RESEARCH ARTICLE

Transfusion Rates in Total Hip Arthroplasty Are lower in Patients with Direct Anterior Approach

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Abstract

Background: Blood conservation and reduction in the need for allogeneic blood transfusion (ABT) has been a subject of importance in total hip arthroplasty. There are a number of well-recognized parameters that influence blood loss during total hip arthroplasty (THA). The role of surgical approach on blood loss and the rate of ABT during THA is not well studied. The hypothesis of this study was that blood loss and the need for ABT is lower with direct anterior (DA) approach.

Methods: In a case-control retrospective cohort study, we analyzed 1,524 primary THAs performed at a single institution by seven fellowship-trained surgeons between January 2015 to March 2017. All patients received THA using either the modified direct lateral (DL) or direct anterior (DA) approach using a standard operating table. The overall ABT rate was 10.2% (155/1,524) in the cohort. Demographic, surgical, and postoperative data were extracted and analyzed. Logistic regression was used to identify independent risk factors for transfusion.

Results: Higher preoperative hemoglobin (p<0.001), use of DA approach (p<0.016) and administration of tranexamic acid TXA, (p=0.024) were identified as independent factors which reduced the odds of ABT. Operative time (p<0.001) was associated with an increased odd of ABT, while age, BMI and type of anesthesia were not statistically significant.

Conclusion: Based on the findings of this study, direct anterior approach for THA appears to be protective against blood loss and reduced ABT rate, when controlling for confounding variables.

Level of evidence: III

Keywords: Total Hip Arthroplasty, Allogeneic Blood Transfusion, Blood Loss, Direct Anterior, Direct Lateral

Introduction

Total hip arthroplasty (THA) is a modern day marvel in alleviating pain associated with end-stage hip arthritis (1). However, blood loss during THA can be high, leading to the need for allogeneic blood transfusion (ABT). Traditionally, transfusion rates during THA have been reported to be up to 26%, with an average of 18% (2–5). However, with increased attention to blood conservation and the use of tranexamic acid (TXA) the transfusion rate has dropped to around 10% (6–8). Despite this reduction, numerous problems are still associated with ABT, including added cost per episode of care, hypersensitivity reactions, and increased incidences of postoperative infections, venous thromboembolism and all-time mortality (9–12).

Risk factors for blood loss and the subsequent need for ABT have been well studied (13–16). However, very few studies evaluating blood loss following THA have examined the influence of surgical approach. The direct anterior (DA) approach to the hip has recently gained popularity because of its potential for accelerated recovery, shorter hospital stay, low risk of dislocation, and early gait improvement (17–27). Previous work has demonstrated that the DA approach reduces ABT; however, those studies were conducted prior to routine TXA use and often did not control for confounding variables (28–30).

To our knowledge, there is no study evaluating whether surgical approach is an independent factor affecting the risk for ABT in the context of unilateral primary THA. The purpose of this study was to investigate the effect of surgical approach on ABT after controlling for confounding variables.

Materials and Methods

After Institutional Review Board (IRB) approval (IRB

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number: #08R.207), Patients` consent was received for the study. A retrospective study was conducted. All primary, unilateral THAs performed at a single institution from January 2015 to March 2017 were included and identified using a prospectively maintained institutional database. Only patients with complete dataset and a minimum 24-hour hospital stay were included. Patients who underwent simultaneous bilateral THA, conversion THA, hip resurfacing procedures,THA in dysplastic cases and THA for femoral neck fracture, or other diagnosis besides osteoarthritis were excluded. A total of 1,524 consecutive primary THAs qualified for inclusion. All THAs were performed by seven high-volume fellowship-trained surgeons at a large academic center. All seven surgeons exclusively performed either the DA or direct lateral (DL) approach on all of their cases; none used a posterior approach. The choice of the approach was based on surgeon's preference and training.

Patient demographics, preoperative diagnosis, surgical variables, blood transfusion data and postoperative complications were extracted. Complication data included in-hospital complications such as deep venous thrombosis (DVT) and pulmonary embolism (PE), and PJI. Only acute (< four weeks from surgery) PJI cases were included in our study. All patients with PJI met Musculoskeletal Infection Society (MSIS) (31) criteria for infection. The minimum follow-up for all cases was three months, so as to capture the post-operative complications investigated.

THA using both the DA and the DL approach is performed in supine position on a conventional operating table. The DA approach employed a modified Smith Petersen dissection that utilized the subfascial interval between the tensor fascia lata and the Sartorius (24). The DL approach used an anterior modified Hardinge, which includes elevating the anterior third of the abductor mechanism (32). Tranexamic acid, when administered, was given intravenously at 10mg/kg (or maximum 1g) dose within one hour prior to incision. Contraindications for the use of TXA were prior history of transient ischemic attack (TIA) or stroke, or history of cardiac or vascular stents. No patient received topical or oral TXA. All patients received uncemented femoral and acetabular components manufactured by Zimmer (Warsaw, IN, USA), DePuy (Warsaw, IN, USA) or Stryker (Mahwah, NJ, USA). Postsurgical drains were not used during the study period in any patient. Perioperative medical management was similar in all patients and included the use of non-steroidal anti-inflammatory drugs (NSAIDs) as part of a multimodal pain management regimen. Postoperative venous thromboembolic prophylaxis was administered to all patients which included aspirin (89.37%), warfarin (6.56%) or oral or subcutaneous agents such as apixaban, dabigatran, rivaroxaban or enoxaparin (4.06 %). Patients were transfused postoperatively if either (a) hemoglobin (Hgb) was below 7.0 g/dL or (b) Hgb was below 8.0 g/dL and concomitant symptoms such as tachycardia, low blood pressure and/or persistent nausea/vomiting after adequate hydration existed. The attending surgeon using the aforementioned criteria

ultimately approved the final decision for transfusion.

The various parameters between patients who did and did not receive a transfusion were compared and data analyzed using the Chi square tests for categorical variables and t-test for independent groups (or its non-parametric variant, the Mann Whitney U, where necessary) for continuous variables. Variables which significantly differentiated these groups at p < 0.1 were considered for inclusion as covariates in a multivariate logistic regression model predicting receipt of transfusion. Regression diagnostics were conducted to eliminate mutlicollinearity and determine the final set of covariates. The following predictors went into the final model: age, BMI (less than versus greater or equal to 30), Charlson Comorbidity Index (CCI, less than versus more than two comorbidities), preoperative hemoglobin, surgery duration, surgical approach (DA versus DL), anesthesia type (spinal versus general), and use of TXA. Note that an interaction term between surgical duration and approach was also included in the final model given DL approaches had significantly longer durations (Mdn = 80 min, IQR: 65-95, Z = -21.26, p<0.0001) than DA approaches (Mdn = 50 min, IQR: 41-65). Preliminary regression diagnostics indicated that BMI and CCI had to both been dichotomized and ASA had to be excluded from the final model to eliminate multicollinearity with age, BMI, CCI, preoperative Hgb, and surgical approach. All statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) version 23 (IBM Corporation, Armonk, NY). No funding was provided for this study.

Results

Overall, 567 patients (37.2%) received THA using the DA approach and 957 patients (62.8%) underwent THA using the DL approach [Figure 1]. The overall rate of ABT during the study period was 10.2% (155/1524). TXA was administrated to 67.1% of patients [Figure 1]. Patients receiving allogeneic transfusion were older, had a higher Charlson Comorbidity Index (CCI), higher ASA score, lower preoperative Hgb, received general anesthesia, underwent THA using the DL approach, were less likely to receive TXA, had a lower postoperative Hgb and had longer operative time [Tables 1, 2].

A multivariate logistic regression model was subsequently conducted to identify significant independent predictors of transfusion. After adjusting for other covariates, higher preoperative Hgb (p<0.001), DA approach (p=0.016) and the use of TXA (p=0.024) were identified as independent factors associated with reduced allogeneic blood transfusion [Table 3]. Longer operative time was independently associated with an increased risk of allogeneic blood transfusion (p<0.001).

In terms of observed postoperative complications, transfused patients had significantly longer hospital stay (3.65 days vs. 1.46 days, p<0.001) and were significantly more likely to develop an acute PJI (7/155 or 4.5%, p=0.004) than non-transfused patients 10/1369 (0.7%). No patient developed DVT in either group, and only one patient (0.6%) developed a PE who had also received ABT [Table 4].

Table 1. Demographics for transfused and not transfused patients

Demographic variables	Transfused patients (n=155)		Non-Transfused patients (n=1369)		p-value
Age (years)	67.43	11.51	63.90	11.09	0.000
BMI (kg/m²)	28.17	6.21	28.79	5.07	0.063
CCI	4.06	1.78	3.37	1.63	0.000
ASA					0.000
1	1	0.68%	59	4.52%	0.04
2	43	29.25%	581	44.45%	0.001
3	100	68.03%	650	49.73%	0.001
4	3	2.04%	17	1.30%	
Gender					0.73
Male	74	48.1%	681	49.7%	
Female	80	51.9%	688	50.3%	
Pre-op HGB(g/dL)	12.120	1.921	13.496	1.446	0.000

*The values are given as means and standard deviations or total numbers and percentages

Table 2. Surgical variables and outcomes for transfused and not transfused patients

	Transfused patients (n=155)		Non-Transfused patients (n=1369)		p-value
Surgical variables					
Anesthesia					0.001
Spinal	118	80.3%	1180	90.1%	
General	29	19.7%	130	9.9%	
Surgery Duration	92.58	42.76	71.13	24.45	0.000
Tranexamic Acid					0.002
Administered	86	55.5%	936	68.4%	
Not administered	69	45.5%	433	31.6%	
Approach					0.000
DA	29	18.7%	538	39.3%	
DL	126	81.3%	831	60.7%	
Post-op Variables					
DVT Prophylaxis					0.91
ASA	137	10,05%	1225	89,95%	
Warfarin	11	11%	89	89%	
Subcutaneous agent	7	11,29%	55	88,71%	

*The values are given as means and standard deviations or total numbers and percentages

Table 3. Adjusted multivariate logistic regression model predicting receipt of transfusion

Predictor	OR	95%CI Lower	95%CI Upper	p
Age	1.02	0.99	1.04	.18
BMI of 30 or greater	0.77	051	1.16	.21
CCI greater than 2	0.89	0.48	1.64	.70
Preoperative hemoglobin	0.64	0.56	.73	.000
Spinal anesthesia (versus general)	0.78	0.46	1.33	.36
TXA administered	0.63	0.42	.94	.024
Duration of surgery	1.01	1.01	1.02	.000
DA approach (versus DL)	0.22	0.06	.75	.016
Duration of surgery by DA approach	1.01	0.99	1.03	.07

OR = odds ratio; CI =confidence interval; CCI = Charlson Comorbidity Index

Table 4. Postoperative outcomes

	Transfused patients (n=155)		Non-Transfused patients (n=1369)		p-value
Post-op Hgb(g/dL)	7.745	1.487	10.335	1.411	0.000
LOS (days)	3.65	3.54	1.46	1.19	0.000
Acute PJI	7	4.5%	10	0.7%	0.004
In-hospital DVT	0	0.0%	0	0.0%	-
In-hospital PE	1	0.6%	0	0.0%	0.10

*The values are given as means and standard deviations or total numbers and percentages
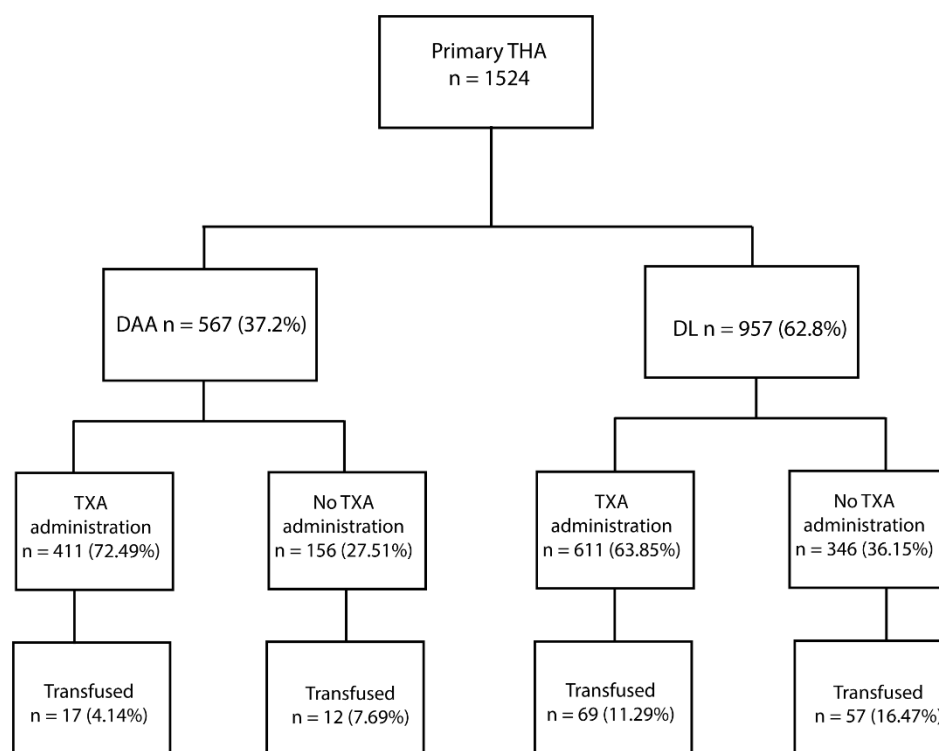
Figure 1. Transfusion rates by approach and TXA administration

Discussion

The adverse effects of allogeneic blood transfusion are well recognized (3,4,10). Blood transfusion is associated with increased mortality, increased infection rates, longer lengths of stay, and higher total charges (3,4,10). Perhaps one of the worst complications after THA is periprosthetic joint infection (PJI) (33–35) and all efforts to reduce its occurrence should be undertaken. Our study results were consistent with previously reported literature that patients receiving ABT demonstrated an increased risk of PJI (36). The current transfusion rate of 10%, despite the routine use of TXA, has marked implications on the potential number of future PJIs. Therefore, all attempts at minimizing transfusion should be undertaken.

A recent randomized prospective study (RCT) demonstrated that the DA surgical approach had significant early functional benefits compared to a mini-posterior approach (37). Reasons for this may be that this approach is a true intermuscular/ internervous approach; therefore, there is less muscle splitting or transection which itself preserves circulation and leads to less bleeding. In a study by van Oldenrijk et al. (38), the DA approach showed less tissue damage compared to other approaches. Furthermore, the DA approach has the least amount of adipose tissue between the skin and the hip relative to other approaches (39). This decreases tissue involvement and reduces the amount of tissue transection. These are perhaps the same reasons for the improved early function after DA THA and may be why previous studies on DA have reported less blood loss and allogeneic blood transfusion.

Alecci et al. (30) compared DA and DL approaches in primary THA and found a greater drop in hemoglobin and higher transfusion rate in the group of patients who underwent THA using the DL approach (40% compared to 19.5% in the DA approach); however, their analyses did not control for confounding variables. Parvizi et al. (28) performed a similar study comparing the same approaches but included use of a validated blood loss formula and multiple regression analysis to control for confounders such as surgical time. They also demonstrated a reduced blood loss and fewer transfusions in the DA cohort. Furthermore, the DA approach remained independently associated with less blood loss and fewer transfusions after covariate adjustment. However, both studies were conducted before the implementation of TXA.

TXA has drastically reduced blood loss and ABT and further evidence continues to demonstrate is safety (7,40). Currently, its use has become ubiquitous and considered standard of care. In the modern THA environment, one must question if surgical approach becomes irrelevant in the presence of TXA given the efficacy of this medication. The results of the study herein demonstrate that despite TXA use in the majority of patients, the DA approach was still independently associated with a decreased rate of ABT. Moreover, similar to the study by Parvizi et al. (28), the DA approach remained significant when controlling for surgical time.

The current study is not without limitations. First, and notably, is the retrospective design of the study and

potential bias in patient selection. One may argue that younger, healthier, and/or more active patients are "selected" for or may "seek out" the DA approach. In addition, some DA surgeons may prefer to use a more extensile approach such as DL or posterior for heavier patients. However, in the multivariate analysis age, BMI, and comorbidities were not significantly associated with the primary outcome. Furthermore, no patient was shunted away from DA given body habitus or weight herein. Second, the study included patients operated on by seven different arthroplasty surgeons and heterogeneity may exist among their criteria for ABT. Our institutional protocol for ABT is based on a consensus from the arthroplasty attendings, review of the current evidence, laboratory tests, and clinical symptoms. However, individual patient circumstances may have warranted a deviation from the protocol. Third, the posterior approach was not performed at our institution during the study period and therefore this approach could not be evaluated. Finally, follow-up was limited to hospital information documented in the electronic medical records; patients that required ABT after hospital discharge were not included.

Despite the aforementioned limitations, the DA surgical approach appeared to significantly reduce the need for ABT in patients undergoing primary THA even after controlling for confounding variables. As the association between ABT and PJI continues to be investigated, the reduction in ABT could be a significant benefit of the DA approach. In the era of value-based care, where minimizing patient complications is crucial, approach may be another important factor under the surgeons' control to reduce the risk of ABT.

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