The Journal of Arthroplasty xxx (2017) 1–8

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Original Article

Hematologic Malignancies Are Associated With Adverse Perioperative Outcomes After Total Hip Arthroplasty

Jared M. Newman, MD [a], Jaiben George, MBBS [a], W. Trevor North, MD [b], Suparna M. Navale, MS, MPH [c], Alison K. Klika, MS [a,*], Wael K. Barsoum, MD [a], Carlos A. Higuera, MD [a]

[a] Department of Orthopaedic Surgery, Cleveland Clinic, Cleveland, Ohio
[b] Department of Orthopaedic Surgery, Henry Ford Hospital, Detroit, Michigan
[c] Department of Epidemiology and Biostatistics, Case Western Reserve University, Cleveland, Ohio

ARTICLE INFO

Article history:
Received 23 December 2016
Received in revised form
14 February 2017
Accepted 3 March 2017
Available online xxx

Keywords:
total hip arthroplasty
hematologic malignancies
complications
length of stay
costs

ABSTRACT

Background: Advancements in treating hematologic malignancies have improved survival, and these patients may be part of the growing population undergoing total hip arthroplasty (THA). Therefore, the purpose of this study was to evaluate the perioperative outcomes of THA in patients with hematologic malignancies.

Methods: The Nationwide Inpatient Sample identified patients who underwent THA from 2000 to 2011 (n = 2,864,412). Patients diagnosed with any hematologic malignancy (n = 18,012) were further stratified into Hodgkin disease (n = 786), non-Hodgkin lymphoma (n = 5062), plasma cell dyscrasias (n = 2067), leukemia (n = 5644), myeloproliferative neoplasms (n = 3552), and myelodysplastic syndromes (n = 1082). Propensity matching for demographics, hospital characteristics, and comorbidities identified 17,810 patients with any hematologic malignancy and 17,888 controls; additional matching was performed to compare hematologic malignancy subtypes with controls. Multivariate regression was used to analyze surgical and medical complications, length of stay (LOS), and costs.

Results: Compared to controls, hematologic malignancies increased the risk of any surgery-related complication (odds ratio [OR], 1.4; $P < .0001$) and any general medical complication (OR, 1.47; $P < .0001$). Additionally, hematologic malignancies were associated with an increase in LOS (0.16 days; $P = .004$) and increased costs ($1,101; $P < .0001$).

Conclusion: Patients with hematologic malignancies undergoing THA have an increased risk of perioperative complications, longer LOS, and higher costs. The risk quantification for adverse perioperative outcomes in association with increased cost may help to design different risk stratification and reimbursement methods in such populations.

Hematologic malignancies encompass a wide range of pathologies [1–4]. The 2014 incidence rates per 100,000 in the United States were as follows: leukemia, 13; Hodgkin disease, 2.7; non-Hodgkin lymphoma, 19.7; plasma cell dyscrasias, 6.1; and myeloproliferative neoplasms, 4.9 [5]. A number of musculoskeletal manifestations may occur including bone pain, arthritis that can be the initial presenting symptom of hematologic malignancies [6], pathologic fractures [7], and osteonecrosis [8–13]. With a better understanding of hematologic malignancies and improved treatments, the 5-year survival rates for hematologic malignancies have significantly increased over the past few decades [5].

As this surviving population ages, patients with hematologic malignancies may be a part of the increasing annual population requiring total hip arthroplasty (THA) [14]. Among cancer survivors, patients with a history of lymphoma and leukemia have the highest risk of undergoing THA compared with the general population [15,16]. Osteonecrosis is a known complication of high-dose chemotherapy of hematologic

One or more of the authors of this paper have disclosed potential or pertinent conflicts of interest, which may include receipt of payment, either direct or indirect, institutional support, or association with an entity in the biomedical field which may be perceived to have potential conflict of interest with this work. For full disclosure statements refer to http://dx.doi.org/10.1016/j.arth.2017.03.002.

* Reprint requests: Alison K. Klika, MS, Department of Orthopaedic Surgery, Cleveland Clinic, Mail Code A41, 9500 Euclid Avenue, Cleveland, OH 44195.

http://dx.doi.org/10.1016/j.arth.2017.03.002
0883-5403/

malignancies, which may further increase the risk of THA in this population [11–13]. These patients may be predisposed to a number of complications after surgery as a result of immunosuppression and variations in blood cell counts [17]. Despite the trending growth in this patient population, the literature that describes the perioperative outcomes of patients with hematologic malignancies after THA is limited and reports on specific types of hematologic malignancies [18–20].

Whether or not these patients are at a significantly higher risk of adverse perioperative outcomes after such procedures has not been reported. Therefore, using a large national inpatient database, perioperative outcomes of THA in patients with hematologic malignancies (stratified by subtype) were compared with those without hematologic malignancies. More specifically, we evaluated the following: (1) surgical and medical complications, (2) hospital length of stay (LOS), and (3) costs.

Materials and Methods

Study Design and Data Source

This study used the Nationwide Inpatient Sample (NIS) to retrospectively analyze data from 2000 to 2011. The NIS is the largest all-payer database of inpatient admissions in the United States and is part of the Healthcare Cost and Utilization Project, Agency for Healthcare Research and Quality [21]. The NIS collects an annual random sample of 20% of the hospitalizations in the United States. The available data include patient demographics, the *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* procedure and diagnosis codes, insurance information, admission data, LOS, discharge status, and total costs. The NIS data are deidentified and publically available, and the study was, therefore, deemed exempt by our institutional review board.

Study Population

Primary THA cases were defined using the *ICD-9-CM* procedure code 81.51 (Fig. 1). A total of 391,037 patients (n = 391,037) were sequentially excluded for the following (in this order): age <18 years; admission type of emergency, urgent, trauma, or emergency room; pathologic fractures; fractures of femur; fractures, other, multiple, ill defined of the lower limb; multiple fractures involving both lower limbs; acute infection of the lower extremity or the buttocks; diagnosis suggestive of previous arthroplasty, complication of previous arthroplasty, or a bilateral lower extremity arthroplasty; metastatic cancer; traumatic fracture of the pelvis; and fractures of the femoral neck [22,23]. The final study population included 2,473,375 patients who underwent THA, of whom 2,455,363 had no hematologic malignancy and 18,012 had any hematologic malignancy. Hematologic malignancies were defined by the *ICD-9-CM* codes and were categorized into the following: any hematologic malignancy, Hodgkin disease (201.0x-201.9x), non-Hodgkin lymphoma (200.2x-200.8x, 202.0x-202.8x, 238.5), leukemia (204.0x-204.9x, 205.0x-205.9x, 206.0x-206.9x, 207.2x, 208.0x-208.9x), plasma cell dyscrasias (203.0x-203.8x, 238.6), myeloproliferative neoplasms (238.4, 238.7x, 289.83, 205.1x, 207.8x), and myelodysplastic syndromes (238.72-238.75). The control group consisted of persons without those codes. Patients were further stratified by subtype of hematologic malignancy, which included the following: Hodgkin disease (n = 786), non-Hodgkin lymphoma (n = 5062), plasma cell dyscrasias (n = 2067), leukemia (n = 5644), myeloproliferative neoplasms (n = 3552), and myelodysplastic syndromes (n = 1082).

Outcomes

The primary outcomes of interest were surgical and medical complications, hospital LOS, and cost. Complications were identified by the *ICD-9-CM* diagnosis codes and included surgical (acute postoperative hemorrhagic anemia [285.1], hematoma/seroma [998.11, 998.12, 998.13, 459.0,729.92], postoperative wound infection [998.51, 998.59, 682.6, 682.9], wound dehiscence [998.3, 998.31, 998.32, 998.33], and other wound problems [998.83, 890, 891, 894]) and medical (thrombocytopenia [287.4, 287.5], central nervous system [997.0x], cardiac [997.1], acute myocardial infarction [410], peripheral vascular [997.2], pulmonary [997.3, 997.31, 997.32], pulmonary insufficiency after surgery [518.51, 518.52, 518.53], gastrointestinal [997.4], genitourinary [584.x, 599.0, 997.5], pulmonary embolism [415.11, 415.13, 415.19], deep venous thrombosis [451.11, 451.19, 451.2, 451.81, 453.40, 453.41, 453.42], postoperative shock [998.0], and transfusion of blood [procedure code: 99.03, 99.04, 99.05, 99.07]). LOS was the number of days from admission to discharge. Costs were determined by multiplying the total charges by a hospital-specific cost-to-charge ratio, provided by the Healthcare Cost and Utilization Project [24] and were inflation adjusted to 2014 dollars.

Covariates

A number of variables were included in our study to compare differences in patient populations between those with and without hematologic malignancies and control for these differences in our analysis. Covariates included patient demographics (age, gender, race, and insurance status), hospital characteristics (region of the United States, urban/rural location, academic/nonacademic, and size), and patient comorbidities. Race was categorized as white, black, Hispanic, other, and unknown/missing. Insurance status was categorized as Medicare, Medicaid, private insurance, uninsured, and other/unknown. Comorbidities were identified based on the definitions in the Comorbidity Software provided by the Agency for Healthcare Research and Quality [25], an expansion of the original Elixhauser coding [26]. The following 3 additional comorbidities were also identified: cardiac arrhythmias, myocardial infarction, and cerebrovascular disease.

Statistical Analysis

All statistical analyses were performed with SAS software, version 9.3 (Cary, NC). A P value <.05 was used to determine statistical significance. Descriptive analysis was performed for all study variables. To compare the any hematologic malignancy group with the control group, the Student t test or the analysis of variance was used for continuous variables, and the Pearson chi-square test was used for categorical variables. For national estimates, sample weights provided by the NIS were applied.

Propensity score matching was used to adjust for any potential confounding due to baseline covariates predicting likelihood of a hematologic malignancy [27]. First, a propensity score was calculated using a logistic regression model with any hematologic malignancy as the outcome and all the aforementioned baseline covariates as the predictors. The log-transformed predicted probability of any hematologic malignancy was used as the propensity score. Then, a 1:1 greedy match without replacement of hematologic malignancy THA patients and control THA patients based on propensity score and a caliper of 0.1 times the standard deviation using the %GMATCH macro was performed [28]. Propensity matching for age, gender, race, insurance, hospital region, location, teaching status, size, and all comorbidities matched 17,810 patients with any hematologic malignancy to 17,888 control patients. In