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Original Article

Quantifying Blood Loss and Transfusion Risk After Primary vs Conversion Total Hip Arthroplasty

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ABSTRACT

Background: Primary total hip arthroplasty (THA) and conversion THA may result in substantial blood loss, sometimes necessitating transfusion. Despite the complexities of the latter, both are grouped in the same category for quality assessment and reimbursement. This study's purpose was to compare both blood loss and transfusion risk in primary and conversion THA and identify their associated predictors.

Methods: A total of 1616 patients who underwent primary and conversion THA at a single hospital from 2009-2013 were reviewed (primary THA = 1575; conversion THA = 41). Demographics, comorbidities, and perioperative data were collected from electronic records. Blood loss was calculated using a validated method. Transfusion triggers were based on standardized criteria. Separate multivariable regression models for blood loss and transfusion were performed.

Results: Conversion THA patients were younger ($P = .002$), had lower age-adjusted Charlson scores ($P = .006$), longer surgeries ($P < .001$), higher blood loss ($P < .001$), and more transfusions ($P < .001$). Primary and conversion THA groups were different in terms of surgical approach ($P < .001$), anesthesia type ($P = .002$), and venous thromboembolism prophylaxis ($P = .01$). Compared to primary THA, conversion THA had an average 478.9 mL higher blood loss ($P = .003$) and increased adjusted odds ratio of 3.2 ($P = .019$) for transfusion.

Conclusion: Conversion THA leads to higher blood loss and transfusion compared with primary THA. These differences were quantified in the present study and showed consistent results between the 2 metrics. The differences between these procedures should be addressed during quality assurance because conversion THA is associated with higher resource utilization, which is important in the allocation of resources and tiered reimbursement strategies.

Total hip arthroplasty (THA) is a common and successful surgical procedure that leads to improved function and quality of life [1,2]. Relative to primary THA, conversion THA is a more complex procedure because of having to remove existing and/or failed hardware. It is typically performed on patients who develop secondary osteoarthritis with hardware in place from a prior surgery, osteonecrosis, failed internal fixation and/or hemiarthroplasty, painful hip arthrodesis, or in hips that underwent surgery for a different pathology, such as a congenital deformity [3-12]. The potential problems associated with conversion THA, as opposed to primary THA, include femoral and acetabular bone defects [5,13], soft tissue deficiency [4], broken hardware [8,9,14], and an increased postoperative complications [15-17]. Furthermore, conversion THA has been shown to be associated with an increased use of hospital resources [18] and higher costs [12]. Although conversion THAs are technically more difficult procedures, they are grouped together with primary THAs under the same diagnosis-related group, which means they are considered to be similar in terms of the procedure and resource use [18].

Although primary THA can result in substantial perioperative blood loss, leading to increased morbidity and mortality [19] and delayed functional recovery [20], conversion THA has been associated with high blood loss, longer operative times, increased length of stay, and high transfusion rates [3,14,21,22]. Transfusion of allogenic blood is not uncommon in total joint arthroplasty [23-27], and have associated risks such as disease transmission

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[28,29], hemolytic transfusion reactions [29,30], transfusion-related acute lung injury [31], transfusion-associated circulatory overload [32], infections [33-35], and increased length of hospital stay and cost [36]. Consequently, efforts have been made to minimize and manage perioperative blood loss including preoperative correction of anemia [37], use of tranexamic acid [27,38], neuraxial anesthesia [39-41], and intraoperative blood salvage [26]. Methods to accurately predict total estimated blood loss during THA would be useful for better preparing perioperative blood management [42,43]. However, determining the total blood loss during THA is difficult because hidden blood loss can account for 26%-60% of the total loss [44-46]. Although studies have focused on risk factors associated with perioperative blood loss in primary and revision THAs [47,48], there is scant literature available on the blood loss and transfusion rates associated with conversion THA [16,22].

Blood loss studies are inherently difficult to perform because of the fact that there are a variety of metrics which can be used to evaluate blood loss (eg, estimation, calculation-based, transfusion requirements), none of which are exact and each one with its own set of assumptions [34,42,49-55]. The primary aims of this study were to compare both blood loss and transfusion risk in primary and conversion THA and identify predictors associated with each. We evaluated both outcomes to compare objective and subjective assessments of blood loss to learn if there are differences. We hypothesize that conversion THAs will be associated with higher blood loss and an increased transfusion rate compared with primary THAs.

Materials and Methods

Once institutional review board's approval was obtained, a query of the institution's electronic medical records was performed to identify patients who underwent primary and conversion THA completed at a single, large academic hospital between October 2009 and June 2013. A total of 1797 primary and conversion THA procedures were identified, and the patient's electronic records were manually reviewed. Patients were excluded because of incomplete data (n = 174), intraoperative death (n = 1), bilateral THA (n = 1), or preoperative transfusion (n = 5). A total of 1575 primary THA and 41 conversion THA were included in the study. The prior surgical procedures in the conversion THA group included hip fusion (n = 2), open reduction internal fixation acetabulum fracture (n = 4), open reduction internal fixation and aneurysmal bone cyst removal (n = 1), hip fracture (n = 20), osteotomy (n = 7), other surgery on acetabulum and femur (n = 1), screw fixation of a slipped capital femoral epiphysis (n = 2), and resurfacing (n = 4).

Patient demographic, clinical, and perioperative data were collected from electronic medical records and included the following: age, gender, body mass index (BMI), American Society of Anesthesiologists (ASA) score, age-adjusted Charlson comorbidity score (CCS), the presence of coronary artery disease (CAD), coagulopathies, hypertension, hyperlipidemia, antiplatelet and/or anticoagulant use, preoperative platelet count, preoperative and postoperative hemoglobin and hematocrit, procedure time, laterality, surgical approach, anesthesia type, type of acetabulum and femur implants, and whether or not they received a blood transfusion. Patients received a blood transfusion based on standardized criteria of a hemoglobin of 6.9 g/dL or lower or a hemoglobin less than 8 g/dL who, after receiving a fluid bolus, remain symptomatic and/or have a change in their vital signs [56]. The patient's preoperative estimated blood volume and total blood loss were calculated with use of the previously validated method described by Rosencher et al and Brecher et al [34,54].

Statistical Analysis

All statistical analyses were performed using SAS 9.4 software (SAS Institute, Cary, NC). Continuous variables were described using means, standard deviations, medians, and interquartile ranges. Categorical variables were summarized using frequencies and percentages. The 2-sample *t* test, or its nonparametric equivalent, the Kruskal-Wallis rank sum test, was used to evaluate the continuous variables. The Pearson chi-square test or Fisher exact test was used to assess the association between the categorical variables. To assess relationships between outcomes and primary THA vs conversion THA, separate multivariable regression models for blood loss and for transfusion were both adjusted for potential confounders including age, sex, BMI, ASA score, CCS, preoperative and postoperative hemoglobin and hematocrit, preoperative platelets, surgery time, CAD, coagulopathy, hypertension, hyperlipidemia, preoperative anticoagulants, surgical approach, anesthesia type, type of acetabulum and femur implants, and venous thromboembolism (VTE) prophylaxis. All testing was 2-sided. *P* values from analyses comparing subgroups were reported without adjustment for multiplicity. Final multivariable models were selected via backward selection. Relationships for blood loss were reported using regression coefficients and risk for transfusion using odds ratios (ORs). A *P* value of less than .05 was used to determine statistical significance.

Results

Univariate analysis of perioperative variables between the primary and conversion THA groups (Table 1) revealed that patients with conversion THA were significantly younger ($P = .002$), had lower CCS scores ($P = .006$), longer surgeries ($P < .001$), higher total blood loss ($P < .001$), and more blood transfusions ($P < .001$); patients with primary THA had a higher prevalence of hyperlipidemia ($P = .04$). There were also significant differences between primary and conversion THA patients in terms of surgical approach ($P < .001$), anesthesia type ($P = .002$), type of femur implant ($P < .001$), and VTE prophylaxis ($P = .01$).

A univariate analysis was performed for total blood loss (Table 2). The total blood loss for conversion THA was 855.8 mL higher than for primary THA ($P < .001$). Total blood loss significantly increased by increasing age (5.2 mL per year increase, $P = .001$), decreased by increased preoperative hemoglobin (−94.8 mL per unit increase, $P < .001$), decreased by increased preoperative hematocrit (−36.6 mL per unit increase, $P < .001$), decreased by increased preoperative platelets (−1.0 mL per unit increase, $P = .002$), increased by increased age-adjusted CCS (60.4 mL per unit increase, $P < .001$), increased by increased procedure time (6.4 mL per unit increase, $P < .001$), increased by increased ASA score ($P < .001$), and was significantly different in terms of surgical approach ($P = .028$), anesthesia type ($P < .001$), and the type of acetabulum implant ($P < .001$) and femur implant ($P < .001$).

A univariate analysis was performed for the risk of receiving a blood transfusion (Table 3). Conversion THA had OR of 4.71 ($P < .001$) for requiring a transfusion compared with primary THA. Other significant variables included age OR = 1.025, per year increase ($P < .001$), male gender OR = 0.48 ($P < .001$), BMI OR = 0.96 per unit increase ($P < .001$), preoperative hemoglobin OR = 0.53, per unit increase ($P < .001$), preoperative hematocrit OR = 0.78, per unit increase ($P < .001$), CCS OR = 1.23, per unit increase ($P < .001$), procedure time OR = 1.013, per unit increase ($P < .001$), ASA score ($P < .001$), CAD OR = 1.43 ($P = .022$), anesthesia type ($P < .001$), and type of acetabulum implant ($P < .001$) and femur implant ($P < .001$).

Multivariable logistic regression for total blood loss found conversion THA to have 478.9 mL higher total blood loss compared