The Journal of Arthroplasty 29 Suppl. 2 (2014) 189–192

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Predictors and Complications of Blood Transfusion in Total Hip and Knee Arthroplasty

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ARTICLE INFO

Article history:
Received 17 August 2013
Accepted 3 March 2014

Keywords:
total hip arthroplasty
transfusion
blood management
total knee arthroplasty
complications

ABSTRACT

Perioperative patient optimization can minimize the need for blood transfusions in patients undergoing total hip arthroplasty (THA) and total knee arthroplasty (TKA). The purpose of this study was to determine predictors and complications of transfusions. This retrospective review analyzed 1795 patients who underwent primary THA and TKA at our institution between January 2011 and December 2012. Of the 1573 patients ultimately included the rates of transfusion were 9.27% in TKA and 26.6% in THA. Significant predictors for transfusion include: preoperative hemoglobin, age, female gender, body mass index, creatinine, TKA, operating room time, operative blood loss, and intra-operative fluids. The DVT rate was comparable, but deep surgical site infection rate among transfused patients was 2.4% compared to 0.5% in non-transfused patients ($P = 0.0065$).

Total hip and total knee arthroplasty (THA and TKA) are among the most common and successful orthopedic surgical procedures performed today. Their frequency is only expected to increase in the coming decades with growth projections nearing 137% and 601% for THA and TKA between 2005 and 2030 [1]. Increased focus has been directed toward peri-operative complications including blood loss and the decision regarding when to transfuse patients throughout the perioperative period. Blood transfusion is not without risks, including the potential for blood-borne infection, allergic reaction and transfusion reactions [2–4]. Furthermore, red blood cell (RBC) transfusion adds significant cost to the healthcare system [5–8] which will likely increase as demand continues to grow. Orthopedic procedures consume a significant portion of the donated blood supply with THA and TKA representing an estimated 4.6% and 1.6%, respectively, of all units transfused [9]. Previously published data have identified several potential predictors of transfusion in total joint patients, including: preoperative hemoglobin (Hgb) concentration, weight, age, estimated blood loss (EBL) and aspirin use [4,7,10–12]. Identification of predictors of transfusion will allow physicians to better optimize patients during the preoperative period in an effort to reduce the need for transfusion and its associated complications. The goal of this study is to identify both predictors and complications associated with blood transfusion in THA and TKA.

Methods

Under institutional review board (IRB) approval, a retrospective chart review was performed of clinical records from 1795 patients who underwent THA or TKA at our institution between January 1, 2011 and December 31, 2012. Data were collected from 6 fellowship trained surgeons at 2 academically affiliated hospitals. Five independent reviewers collected all data and performed extensive chart reviews. After excluding patients who underwent bilateral procedure, partial arthroplasty or revision surgery, a total of 1573 patients were ultimately included in the statistical analysis. Of the 1573 patients ultimately included in the study 949 patients underwent TKA and 624 patients THA.

Gender, age, body mass index (BMI), preoperative Hgb, preoperative creatinine, operating room time, estimated blood loss (EBL) and intravenous fluid (IVF) were examined for their relationship to blood transfusion in the perioperative period. Primary outcome variables related to complications included deep vein thrombosis (DVT), pulmonary embolism (PE) and infection. Patients received pharmacologic VTE prophylaxis beginning the morning after surgery with either enoxaparin (40 mg subcutaneous [SQ] daily for 21 days for THA patients, 30 mg SQ twice daily for 14 days for TKA patients) or rivaroxaban (10 mg oral daily for 35 days for THA patients, 10 mg oral daily for 12 days for TKA patients). Prior to February 2012, our institution administered enoxaparin for routine VTE prophylaxis after primary THA and TKA. In February 2012, our institution changed the VTE prophylaxis protocol to include the routine use of rivaroxaban. Patients with renal insufficiency are routinely placed on enoxaparin,

The Conflict of Interest statement associated with this article can be found at http://dx.doi.org/10.1016/j.arth.2014.03.048.

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http://dx.doi.org/10.1016/j.arth.2014.03.048
0883-5403/

due to the medical team's greater familiarity with this medication in these situations. Patients in both groups wore thromboembolism-deterrent stockings until 2 weeks post-operatively and wore intermittent pneumatic compression devices during their hospital stay. Both groups received 24 hours of post-operative antibiotics.

Logistic regression models were used to evaluate variables predictive of transfusion and a stepwise logistic model determined the best-fit multivariate model. A Wilcoxon two-sample test, a Spearman's correlation and a linear regression were used to analyze the number of units transfused. Chi-squared tests were used to analyze differences in complications among the transfused and non-transfused groups. A priori alpha (α) = 0.05.

Results

Currently there are a variety of criteria used for calculating preoperative risk for adverse cardiac and pulmonary events preoperatively, including the revised cardiac risk index (RCRI) and cardiopulmonary risk index. Rather than focusing on cumulative risk assessment, we focused on individual variables including: age, gender, BMI, pre-operative Hbg, and preoperative creatinine. The final study group was 66.3% female. The average age was 66.2 years [standard deviation (SD) = 10.71], BMI = 31.94 kg/m^2 [SD = 6.89], pre-operative Hgb = 13.17 mg/dL [SD = 1.53], creatinine = 0.95 mg/dL [SD = 0.89], OR time = 169 minutes [SD = 40], EBL = 180 mL [SD = 245] and IVF = 2052 mL [SD = 749] (Fig. 1).

Of the 1573 patients included in the study 949 patients underwent TKA and 624 patients THA. Eighty-eight (9.27%) TKA patients received a blood transfusion compared to 166 (26.6%) THA patients (Fig. 2). Significant predictors for transfusion are hemoglobin (odds ratio (OR) = 0.62 [95% CI, 0.53–0.76, P = 0.001]), age (OR = 1.45 [1.19–1.77, P = 0.001]), female gender (OR = 2.60 [1.55–4.43, P = 0.001]), BMI (OR = 0.84 [0.72–0.98, P = 0.027]). Also, preoperative creatinine (OR = 1.35 [1.05–1.74, P = 0.020]), TKA (OR = 0.39 [0.25–0.63, P = 0.001]), operating room time (OR = 1.25 [1.05–1.74, P = 0.029]), EBL (OR = 1.14 [1.06–1.24, P = 0.001]), intra-operative fluids (OR = 1.04 [1.01–1.07, P = 0.012]) were all found to be predictive of transfusion (Fig. 3).

	Number (N)	Transfusion	Rate (%)
Knee	949	88	9.27
Hip	624	166	26.6
Total	1573	254	16.2

Fig. 2. Overall transfusion rates among total hip and total knee arthroplasty patients.

Stepwise logistic regression modeling calculated the odds ratio for transfusion associated with each variable (Fig. 3). Deep vein thrombosis (DVT) rate was 1.99% and 2.27% in transfused and non-transfused patients, respectively and was not statistically significant (P = 0.938). However, the deep surgical site infection (DSSI) rate among transfused patients was 2.4% compared to 0.5% in non-transfused patients (P = 0.0065) (Fig. 4).

Discussion

Despite several studies reporting on transfusion rates in TKA and THA, there is substantial variability in reported rates. Rate for TKA ranges from 3 to 67% and for THA from 4 to 68% [2,4,7,12–15]. One reason for the extreme variability in transfusion rates may be associated with the relative lack of clear consensus regarding the appropriate indications for transfusion. At our institution, we transfuse patients who are symptomatic with hemoglobin less than 8 mg/dL and asymptomatic with hemoglobin less than 7 mg/dL. During the time period of our study, the clinical indications to transfuse packed red blood cells at our institution did not change, nor does it appear that the change in pharmacologic VTE prophylaxis to

	Number (N)	Mean	Standard Deviation
Female Gender	1001	66.3%	
Age (years)	1573	66.2	10.71
BMI (kg/m^2)	1573	31.94	6.89
Hemoglobin (mg/dL)	1484	13.17	1.53
Creatinine (mg/dL)	1465	0.95	0.89
Operating Room Time (min)	1568	169	40
Estimated Blood Loss (mL)	978	180	245
Intravenous Fluid (mL)	972	2052	749

Fig. 1. Demographic and patient characteristics included in the study population.