)</td>
<td>118±12 (102–131)</td>
</tr>
<tr>
<td>Immediate postoperation (lowest value)</td>
<td>111±12 (74–142)</td>
<td>110±12 (86–126)</td>
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</tbody>
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