Effect of Autologous Blood Donation with Intraoperative Cell Salvage and Blood Transfusion on the Requirements of Revision Total Hip Arthroplasty

Tomoko Nagano, Koichi Kinoshita, Yoshinari Nakamura, Masatoshi Naito

Abstract

Background: Revision total hip arthroplasty (THA) is associated with increased blood loss.

Patients and methods: We reviewed 32 patients who underwent revision THA to identify modes of implant failure, use of autologous blood donation with/without intraoperative cell salvage, and allogeneic blood transfusion requirements.

Results: Five patients underwent revision THA for infection or fractures. None used autologous blood donation and four required allogeneic blood transfusion. Twenty-seven patients underwent revision THA for aseptic loosening. In this group, 17 used autologous blood donation with intraoperative cell salvage, and the other 10 used intraoperative cell salvage without autologous blood donation. Allogeneic transfusion was required in only two of 17 patients of the former group, and in seven of 10 patients of the latter group (p=0.007). Use of autologous blood donation with intraoperative cell salvage led to lower allogeneic blood transfusion requirements.

Conclusions: These data show that use of autologous blood donation with intraoperative cell salvage is clearly associated with decreased allogeneic blood transfusion requirements for revision THA. Identification and treatment of patients at a higher risk of allogeneic blood transfusion may guide probable allogeneic blood transfusion requirements, and is a safe, effective method of managing blood loss for revision THA.

Key words: Revision hip arthroplasty, Blood loss, Transfusion, Autologous blood donation, Intraoperative cell salvage

Introduction

Patients undergoing revision total hip arthroplasty (THA) are at considerable risk of massive perioperative blood loss that necessitates allogeneic blood transfusion. Allogeneic blood transfusion carries the risk of disease transmission and immunologic reactions. Identification of patients that might require transfusion is desirable to improve blood use and more accurately identify which patients should receive established perioperative blood conservation interventions. We examined the influence of variables such as age, sex, preoperative haemoglobin (Hb) concentration, modes of implant failure, use of autologous blood donation (ABD) and inoperative cell salvage (ICS), and allogeneic blood transfusion requirements following revision THA.

Patients and Methods

A retrospective analysis was conducted on 32 patients who underwent elective revision THA in the Department of Orthopaedic Surgery, Faculty of Medicine, Fukuoka University (Fukuoka, Japan) over a two-year period.

Several weeks before THA, patients deposited 200–400 mL of blood weekly as long as their Hb level remained >11.0 g/dL. To prevent dizziness, nausea, and syncope caused by hypovolemia, patients were given lactated Ringer’s solution after autologous blood was collected. Patients were given iron supplementation in accordance with the preoperative haemoglobin level.
with guidelines set by our hospital. Patients with Hb <13.5 g/dL were given iron supplementation via the intravenous route. Patients with Hb <12.5 g/dL were given iron supplementation via oral and intravenous routes. Intravenous iron supplementation 40mg was given immediately after autologous blood collection. Oral iron supplementation 210mg per day was given everyday from autologous blood collection until surgery. After the induction of general anaesthesia, procedures were carried out by two senior surgeons using various surgical methods. The analysis focused on the modes of implant failure, and included cases of revision THA for infection or fractures as well as early revisions for dislocations secondary to malpositioning of implants. Intraoperative cell salvage (ICS) was carried out using a continuous autotransfusion system (Electa®; Sorin, Milan, Italy). Blood was retrieved from the operative field using a single dedicated suction catheter. Collected blood was separated via centrifugation and red blood cells collected in sterile bags for autotransfusion. Blood from ICS was transfused intraoperatively, and autologous blood collected preoperatively was transfused immediately after surgery. In accordance with guidelines set by our hospital, patients with Hb <7~8 g/dL should be considered use of allogeneic transfusion. In this study, allogeneic transfusion was used in consideration of each Hb level, amount of bleeding, anamnesis, blood pressure, and the general state. Prophylactic anticoagulants such as edoxaban were administered postoperatively for 12 days to prevent deep-vein thrombosis. Drains were removed <24 h after surgery. Hb levels were measured just before preoperative donation of autologous blood as well as 1 day and 7 days after surgery.

The electronic database of our hospital was searched. Variables such as preoperative and postoperative Hb concentrations, patient demographics (e.g., age, sex), type of revision surgery, mode of implant failure, use of ABD and ICS, and allogeneic blood transfusion requirements were recorded for each case.

### Statistical analyses

Fisher’s contingency table analysis was used to test for differences in allogeneic blood transfusion requirements of patients who underwent revision THA for aseptic loosening between groups using ABD with ICS, and ICS without donation of autologous blood. p<0.05 was considered significant.

### Results

Three patients underwent revision THA due to infection (Table 1). Types of components that underwent revision were femoral component, acetabular component, and dual components each. Seventy-six-y female and 58y female had many amounts of intraoperative bleeding. Seventy-four-y female had the anamnesis hemorrhage in the precedence surgery: extraction of implant and debridement. Furthermore, in this operation, her preoperative blood pressure dropped. All three patients could not take advantage of ABD and ICS, so they required allogeneic blood transfusion. Two patients underwent revision THA for fractures. Types of components revised were acetabular

### Table 1. Allogeneic blood transfusion requirements upon revision total hip arthroplasty due to infection or fracture

<table>
<thead>
<tr>
<th>Mode of implant failure</th>
<th>Infection</th>
<th>Infection</th>
<th>Infection</th>
<th>Fracture</th>
<th>Fracture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td>60</td>
<td>52</td>
<td>65</td>
<td>53</td>
<td>61</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>26.5</td>
<td>23.7</td>
<td>26.9</td>
<td>17.1</td>
<td>26.2</td>
</tr>
<tr>
<td>Type of component revised</td>
<td>Femoral</td>
<td>Acetabular</td>
<td>Dual</td>
<td>Dual</td>
<td>Acetabular</td>
</tr>
<tr>
<td>Operative time (min)</td>
<td>77</td>
<td>195</td>
<td>356</td>
<td>208</td>
<td>150</td>
</tr>
<tr>
<td>Perioperative blood loss (mL)</td>
<td>2260</td>
<td>495</td>
<td>1800</td>
<td>unknown</td>
<td>370</td>
</tr>
<tr>
<td>Preoperative haemoglobin concentration (g/dL)</td>
<td>9.6</td>
<td>9.9</td>
<td>11.2</td>
<td>11.6</td>
<td>13.6</td>
</tr>
<tr>
<td>Haemoglobin concentration just before allogeneic transfusion (g/dL)</td>
<td>8.3</td>
<td>unknown</td>
<td>7.3</td>
<td>5.9</td>
<td>N/A</td>
</tr>
<tr>
<td>Postoperative haemoglobin concentration: POD1 (g/dL)</td>
<td>10.1</td>
<td>11.6</td>
<td>9.3</td>
<td>11.1</td>
<td>9.6</td>
</tr>
<tr>
<td>Postoperative haemoglobin concentration: POD2 (g/dL)</td>
<td>9.2</td>
<td>10.9</td>
<td>6.3</td>
<td>9.5</td>
<td>8.6</td>
</tr>
<tr>
<td>Transfusion</td>
<td>RBC 2 units</td>
<td>RBC 4 units</td>
<td>RBC 4 units</td>
<td>ICU 1103 mL++</td>
<td>RBC 4 units</td>
</tr>
</tbody>
</table>

ICS – intraoperative cell salvage.

### Table 2. Characteristics of cases of revision total hip arthroplasty due to aseptic loosening

<table>
<thead>
<tr>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Autologous blood donation with intraoperative cell salvage</strong></td>
<td><strong>Intraoperative cell salvage without autologous blood donation</strong></td>
</tr>
<tr>
<td>Number of cases (n)</td>
<td>17</td>
</tr>
<tr>
<td>Age (years)</td>
<td>64.2±18.8</td>
</tr>
<tr>
<td>Male/female</td>
<td>2:15</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>53.2±11.8</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>22.3±6.6</td>
</tr>
</tbody>
</table>
Fig. 1 Haemoglobin concentration and allogeneic blood transfusion requirements upon revision total hip arthroplasty due to aseptic loosening

HB – haemoglobin; ICS – intraoperative cell salvage; PBD – preoperative blood donation; POD – postoperative day.

Allogeneic blood transfusion requirements of groups that used autologous blood donation with intraoperative cell salvage were significantly lower than those of groups that did not use autologous blood donation ($p=0.007$).

<table>
<thead>
<tr>
<th>Group A</th>
<th>n=17</th>
<th>PBD with ICS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBD</td>
<td>494±306 mL</td>
<td></td>
</tr>
<tr>
<td>ICS</td>
<td>271±453 mL</td>
<td></td>
</tr>
<tr>
<td>Preoperative Hb</td>
<td>12.8±1.8 g/dL</td>
<td></td>
</tr>
</tbody>
</table>

Allogeneic blood transfusion

<table>
<thead>
<tr>
<th>n=7</th>
<th>Postoperative Hb (POD1)</th>
<th>7.6±1.0 g/dL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Postoperative Hb (POD7)</td>
<td>8.2±1.8 g/dL</td>
</tr>
</tbody>
</table>

No use of allogeneic blood transfusion

<table>
<thead>
<tr>
<th>n=15</th>
<th>Postoperative Hb (POD1)</th>
<th>10.5±3.0 g/dL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Postoperative Hb (POD7)</td>
<td>10.1±3.7 g/dL</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group B</th>
<th>n=10</th>
<th>ICS without PBD</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICS</td>
<td>302±176 mL</td>
<td></td>
</tr>
<tr>
<td>Preoperative Hb</td>
<td>12.4±2.3 g/dL</td>
<td></td>
</tr>
</tbody>
</table>

Allogeneic blood transfusion

<table>
<thead>
<tr>
<th>n=2</th>
<th>Postoperative Hb (POD1)</th>
<th>11.3±2.5 g/dL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Postoperative Hb (POD7)</td>
<td>9.3±1.7 g/dL</td>
</tr>
</tbody>
</table>

No use of allogeneic blood transfusion

<table>
<thead>
<tr>
<th>n=3</th>
<th>Postoperative Hb (POD1)</th>
<th>10.3±1.5 g/dL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Postoperative Hb (POD7)</td>
<td>9.5±2.6 g/dL</td>
</tr>
</tbody>
</table>

Discussion

ABD can be carried out in several ways: preoperative ABD, intraoperative blood salvage, and postoperative blood salvage. Preoperative ABD has been shown to reduce the absolute risk of allogeneic blood transfusion by 43.8%.

Preoperative ABD offers theoretical advantages, and should be targeted to males with a Hb level 11.0–14.0 g/dL and to females with a level of 13.0–14.0 g/dL whose anticipated perioperative blood loss is ≈1 L. The results of a recent Cochrane review on perioperative cell salvage showed that re-transfusion of autologous blood reduced allogeneic blood transfusion requirements by 54% as compared with conventional drains in orthopaedic procedures. If high levels of blood loss are anticipated, preoperative blood donation may be considered, possibly combined with ICS. The results of a review by Mahadevan et al. showed greater blood loss in males, older patients, during revision surgery of cemented implants, and dual-component revision THAs. In the present study, use of ABD with ICS was clearly associated with decreased allogeneic blood transfusion requirements for revision THA. However, ABD cannot be employed for patients with anaemia, who are prone to infection, or immediately before surgery. Additionally, preoperative ABD can present logistical problems, be time-consuming, and waste donated blood. In the present study, iron supplementation was used for patients with preoperative anaemia. There was no
wastage of donated blood. Identification and perioperative
treatment of patients at a higher risk of allogeneic blood
transfusion may guide probable reduction of allogeneic
blood transfusion requirements, and be a safe, effective
method of managing blood loss for revision THA.

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