

Postoperative Changes in Hemoglobin and Hematocrit in Patients Undergoing Primary Total Hip and Knee Arthroplasty

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INTRODUCTION

Total hip arthroplasty (THA) and total knee arthroplasty (TKA) are currently two effective treatments for many diseases of the hip and knee. Despite the ability to minimize intraoperative blood loss, postoperative hemoglobin (Hgb) loss is expected, and a number of studies have reported on hidden blood loss after THA and TKA.^[1,2]

It has been noted that patients undergoing hip surgery and THA or TKA are commonly relatively older, and failure to monitor postoperative Hgb changes in these patients may lead to serious consequences.^[2] However, previous studies on hidden blood loss after THA and TKA have involved Hgb and hematocrit (Hct) measurements at different time points, thus reducing the comparability of their results. We sought to determine at what time point postoperative Hgb and Hct levels are lowest in patients undergoing THA and TKA.

In the present study, a retrospective analysis was performed on the clinical data of 239 patients undergoing primary TKA and THA from August 2012 to March 2013. Curves for postoperative Hgb and Hct changes after TKA and THA were constructed and analyzed. The objectives of this study were: (1) To identify the pattern of postoperative Hgb and Hct changes after THA and TKA; (2) to examine the consistency between postoperative Hgb and Hct changes after THA and TKA; (3) to determine the time points for the lowest values and recovery of Hgb and Hct levels after THA and TKA. The results will provide a better understanding of the pattern of postoperative Hgb and Hct changes and thus new clinical thinking about THA and TKA.

METHODS

From August 2012 to March 2013, 239 patients were included, who underwent primary unilateral THA or TKA,

postoperative fluid replacement for 1 day, applied same method of postoperative anticoagulation, and removed drainage tubes 24 h postoperatively. Sixteen patients quit this research for postoperative transfusion.

This study included 106 men and 133 women, age 53–82 years old (mean 68.5 years). Of these, 168 patients underwent THA, including 26 cases of femoral neck fracture, 101 cases of femoral head necrosis, 16 cases of osteoarthritis, 25 cases of congenital hip dysplasia, and 6 cases of intraoperative subtrochanteric osteotomy. The remaining 71 patients underwent TKA for osteoarthritis exclusively. Thirteen patients received preoperative phlebotomy for blood-thinning (extraction of 2–4 units before anesthesia) and autologous blood transfusion immediately postoperatively, and 21 patients received intraoperative allogeneic blood transfusion. THA of 168 patients was performed using a bio-based acetabular cup, with eight receiving a cemented femoral stem and 160 a bio-based stem. For TKA, all femoral and tibial components were fixed with cement.

The same group of physicians completed the surgeries. For TKA, patients under general anesthesia were placed in a supine position and the lower extremity sterilely prepared and draped. The antibiotics were utilized before one-half an hour before operation. The leg was exsanguinated, and a pneumatic tourniquet applied, in which pressure was synchronized with systolic blood pressure for 1 h. A standard midline incision was made on the knee, followed by a parapatellar incision to expose the joint. Twenty-nine patients underwent patellar replacement, and 42 patients received cemented fixation of the prosthesis without patellar replacement. The incision was sutured after the placement of a drainage tube, and the lower limb was bandaged postoperatively. For THA, patients under general anesthesia were placed in a lateral position to make a posterolateral incision. The incision was sutured after the placement of a drainage tube. After TKA and THA, the drainage tube was clamped for 2 h before opening.

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From the 1st postoperative day (POD), all patients were given one tablet of rivaroxaban once daily for anticoagulation. The drainage tube was removed 24 h postoperatively. Patients in the TKA group wore elastic stockings after surgery. After THA and TKA, all patients started doing rehabilitation exercises on the first POD and walked with the aid of a walker on POD 2. Sutures were removed during postoperative week 2.

Routine blood tests were performed on POD 1, 2, 3, 4, 5, 7, and 14 days.

RESULTS

General information

Postoperatively, incisions underwent primary healing in both groups of patients. Sixteen patients who received postoperative infusion of allogeneic erythrocyte suspension were removed from the study.

Postoperative hemoglobin and hematocrit changes

It shows that 186 cases⁷ (82.3%) Hgb level was the lowest on POD 4, 32 cases (14.1%) on POD 3, six cases (2.7%) on POD 5, and two cases (0.8%) on POD 2.

Figure 1 demonstrates the same pattern of changes in postoperative Hgb and Hct levels, both starting to recover beginning on POD 5. The postoperative Hgb level displayed the same pattern in the THA and TKA groups. However, the average Hgb level consistently increased after THA than after TKA.

Figure 2a and 2b compare postoperative Hgb and Hct levels between THA and TKA patients and show the same pattern of changes. The average Hgb and Hct level was consistently higher after THA than after TKA, with significant differences observed on POD 1 and 2, but not on POD 3–14.

The postoperative Hgb level was significantly higher in the intraoperative-transfusion group than in the no-transfusion and phlebotomy/autologous-transfusion groups on POD 1–4 [Figure 2c]. The postoperative Hgb level was slightly higher in the phlebotomy/autologous-transfusion group than in the no-transfusion group. The postoperative Hct level was significantly higher in the intraoperative-transfusion group than in the no-transfusion and phlebotomy/autologous-transfusion groups on POD 1–4 [Figure 2d]. A significant difference was not seen in postoperative Hct level between the latter two groups ($P > 0.01$), although the values in the phlebotomy/autologous-transfusion group were greater than those in the no-transfusion group.

DISCUSSION

In recent years, the technology of arthroplasty has undergone continuous improvement, and THA as well as TKA is widely used for the surgical treatment of diseases of the hip and knee. Despite the small amount of intraoperative bleeding, a large number of patients show postoperative

symptoms of anemia after THA and TKA. Anemia in these patients may cause adverse effects such as infection, poor wound healing, and delayed recovery of joint function; with the slow recovery of walking ability as an especially important manifestation.^[3] Therefore, it is necessary to monitor postoperative Hgb frequently and implement appropriate measures in order to improve the outcomes of THA and TKA.

Hidden blood loss is a major cause for early anemia that continues to worsen after THA.^[1,3] Arthroplasty often requires amputation of substantial bone mass, thereby causing bleeding of the bone bed. Erythrocytes enter the interstitial space and are involved in the systemic circulation, resulting in a further decline in Hgb level. Additionally, bone marrow fat, bone cement, and bone debris enter the blood circulation intraoperatively and cause abnormal opening of capillary beds, and free fatty acids produced intraoperatively further destroy erythrocytes. These mechanisms may be the main reasons for a further decline in postoperative Hgb level.^[4] Anemia enables the body to initiate compensatory and corrective mechanisms. Because of an already existing reduction in red bone marrow constituents, the elderly have a hematopoietic system with inadequate compensatory ability and poor capability for correction of hemorrhagic anemia, thus often requiring time for correction of anemia.^[5]

The results presented in this study reveal a pattern of postoperative anemia that occurs in patients undergoing THA and TKA. Among the 239 study patients, 16 patients were withdrawn from the study for postoperative blood transfusion because of allogeneic erythrocyte suspensions. It can be seen from Figure 1 that postoperative Hgb and Hct changes followed the same pattern, which is consistent with the conclusions of Sehat^[2] that the blood loss can be calculated from the Hct level and is caused by erythrocyte loss. Figure 2a and b indicate that postoperative changes in blood loss followed the same pattern in THA and TKA patients, both showing significant hidden blood loss after surgery. The data which show the timing of the lowest Hgb level postoperatively, demonstrate that it takes approximately 4 days for the decline of Hgb to reach its nadir in the human body. Previous studies have focused on postoperative blood loss in THA and TKA within the first 2 or 3 PODs,^[3,4] which is insufficient and

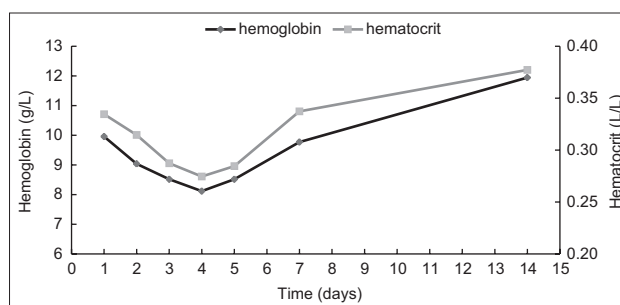


Figure 1: Postoperative hemoglobin/hematocrit changes in patients undergoing total hip and knee arthroplasty ($n = 223$).

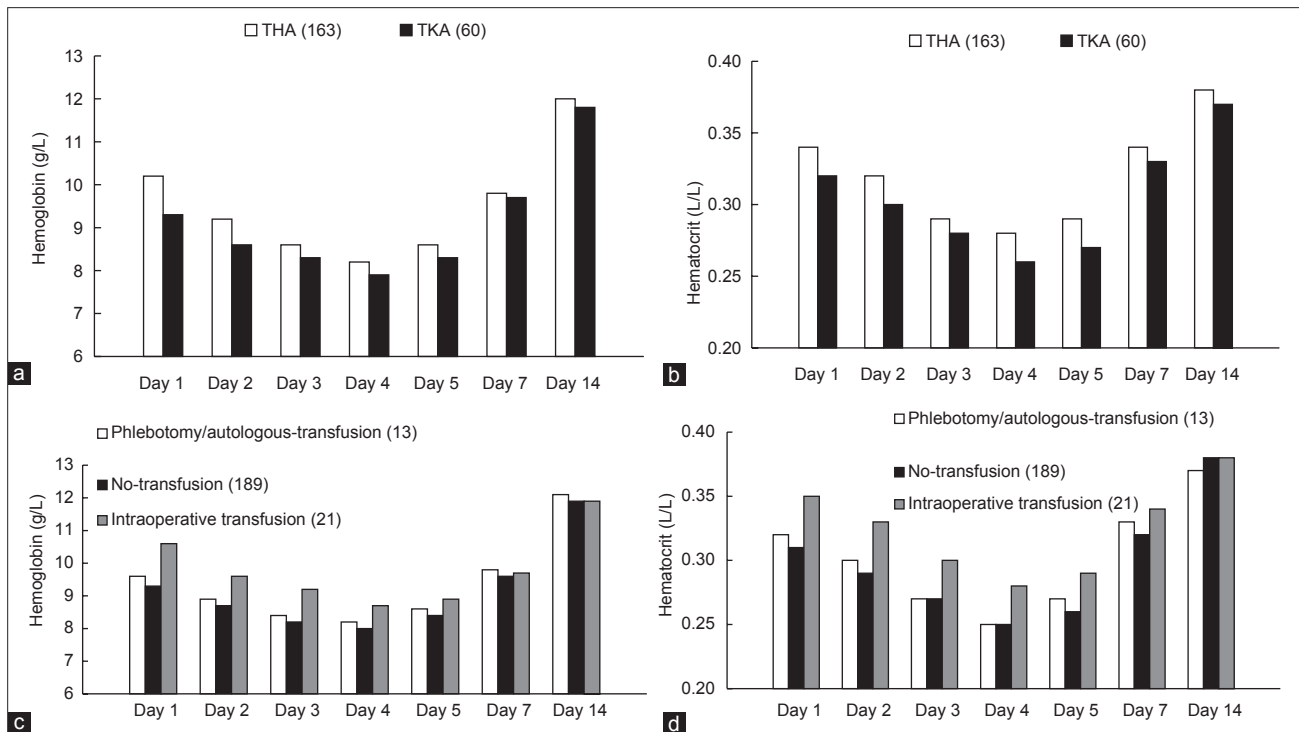


Figure 2: Comparison of postoperative hemoglobin (Hgb) (a) and hematocrit (Hct) (b) levels, in patients undergoing total hip arthroplasty and total knee arthroplasty. Comparison of postoperative Hgb (c) and Hct (d) levels between phlebotomy/autologous-transfusion, no-transfusion and intraoperative-transfusion.

should be extended to at least POD 4 or the occurrence of the lowest Hgb level. Our results demonstrate that postoperative hidden blood loss is greater than that previously reported in the literature. Figure 1 demonstrates that postoperative Hgb and Hct levels had fully recovery by POD 7. It is possible that because of postoperative erythrocyte loss, bone marrow proerythroblasts proliferate and differentiate into mature erythrocytes, which take approximately 5 days to occur. Thus, POD 4 is the time point of the greatest concern in postoperative clinical management.

As shown in Figure 2a and 2b, patients undergoing THA and TKA had significantly different postoperative Hgb and Hct levels on POD 1. We infer that the larger cut surface of bone and wider opening of the bone bed in TKA patients may account for greater erythrocyte loss than in THA patients.^[5]

Figure 2c and 2d show that after THA and TKA, the intraoperative-transfusion group had significantly higher postoperative Hgb and Hct levels than the groups with no-transfusion and the phlebotomy/autologous blood-transfusion groups within the first four POD ($P < 0.01$ for both comparisons). This demonstrates that intraoperative-transfusion in anemic patients is effective for improving postoperative levels. Although postoperative Hgb and Hct levels were slightly higher in the phlebotomy/autologous blood-transfusion group than in the no-transfusion group, the difference was not significant. That is, preoperative phlebotomy combined with autologous blood transfusion has little effect on postoperative Hgb

and Hct levels. Until POD 5, 7, and 14, postoperative Hgb and Hct levels were not significantly different among the three groups, possibly related to the maturation cycle of pronormoblasts. In patients with substantial loss of erythrocytes, proliferation and differentiation of more bone marrow pronormoblasts may be initiated.

In summary, we conclude that there is a clear pattern of changes in postoperative Hgb and Hct levels in patients undergoing primary THA and TKA. Understanding this pattern may assist physicians in predicting clinical trends in the recovery process and enable them to take timely, effective measures to reduce complications.

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