Primary Arthroplasty

Extremely Low Transfusion Rates: Contemporary Primary Total Hip and Knee Arthroplasties

Ida S. Lindman, MD *, Lars V. Carlsson, MD, PhD
Ortho Center Göteborg, Gothenburg, Sweden

A R T I C L E   I N F O

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A B S T R A C T

Background: Considerable blood loss which requires transfusion is frequently reported after total hip and knee arthroplasties (THA and TKA). The purpose of this study is to review the transfusion rates in contemporary THA and TKA with optimized perioperative protocols including minimized surgical trauma and optimal perioperative patient care.

Methods: This retrospective study included 1442 consecutive patients receiving either a primary THA or a TKA from the same high-volume surgeon between January 2008 and December 2015. Demographics and surgical data were collected from patients’ journals. Estimated blood loss, decline in hemoglobin, and use of transfusion were registered.

Results: One (0.0013%) THA and 3 (0.0044%) TKAs required blood transfusion postoperatively. Average measured bleeding was 253 mL ± 142 and 207 mL ± 169 in THA and TKA, respectively. Average decline in hemoglobin was 23.5 g/L ± 11.4 and 22.9 g/L ± 11.6 for THA and TKA, respectively.

Conclusion: In contemporary THA and TKA, perioperative protocols and patient optimization can decrease the rate of blood transfusion to near zero.

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Blood transfusion in orthopedic surgery is common. Between 2% and 70% of the patients undergoing total hip or knee arthroplasty (THA or TKA) receive blood transfusion [1–7]. Studies have noticed an increase in this trend [8]. Data vary between countries and hospitals because of various guidelines and the lack of general transfusion criteria [9]. Several studies have considered the transfusion rate in arthroplasty surgery and have raised the question of the need of guidelines; however, few have come with any solutions nor recommendations [9,10].

Many factors increase the risk of receiving blood transfusion, among these are low preoperative hemoglobin (Hb) [8,11], female gender, age, and long surgical endurance [12,13]. Another strong predictor for blood transfusion is perioperative bleeding. Studies report that the average bleeding in TKA ranges between 800 mL and 1700 mL [14,15] and THA has an average bleeding of 400–1500 mL [15].

A blood transfusion increases the risk of several complications, such as the risk of infections, both respiratory and infection in the surgical wound [2], systemic complications as allergic reactions, graft-vs-host disease, transfusion-associated circulatory overload, and transfusion-related acute lung injury [10,16,17]. Furthermore, transfusion is also associated with longer hospitalization and an increased cost for the hospital [3,8,18–20].

The primary aim of this study is to review the transfusion rates in contemporary THA and TKA with optimized perioperative protocols. The secondary aim is to analyze the decline in Hb after THA and TKA.

Materials and Methods

All patients undergoing either a THA or a TKA between 2008 and 2015, operated by the same senior surgeon were studied in a retrospective study. Data were collected from the perioperative anesthesia journal and the medical ward journal. Variables such as gender, age, body mass index (BMI), preoperative and postoperative Hb, bleeding during surgery (including collected blood in drainage when used), length of operation, premedication including the use of anticoagulants, acetylsalicylic acid and nonsteroidal...
anti-inflammatory drugs (NSAIDs), length of hospital stay, and the need of transfusion during hospital stay were collected. A total of 1442 consecutive patients were included in the study, 768 THA and 674 TKA. Among the TKA, 42 patients were operated simultaneously bilaterally with knee arthroplasty. All patients being considered candidates for elective hip or knee arthroplasty and thereafter operated at the hospital were included in the study. Exclusion criterion was American Society of Anesthesiologists (ASA) >4 or BMI >40 kg/m², and these patients were referred to a tertiary hospital. The study was approved by the Regional Ethical Review Board at Gothenburg University, Sweden.

To analyze the patients’ blood loss, Hb and bleeding throughout and after the surgery were estimated. Bleeding during surgery was considered by the anesthetic nurse because of the blood from wound suction and calculated amount of blood in the swabs. In addition, if drainage was used for the TKA, this blood was included in the calculation. Hb was measured in g/L and the Hb balance was calculated with the formula Hb preoperatively minus the lowest Hb in the calculation. Hb was measured postoperatively. Neither of the authors were involved in the blood loss estimation.

The hip patients were operated in a lateral position with an anterolateral incision [21]. For the knee patients, most patients were operated with a straight midline anterior incision and a medial para patellar access to the joint. For patients with previous surgery in the affected knee, the former scar was usually used for incision.

An 8-step checklist was used for all patients to decrease bleeding (Table 1). Before surgery, their Hb level was controlled and values under the reference value indicated further investigation and eventually treatment. The reference values were 117–153 g/L for women and 134–170 g/L for men. If a patient was found to still have an Hb below these values after treatment to increase their blood value, they were operated with the knowledge of the increased risk for blood transfusion. However, the lowest threshold was of 100 g/L. Nonsteroidal anti-inflammatory drugs were discontinued 10 days before surgery and anticoagulants 4 days before surgery, where low molecular heparin substituted the latter until surgery. However, low dose of acetylsalicylic acid was not discontinued. No patient with an international normalized ratio level >1.2 was operated on; and if the patient had a value above this, the surgery was postponed until the acceptable international normalized ratio level. The patient received 10 mg/kg tranexamic acid [22] 30 minutes before surgery and 4 hours after the surgery was finished. Tranexamic acid was given to all patients except for the ones having a history of previous cardiac history including myocardial infarction, coronary bypass graft and percutaneous coronary intervention, cerebrovascular accident, deep vein thrombosis, pulmonary embolism, or if they had any prothrombotic conditions including factor V deficiency or protein C deficiency. Before incision, a local infiltration anesthesia (LIA) of 1 mL adrenaline 0.1 mg/mL, 1 mL ketorolac 30 mg/mL, and 100 mL ropivacaine 2.5 mg/mL was injected into the tissue surrounding the wound. The hemostasis was continuously under control with diathermia throughout the surgery. For the THA, after cervical osteotomy, a piece of bone wax was attached temporarily to the femoral stump. There was a strive for short operation time. The postoperative Hb was checked the day after surgery. For patients with a large amount of bleeding or who were clinically affected by the surgery, the Hb level was continuously followed up during the hospital stay. The lowest postoperative Hb was then used in this study. After surgery, all patients received either dabigatran or low molecular heparin as thrombosis prophylaxis. The first doses were administrated 6 hours after the surgery.

BMI was missing for 2 of the THA and 4 of the TKA. Postoperative Hb was missing for 3 of the THA and 2 of the TKA; and for these patients, delta Hb could not be measured and they were not included in the calculations. However, none of these received a blood transfusion.

Results

Of the 1442 patients included in the study, 4 patients received blood transfusion. One (0.0013%) patient undergoing hip arthroplasty and 3 (0.0044%) undergoing knee arthroplasty. All the 3 TKA patients receiving a blood transfusion had a tourniquet during surgery. The single THA patient receiving a blood transfusion was a woman; and of the 3 TKA patients receiving blood transfusion, 2 were women. One patient who received transfusion was man, and had simultaneous bilateral surgery. Tranexamic acid was not used on the single man receiving a blood transfusion because of contraindication.

Of the THA, 43% were women; and of the TKA, 41% were women. The presented THA and TKA patients had a BMI of 26.3 ± 3.5 and 27.9 ± 4.0 kg/m², respectively, and an average age of 61 years (range 34-86 years) and 65 years (range 35-89 years) (Table 2). According to the ASA, most of the patients belonged to ASA groups 1 and 2 (Table 3). Anticoagulants were used by 14% of the THA and 21% of the TKA patients preoperatively. Acetylsalicylic acid was used by 8% of the THA and 13% of the TKA. Average length of hospital stay was 2 days.

Of the TKA, 80% were operated with the use of a postoperative drainage, and a tourniquet was used in 87% of the knee patients. None of the THA had drainage postoperative. Cemented fixation was used in 95% of the TKA. Of the THA, 38% were cemented and 2% were hybrids. Spinal anesthesia was used for 88% and 89% of the THA and TKA, respectively.

The lowest Hb preoperatively was 102 g/L for a man and 103 g/L for a woman in the THA group and 103 g/L for a man and 100 g/L for a woman in the TKA group; however, none of these patients received a blood transfusion. The average preoperative Hb was 141 g/L for both THA and TKA and the average postoperative Hb was 118 and 119 g/L for THA and TKA, respectively. The average bleeding

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**Table 1**

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Normalized Hb</td>
</tr>
<tr>
<td>2.</td>
<td>Discontinuing NSAIDs and anticoagulants before surgery</td>
</tr>
<tr>
<td>3.</td>
<td>Injection iv of tranexamic acid 30 min preop and 4 h postop</td>
</tr>
<tr>
<td>4.</td>
<td>Local injection of ropivacaine, adrenaline, and ketorolac before incision</td>
</tr>
<tr>
<td>5.</td>
<td>Careful hemostasis—dry wound</td>
</tr>
<tr>
<td>6.</td>
<td>Bone wax after femoral neck ostetomia (only THA)</td>
</tr>
<tr>
<td>7.</td>
<td>Avoid hypertension throughout the anesthesia</td>
</tr>
<tr>
<td>8.</td>
<td>Effective surgery with short operation time</td>
</tr>
</tbody>
</table>

Hb, hemoglobin; iv, intravenous; min, minutes; NSAID, nonsteroidal anti-inflammatory drugs; postop, postoperative; preop, preoperative; THA, total hip arthroplasty.

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**Table 2**

<table>
<thead>
<tr>
<th></th>
<th>THA (n = 768)</th>
<th>TKA (n = 674)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographic Data for THA and TKA.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td>Female:Male</td>
<td>43:57</td>
</tr>
<tr>
<td>Average BMI</td>
<td>26.3 ± 3.5</td>
<td>27.9 ± 4.0</td>
</tr>
<tr>
<td>Average age</td>
<td>61 (34-86)</td>
<td>65 (35-89)</td>
</tr>
<tr>
<td>Patients with preop anticoagulants</td>
<td>14%</td>
<td>21%</td>
</tr>
<tr>
<td>Patients with preop acetylsalicylic acid</td>
<td>8%</td>
<td>13%</td>
</tr>
</tbody>
</table>

Sex is presented in percentage. BMI as the mean and the standard deviation; and age in years with range in parentheses. Preop, ie, the ratio of patients who were treated with anticoagulant or acetylsalicylic acid before surgery shown in percentages. BMI, body mass index; preop, preoperative; THA, total hip arthroplasty; TKA, total knee arthroplasty.
Table 3
Classification According to the ASA in THA and TKA.

<table>
<thead>
<tr>
<th>ASA Grade</th>
<th>THA (n = 768), %</th>
<th>TKA (n = 674), %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>53</td>
<td>36</td>
</tr>
<tr>
<td>2</td>
<td>44</td>
<td>58</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>

ASA, American Society of Anesthesiologists; THA, total hip arthroplasty; TKA, total knee arthroplasty.

Discussion

The transfusion rate in THA and TKA is still a problem as reported in the literature. Transfusion is related to an increased risk of various complications. The need of a protocol and general guidelines would help physicians to decide when a patient needs a blood transfusion. With this study, we have shown that it is possible to decrease the transfusion rate and to aim for a transfusion rate of zero for the standard patient receiving THA or TKA.

There are benefits for the patient as well as the hospital and the society with a decrease in the transfusion rate in arthroplasty surgery. With fewer transfusions, there will be a lower incidence of complications as infections and systemic complications, and will also cause in shorter hospitalization as mentioned in the literature [8]. A decrease in complications for the patient will further lead to more satisfied patients. Not to be forgotten is the economical aspect of a blood transfusion. To order, store and transport blood is, according to the results in this study, an unnecessary cost for the hospital. These factors will result in less expenses for the hospital in several ways because both complications and longer hospitalization as well as the transfusion itself cost money [6]. There is a deficiency of predonated blood in hospitals. Blood stored and reserved for patients receiving an arthroplasty might instead be used for a patient in another medical field. The almost negligible rate of transfusion in this study (0.0013% of the THA and 0.0044% of the TKA) suggests that it is not necessary to order blood before a standard arthroplasty surgery. Because of the result accomplished in this study, the local decision was made that it is unnecessary to order blood as well as cross or type test the patients’ blood before surgery, this is a significant reduction in the hospital expenses.

As there are only 4 transfusion occasions of 1442 patients in this study, it was not meaningful to do further subgroup analysis. Among these 4 patients receiving a blood transfusion, 3 were women and the only man receiving a blood transfusion had bilaterally knee arthroplasty. This might strengthen the conclusions previously made in the literature [13] that female gender is a risk factor for blood transfusion; however, no conclusions can be drawn because of the small number of patients receiving blood transfusion in this study.

Frisch et al [13] have shown several predictors for blood transfusion, and among these are low preoperative Hb, long operating time, and operative blood loss. The patients in this study were all optimized before surgery to reduce the risk of blood loss. We suggest the use of a stepwise checklist before, throughout and after the surgery. The 8-step guidelines used in this study will make sure to control the patient’s Hb level before surgery, which will reduce the risk of receiving a blood transfusion. We believe that the most important single factor to reduce blood loss is the surgical technique with meticulously hemostasis throughout the surgery.

Studies have shown that LIA before surgery reduces blood loss and risk of blood transfusion [23]. All patients in this study received a LIA of adrenaline, ketrolol, and ropivacaine for optimizing vasoconstriction, and this is included in the 8-step guideline. Furthermore, the surgeon cauterized any bleeding source before proceeding surgical exposure and the wound was kept as dry as possible throughout the surgery to decrease blood loss.

Furthermore, several studies have proven that tranexamic acid infusion before surgery has decreased blood loss and the risk of blood transfusion [22, 24, 25]. All included patients in this study received tranexamic acid if no contraindication was present. In this study, the patients received an intravenous injection of tranexamic acid; however, other studies have proven that topical given medication might further reduce the bleeding. Studies have aimed to control if there is a higher risk of venous thrombosis with tranexamic acid and to the knowledge of the authors in this study—no such higher risk has yet been detected [26].

Transfusion rates vary widely between hospitals and countries. Few clinicians have protocols when transfusion is indicated and even when protocols do exist they are incoherently followed [16, 27]. This article suggests a stricter and more careful protocol if a transfusion is indicated. The level of Hb postoperative is usually the main transfusion criterion [28, 29], and we recommend a transfusion threshold of <80 g/L for a patient with anemic symptoms. In a stable patient, with a low postoperative Hb and without any anemic symptoms, a blood transfusion may be unnecessary. The same levels are suggested for all patients, including patients with cardiac risk factors. However, studies suggest an even lower threshold for blood transfusion for noncardiac risk patient [30, 31].

There are limitations to this study. First, it is a retrospective journal study. Second, the measure of bleeding during surgery is blunt; however, the primary aim of the study was not to measure the exact bleeding, but to measure the transfusion rate. Hb was checked only during the hospital stay and further reduction may have occurred after the patient was discharged. Furthermore, the casemix in this study varies compared with a tertiary hospital because patients in this study are all elective patients with mostly an ASA group of 1 or 2, with a slightly lower average age and BMI. The literature [1] suggests that the risk of transfusion is higher in the elderly population and with a higher ASA group. However, the transfusion rate of zero should therefore be aimed for the standard elective patient.

Conclusions

This study demonstrates that with an optimization of perioperative pharmacological and patient protocols, the transfusion rate is reduced to near zero. In addition, adopting standardized protocols to minimize intraoperative bleeding may assist surgeons in reducing their patients’ transfusion rates and thus possibly complication rates. The nearly negligible rate of transfusion in this study may be a benchmark for arthroplasty surgery as arthroplasty surgeons strive to minimize transfusions and complications.

Table 4
Results for THA and TKA.

<table>
<thead>
<tr>
<th></th>
<th>THA (n = 768)</th>
<th>TKA (n = 674)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average bleeding, mL ± SD</td>
<td>253 ± 142</td>
<td>207 ± 168</td>
</tr>
<tr>
<td>Delta Hb, g/l</td>
<td>23.5 ± 11.4</td>
<td>22.9 ± 11.6</td>
</tr>
<tr>
<td>Average operation time, min</td>
<td>75 ± 16</td>
<td>74 ± 13</td>
</tr>
</tbody>
</table>

Values are given as the mean and standard deviation and preoperative medication is given as percentage. Delta Hb was calculated as preoperative Hb minus the lowest measured postoperative Hb during the hospital stay.

Hb, hemoglobin; SD, standard deviation; THA, total hip arthroplasty; TKA, total knee arthroplasty.
References


