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Is there a need for routine post-operative hemoglobin level estimation in total knee arthroplasty with tranexamic acid use?

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ABSTRACT

Background: Total knee arthroplasty (TKA) can result in significant blood loss, leading to a need for blood transfusion. The major indication of transfusion is post-operative hemoglobin (Hb) levels in association with symptomatic anemia. The aim of this study was to determine the possibility of eliminating routine post-operative Hb tests in patients undergoing TKA with intra-articular tranexamic acid (TXA) use based on the predictability of pre-operative factors.
Methods: We conducted a retrospective analysis of 487 patients who underwent TKA with intra-articular TXA use. Statistical analysis was done to predict the transfusion risk based on multiple pre-operative parameters.
Results: Post-operative blood transfusions were required in 2.5% of all patients. Pre-operative-Hb was the only significant predictor of post-operative transfusion ($p < 0.0001$). Age, sex, weight, height and body mass index (BMI) were not related to post-operative transfusion risk. Transfusions were needed in 4.2% of patients with pre-operative Hb levels < 14 g/dl. No patient with a pre-operative Hb > 14 g/dl required a transfusion ($p < 0.0001$).
Conclusions: Pre-operative Hb is a strong predictor of post-operative blood transfusion risk. Patients who receive TXA in TKA, with a pre-operative Hb > 14 g/dl do not require routine post-operative Hb evaluation.
Level of evidence: IV

1. Introduction

Significant blood loss of more than 1.5 l, requiring post-operative transfusions has been reported to be associated with total knee arthroplasty (TKA) [1–3]. One of the methods to quantify surgical blood loss involves evaluating the decrease in hemoglobin (Hb) levels post-operatively compared to the pre-operative levels. Post-operative Hb levels along with clinical symptoms are used to assess the need for transfusion.

The Australian National Blood Authority guidelines recommend appropriate use of red blood cell transfusion with Hb level of < 7 g/dl. A single unit of red blood cells for Hb levels between seven and 10 g/dl is recommended if there is associated acute myocardial or cerebrovascular ischemia. Blood transfusion is not advised if the Hb level is ≥ 10 g/dl and is considered inappropriate for post-operative Hb levels more than eight grams per deciliter in the absence of acute myocardial or cerebrovascular ischemia [4].

Multiple pre-operative risk factors such as age, weight, pre-operative Hb and lateral retinacular release are known to predict transfusion after TKA [5]. Multiple other studies have reported low pre-operative Hb to be a predictor for post-operative blood transfusions [6–9]. One of the methods to decrease the risk of post-operative transfusions is to optimize the pre-operative Hb. However, not all patients need to be optimized to the same pre-operative Hb levels to avoid transfusion [10]. This is especially true when using tranexamic acid (TXA), which has been shown to decrease both blood loss and transfusions in TKA [11–13].

TXA is an antifibrinolytic which reduces bleeding by preventing plasminogen activation, achieved by binding to plasminogen and plasmin and preventing fibrin degradation [14]. Both the intra-articular and the intravenous routes are now known to be effective [15–18].

Routine venipuncture to assess post-operative Hb is an accepted standard of care for most surgical units following TKA, and is performed usually on the first, and sometimes the second post-operative day. However, its role as a routine test has never been questioned with modern arthroplasty techniques. Thus, with the established role of TXA in decreasing blood loss, this study was undertaken to analyze the possibility of eliminating routine post-operative Hb tests, based on the predictability of transfusions by pre-operative patient factors.

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2. Material and methods

We performed a retrospective review of a consecutive group of patients who underwent primary, unilateral TKA with the use of intra-articular TXA over a four year period. Ethics approval was obtained prior to the review. All the patients underwent surgery at the same institution. All operations were performed by two fellowship trained arthroplasty surgeons.

All the patients underwent surgery by a medial parapatellar approach. Most of the surgeries were performed under a spinal anesthetic with sedation, while general anesthesia was only performed if there was a contra-indication to regional anesthesia. Tourniquet was used for all surgeries during the initial soft tissue exposure, and was deflated after the first bone cut was made. All the patients received posterior stabilized cemented implants with resurfacing of the patella.

All the patients received 3000 mg of TXA at the end of the surgery following wound closure by injection through an intra-articular pain catheter. This was inserted into the knee joint prior to the arthrotomy closure. The pain catheter was removed the following day after one single 50 ml bolus dose of Ropivacaine 0.2% injection. This technique has remained consistent throughout. Deep surgical drains were not used.

Hb levels were performed for all patients on post-operative day 1 and day 2. Transfusions were given based on the Australian National Blood Authority guidelines [4].

The pre-operative data collection also included patient's age, sex, height, weight and body mass index (BMI). Statistical analysis was done using SPSS V22 for Windows. The unpaired t-test was used to compare means between groups (e.g., transfused and not transfused). Fisher exact test was used to assess differences in categorical data. Univariate analysis and logistic regression analysis was done to calculate predictors of post-operative transfusion requirements (Table 1). p-Value <0.05 was taken as significant.

3. Results

A consecutive group of 487 patients were reviewed. The mean age of patients in the study was 68.1 years. The mean weight of the study population was 84.8 kg and the mean height was 1.67 m. The study population consisted of 292 females and 195 male patients.

Mean day 1 post-operative Hb level was 11.93 g/dl and the mean day 2 post-operative Hb level was 11.19 g/dl. Mean pre-operative Hb for patients who were transfused was 11.53 g/dl, compared to 13.81 g/dl, in patients who were not transfused (Fig. 1).

Blood transfusion was required in 12 (2.5%) of the 487 patients. Only pre-operative Hb was found to be a significant predictor of transfusions in both the univariate and multiple logistic regression models. Age, sex, height, weight and BMI did not predict the need for transfusion.

Pre-operative Hb was further analyzed and the risk calculation showed that for each 0.1 g/dl increase in pre-operative Hb, the odds of transfusion decreased by approximately 11% (Odds ratio = 0.88, 95% confidence interval = 0.84 to 0.93).

Predictive probability values were then calculated and a probability graph was plotted. The graph demonstrates a significant inverse relationship with increasing pre-operative Hb and blood transfusion ($p < 0.0001$).

Comparison of post-op Hb to pre-op Hb groups is depicted in Fig. 2.

The rate of transfusion was 2.1% with pre-operative Hb >10.0 g/dl, 1.7% for Hb >11.0 g/dl, 0.5% for Hb >12.0 g/dl, 0.3% for Hb >13.0 g/dl and 0% with Hb >14.0 g/dl. No patient with pre-operative Hb >14.0 g/dl (204 patients), received a blood transfusion. In the two of 421 patients (0.5%) needing transfusion who had a pre-operative Hb >12.0 g/dl, the lowest recorded post-operative Hb level was 8.9 and 7.7 g/dl for each patient. For the patient transfused at post-operative Hb of 8.9 g/dl, there was a history of anterior wall myocardial ischemia, hence the decision to transfuse, so as to optimize the oxygen carrying capacity with associated medical complications and symptoms associated with anemia. For the patient with post-operative Hb of 7.7 g/dl, there were no associated cardiovascular problems, however the decision to transfuse was made by the treating physician who felt that they were clinically warranted.

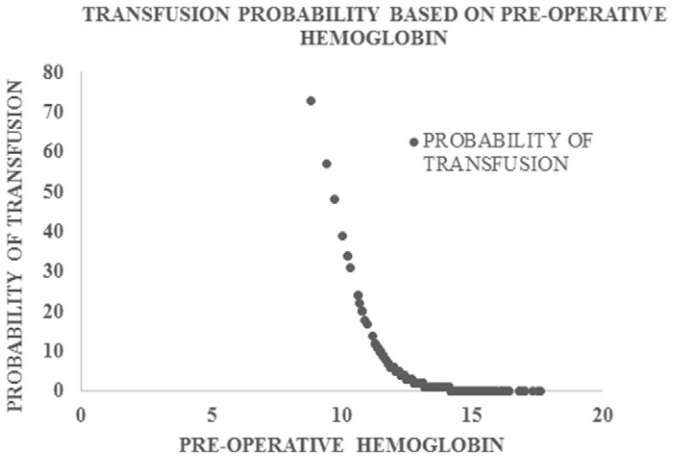

Fig. 1. Transfusion probability based on pre-operative hemoglobin.

Table 1
Univariate and logistic regression comparing different patient parameters to post-operative blood transfusions.

Parameter	Univariate p-Value	Logistic regression p-Value
Age	0.07	0.74
Sex	0.65	0.07
Weight	1.00	0.06
Height	0.21	0.05
Body mass index (BMI)	1.00	0.07
Pre-op hemoglobin	<**0.0001**	<**0.0001**

p-Value <0.05 is taken as significant.

4. Discussion

Despite the advent of newer methodologies, blood loss in TKA remains a significant problem. Prior to the introduction of TXA in TKA, blood loss of up to 1500 ml, with an approximate 3.85 ± 1.4 g drop in Hb has been reported [19]. Increased intra-operative bleeding can lead to swelling of the knee, pain, restricted motion of the knee and knee stiffness, along with a need for increased hospital stay and a possibility for transfusion. Complications of blood transfusions include transmission of bacterial and viral infections, immunosuppression, transfusion-related acute lung injury, anaphylaxis and death [12].

Multiple studies have discussed the predictors of post-operative blood transfusion after various surgical procedures. Ahmed et al. found patients' age at surgery ($p < 0.001$), pre-operative Hb ($p < 0.001$), weight ($p = 0.009$) and lateral retinacular release ($p < 0.001$) to be independent predictors of blood transfusion in TKA [5].

Yoshihara et al. identified the predictors of allogenic blood transfusion in total hip and TKA in a 10 year period and found age, female gender, race, weight loss and anemia amongst other factors as significant predictors [20].

Mesa-Ramos et al. found a statistically significant correlation between pre-operative Hb, hematocrit and erythrocyte count and the need for transfusion, with Hb level as the main predictor. They did not find any correlation with patients' age, sex, BMI, blood pressure or number of co-morbidities [21]. Our results are similar to this study, however we did not assess operative factors such as lateral retinacular release.

Pre-operative prediction is an important step in identification of at risk patients for blood transfusion following TKA. Modalities to decrease blood loss and therefore blood transfusion have considerably helped to decrease the overall financial burden on patients and the health sector [11,22,23].

TXA has been a significant contributor in decreasing blood loss and transfusion in TKA. Alshryda et al. undertook a randomized controlled trial of 157 patients who underwent unilateral primary TKA and found that intra-articular TXA reduced the absolute risk of blood transfusion by 15.4%, from 16.7% to 1.3%, and reduced blood loss by 168 ml [15]. A