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Perioperative Blood Loss during Primary Total Hip Replacement. Standardisation of Practice

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Abstract

Background: The reduction of intraoperative blood loss rate during total hip replacement is dependent on many factors

Material: In a review of a consecutive 355 primary total hip performed by four orthopaedic surgeons in a six-month period, 7% required blood transfusion; the confounding factors among patients who received blood transfusion were studied and changes were introduced. A year later another 268 patients underwent total hip replacement, blood transfusion rate after introducing the changes became 3.2%. To analyse the confounding factors further, one hundred patients who had a primary total hip replacement and did not receive an allogenic blood transfusion was consequentially selected from each group of patients to analyse the confounding factors before and after the introduction of changes.

Results: The rate of blood loss varied between the four surgeons among patients received blood transfusion in both groups. There was a lack of consistency in the utilization of the cell saver and the tranexamic acid. High ASA grade, low preoperative Haemoglobin, the coexistence of cardiac diseases had an impact on the amount of blood loss during total hip replacement. High BMI did not seem to affect the rate of blood loss.

Conclusion: Standardization of the practice by increasing the use of cell saver and parenteral and local Tranexamic acid and optimization of preoperative haemoglobin and cardiac disease will undoubtedly reduce the rate of blood loss and transfusion. The impact of surgeon's technique on the mean Hb drop was statistically significant, mean blood loss however remained within the national average.

Keywords: Total; Hip; Replacement; Blood; Loss

Introduction

There is a high prevalence of blood product transfusions in orthopaedic surgery. The reported prevalence of red blood cell transfusions in unselected patients undergoing total hip replacement (THR) or knee replacement varies between 21% and 70%. Low preoperative haemoglobin levels, low body mass index, and long duration of operations is associated with an increase the risk for red blood cell transfusion [1,2]. A retrospective analysis of all patients undergoing THA surgery over 12 months has shown that pre-operative haemoglobin and haematocrit levels and high ASA (American society of anaesthesiology) are valuable predictors of patients requiring blood transfusion [3]. The identification and optimization of preoperative low haemoglobin, the introduction of new drugs like Tranexamic acid, meticulous surgical technique and the use of cell saver have reduced the rate of perioperative blood transfusion. Recent studies reveal that the prevalence of red blood cell transfusion was lower than previously reported. In a paper, the overall transfusion rate was 16% (18% in hip patients and 11% in knee patients, $p = 0.19$). The median estimated blood loss was significantly higher in hip patients (984 *vs* 789 ml, $p < 0.001$). The average peri-operative haemoglobin drops following total hip replacement is estimated to be 30 g/L (1-5). The post-arthroplasty transfusion protocol agreed on to be adhered to includes patients' post-operative haemoglobin of less than 80 g/L, symptomatic patients in the presence of cardiovascular disease. Intra-operative

blood management strategies include maintenance of body temperature, meticulous use of diathermy, reduction in operative time and administration of intravenous tranexamic acid [4]. The current study investigates the confounding factors having an impact on blood loss and transfusion during and following total hip replacement.

Material and Methods

In a quality improvement project of two parts, the rate of blood transfusion and the drop of hemoglobulin following primary total hip replacement among four surgeons were conducted in two parts. The study focussed on the confounding factors affecting the haemoglobin drop and the rate of blood transfusion following primary total hip replacement. The first part of the project was investigating what the blood loss was, investigated it, introduced some changes, and reassessed the findings after the introduction of the changes. We calculated the number of primary total hip replacement and the rate of blood transfusion between October 2021 to February 2023, 355 total hips replacements conducted, in the department; among these patients only twenty-five patients received postoperative blood transfusion (7%). To investigate this further, one hundred patients who did not receive blood transfusion were consecutively chosen between 2021 and 2022: 25 patients from each surgeon. The surgical approaches used were, anterior, modified Harding approach and the remaining two surgeon were using posterior approach. The following patients were excluded from the study; patients who underwent bilateral THR and revision hip replacement.

The following areas were studied in those patients who received blood transfusion. The estimated blood loss calculated in the operating theatre, from the cell saver (when used), the weight of the swab, the input and output of fluid, the suckers. Preoperative and first postoperative haemoglobin check. Postoperative haemoglobin check was performed using portable hemoglobinometer in the recovery of theatre and evaluated later first postoperative day and later on. The intraoperative and local administration of Tranexamic acid. The type of the total hip replacement (cementless, hybrid and cemented total hip replacements), the approach, The ASA grade and the BMI, A record of preoperative use of anticoagulant and anti-platelet, and the record of any existing cardiac diseases. The findings were discussed in the governance meetings and some plans were introduced following data collection and interpretation to reduce blood loss. In the second part of the study, which was conducted between Aug 23 and June 2024, 248 patients underwent primary total hip replacement, eight patients among which received blood transfusion (3.2%) in the postoperative period. All the confounding factors affecting the rate of blood loss was again studied. To study this further and correlate the blood loss to the four surgeons with similar number of patients for each surgeon, 100 consecutive patients during the same period was collated to investigate the confounding factors related to blood transfusion, none of these patients received blood transfusion, the total blood loss, the mean HB drop was collated. The medical electronic records of all patients were studied using the computerised patient records and the records from blood transfusion unit. The data was collated.

Results

The first part of the study: The mean age of the patients was seventy-five, male to female of the patients in 0.87. The procedure was performed under spinal anaesthesia in 90% of patients. Cemented total hip replacement was performed in 80% of cases, hybrid total hip replacement in 15% and in 5% the prosthesis was uncemented. Surprisingly the Hb drop was higher in patients who have had hybrid total hip replacement, compared to cemented and uncemented THR; this was however not statistically significant. The preoperative cardiac history and preoperative anticoagulation were a contributing factor in the decision making of blood transfusion, with lower threshold to transfuse in patients with ischemic heart disease. (Tables 1-3) and (Figures 1 and 2), provide a summary of the patients' demographic.

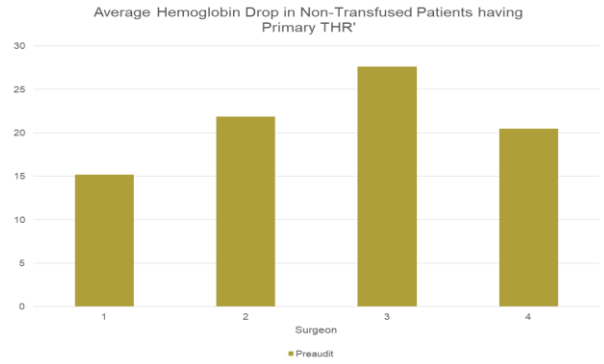

Figure 1: *Average HB drop in the non-transfused patients.*

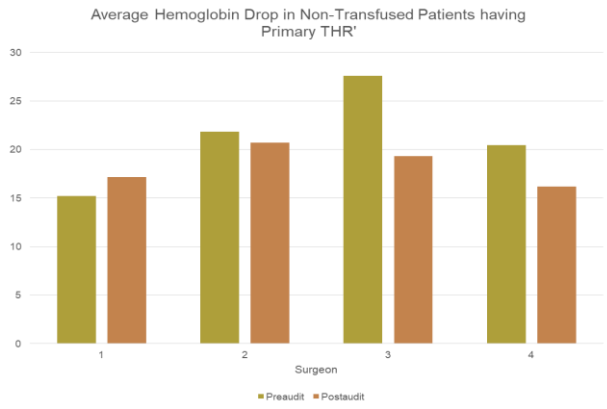

Figure 2: *Mean HB drop in the non-transfused patients comparing the surgeons in the first.*

Table 1: *The impact of the use of TXA and cell saver in each part of the transfused group.*

Assessment	Pre-audit Transfused	Pre-audit non-transfused	Post-audit transfused	Post-audit non-transfused
Cell Saver use	Forty-eight percent Used. Fifty-two percent not used	Not assessed	Seventy-five percent used. Twenty-five percent not used	67.6% used. 31.4% used
Local TXA	Sixty percent used. Forty percent not used	Not assessed	100% used	Seventy-eight percent used. Twenty-two percent not used

Table 2**:** *The correlation of mean Hb drop and the rate of transfusion in both groups***.**

Surgeon	Hg Drop Pre-audit	HG Drop Post-Audit
1	15.2	17.2
2	21.9	20.7
3	27.6	19.3
4	20.45	16.2

Table 3: *The rate of transfusion among the surgeons in both group.*

Surgeon	Transfusion % Pre-Audit	Transfusion % post-audit
1	1.9	5.26
2	3	0
3	13.7	4.1
4	11.9	0

Demographic findings of the twenty-five patients who received blood transfusion: In seventeen patients the preoperative Hb was less than 13g/dl. Two patients had chronic anaemia and Hb% was below 120g/d. Four patients received Iron treatment because of low Ferritin preoperative level, one of which had parenteral as well as oral treatment, the remaining had only oral. The ASA grade was high in patients who received blood transfusion. There was history of a coexisting cardiac disease in twenty-two patients. Regarding BMI, those who received blood transfusion had a mean BMI of less than 30; BMI did not seem to affect the blood transfusion rate. Cell saver was used for twelve patients in the transfused group (48%). Forty percent of patients received postoperative blood transfusion, did not receive local Tranexamic acid, but they did receive intravenous Tranexamic acid (Figure 2).

Cell saver

The objective is to use the cell saver for all patients, 100% target has not been achieved because of the lack of trained staff operating the cell saver machine. Only 67.6% of non-transfused patients received cell saver. Cell saver was used in 80% of patients with a preoperative haemoglobin of <12gm/dl.

Tranexamic acid

Local and systemic Tranexamic acid was used in all the transfused group in the second cycle compared to 60% utilisation in the first cycle. Systemic TXA was used in all patients unless contraindicated.

Hb drop

The haemoglobin drops in the non-transfused total hip replacement varied among surgeons; the mean drops of postoperative haemoglobin compared to preoperative haemoglobin was higher among those with higher blood loss. Two surgeons had slightly higher blood loss and haemoglobin drop than the remaining. Tables 2-4, demonstrate the results and data analysis. Surgeons and approach: Two surgeons had higher mean blood loss during surgery one using modified Hardinge and the other one using posterior approach. The average blood loss however remained within the national reported average blood loss. There were no postoperative complications in this series.

Changes introduced after the first part of the study

The following changes were introduced to reduce the blood loss during primary total hip replacement and in the second part of the study.

- Liberal use of cell saver at 100% target for all primary total hip replacement operations regardless of the Hb%
- Ensuring that consistently intravenous and local Tranexamic acid is used for every patient.
- The infiltration during the procedure a mixture of 100ms of saline 50mg of bupivacaine and mg Adrenaline
- Meticulous surgical technique with liberal use of haemostasis.

The completion of the audit cycle:

The outcome noticed in the transfused patients (8 patients) following the introduction of the proposed changes were as follows:

Cell saver

The cell saver was used in the second part of the study (70% of patients compared to the first part of the study which had 60% cell saver usage). In 80% of patients with Hb% less than 120g, and in 20% of patients with Hb% of more than 140g/dl. When cell saver was used, the postoperative drop of Hb was 16.7 g/Dl, which was better than when the cell saver not used (19.130 g/DL). The lack of trained staff in using the cell saver was the main reason for not using the cell saver for all the patients. The average Hb drop in the postoperative period was better in the second part of the study in all but one surgeon. The mean drop of Hb in the second part of the study was less than the first part of the study. Three percent compared to 7%. The frequency of local Tranexamic acid injection utilization increased from 60 to 100% in the transfused group and 78% of the non-transfused patients. There was a significant increase int use of local infiltration and IV TXA used in the second group [table 1]. The mean Hb drop among surgeon varied among the two parts of the study with some improvement among those who had higher blood loss and deterioration among those who had less blood loss in the first part of the study [Table 2]. The rate of blood transfusion among surgeon varied in the end part of the study [table 3]. In this data the significance of haemoglobin drop among the four arthroplasty surgeons was determined using analysis of variants (ANOVA). The same statistical analysis was used for cemented, cementless or hybrid total hip replacement and the impact on haemoglobin drop. Equality of variance was assessed, and T-test was used to ascertain whether the discrepancy between pre and postoperative haemoglobin, which statistically was significant. All statistical analysis was performed using statistical package for social science (SPSS, version 25.0).

Discussion

The complications of blood transfusion are a drive to reduce the rate of blood transfusion during and after surgery. Complications are transfusion-induced immunosuppression, febrile reactions. Anaphylaxis, transfusion related acute lung disease. Graft vs host reaction, cost, increased hospital stays and possible joint infection after artificial joint replacement [5]. Approximately 90% of blood loss occurs between skin closure and the first postoperative 24 hours. “Intraoperative blood loss” and “transfusion rate” are not reliable markers of total blood loss. Some factors, however, are contributing to the blood loss and the rate of blood transfusion [5]. The use of tranexamic acid (TXA) in total hip replacement (THR) typically reduces blood loss by approximately 400 mL, and typical total blood loss is still approximately 1 L. The total blood loss during surgery was calculated using the reduction of haematocrit. After 24 and 48 hours of surgery. In a study it was found that the blood loss was 1505, in the second postoperative day, for hip replacement [5].ASA grade is considered significant predictive factor for requiring post-operative transfusion [6]. The higher the grade, the more likely, the patient needs blood transfusion. Although transfusion is often related to increased morbidity and mortality, it is difficult to establish causation. Often, these patients may be pre-disposed to poorer outcomes due to their pre-operative co-morbidities [7]. Conversely, in patients with cardiac disease and anaemia, transfusion has been shown to improve survival [8]. Other studies have shown no difference in mortality rates between patients, regardless of background, undergoing transfusion [9]. In addition to correcting anaemia, other factors which may impact the amount of blood loss, is the pressure and tidal volume of ventilator should be adjusted to decrease the mean intrathoracic pressure because positive pressure ventilation under general anaesthesia may have an adverse effect on venous return [9,10]. Intraoperative hypothermia may increase bleeding by reducing platelet function and enzyme activity in the coagulation cascade, the maintenance of normal body temperature. Intraoperative temperature is important to keep the record of [10]. Controlled hypotension technique reduces blood loss by decreasing blood extravasation and local wound blood flow, patients with coronary artery disease are exemption for controlled hypotension [11]. Central neuraxial blocks such as spinal and epidural anaesthesia are known to have blood saving effects by decreasing sympathetic tone and venous tone, and their effects last until postoperative period [1] [10-15]. Local anaesthesia can reduce the need for transfusion and complication rates (e.g., postoperative mortality, thromboembolic events, pneumonia, respiratory depression, myocardial infarction, renal dysfunction) [16].

Intraoperative blood loss can be collected and processed for re-use using RBC salvage and re-infusion system [9]. Cell saver, one

intraoperative autologous transfusion technique in which drained blood is collected, washed, and reinjected, can also be considered. Cell saver is a reinjection technique in which the drained blood is filtered to remove haemolyzed cells, free haemoglobin and other impurities and washed for reinjection [17]. The use of cell saver protects patients and decreases the need for total RBC transfusions since the patient's own blood is being transfused by collecting intraoperative blood loss [17]. The early diagnosis and treatment of intraoperative coagulopathy is crucial to reduce blood loss. Point-of-care testing is useful for early diagnosis because several haemostasis-related factors can be identified at the bed side; fresh frozen plasma or fibrinogen concentrate can be used for treatment as needed [16,17,18]. The utilization of cell saver for every patient requiring total hip replacement is recommended to patients with preoperative HB of 120g/dl or less. However, in an ideal world and unless there is a contraindication, it should be used for everyone regardless of cost issue, it is said to be cost effective (19). The administration method and intraarticular injection of tranexamic acid (TXA) can significantly reduce bleeding volume [17]. In addition to TXA, the appropriate use of topical haemostasis agents can also be effective at reducing bleeding. Pre- and post-operative anaemia is common, and “the 10/30 transfusion trigger rule” was empirically applied in the past. Transfusion is given when there is a transfusion trigger (i.e., haemoglobin level below 10 g/dL or a haematocrit level below 30%). However, this rule does not always apply in clinical practice since it is outdated and lacks straightforward evidence. Carson et al. Suggested that there is no need to use this conventional rule since there was no difference in mortality and morbidity of cardiovascular disease between a group of patients undergoing transfusions at haemoglobin levels of less than 10 g/dL compared with those undergoing transfusions at a haemoglobin level of 8 g/dL [18]. According to the National Institute for Health and Clinical Excellence (NICE) guidelines, an RBC transfusion should be considered when haemoglobin levels are less than 7 g/dL; transfusions are also permitted in patients with cardiovascular disease if their haemoglobin concentration is less than 8 g/dL. However, patients with chronic anaemia should be assessed individually. Platelet transfusion is considered for patients who are associated with severe bleeding, or a platelet count of less than 50×109/L and undergoing surgery expected to have blood loss. Fresh frozen plasma should only be used to replace a single coagulation factor deficiency when abnormal findings are confirmed in coagulation tests and heavy bleeding occurs [18]. The haemoglobin drop was higher in the hybrid total hip replacement; however, the number of these cases were not high enough to draw a solid conclusion.

Conclusion

Preoperative Haemoglobin and Surgeon are influential factors in blood transfusion, Haemoglobin should be done and documented in notes prior to commencement of blood transfusion in order to exclude other causes of hypotension 3-Cell Savers and combined IV and LI Tranexamic acid should be utilised especially in anaemic patients

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Declaration of interest

None

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