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Original Article

The Impact of Solid Organ Transplant History on Inpatient Complications, Mortality, Length of Stay, and Cost for Primary Total Hip Arthroplasty Admissions in the United States

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ABSTRACT

Background: As the prevalence of and life expectancy after solid organ transplantation increases, some of these patients will require total hip arthroplasty (THA). Immunosuppressive therapy, metabolic disorders, and post-transplant medications may place transplant patients at higher risk of adverse events following surgery. The objective of this study was to compare inpatient complications, mortality, length of stay (LOS), and costs for THA patients with and without solid organ transplant history.

Methods: A retrospective cross-sectional analysis was conducted using 1998-2011 Nationwide Inpatient Sample. Primary THA patients were queried (n = 3,175,456). After exclusions, remaining patients were assigned to transplant (n = 7558) or non-transplant groups (n = 2,772,943). After propensity score matching, adjusted for patient and hospital characteristics, logistic regression and paired t-tests examined the effect of transplant history on outcomes.

Results: Between 1998 and 2011, THA volume among transplant patients grew approximately 48%. The overall prevalence of one or more complications following THA was greater in the transplant group than in the non-transplant group (32.0% vs 22.1%; $P < .001$). In-hospital mortality was minimal, with comparable rates (0.1%) in both groups ($P = .93$). Unadjusted trends show that transplant patients have greater annual and overall mean LOS (4.47 days) and mean admission costs ($18,402) than non-transplant patients (3.73 days; $16,899; $P < .001$). After propensity score matching, transplant history was associated with increased complication risk (odds ratio, 1.56) after THA, longer hospital LOS (+0.64 days; $P < .001$), and increased admission costs (+$887; $P = .005$).

Conclusion: Transplant patients exhibited increased odds of inpatient complications, longer LOS, and greater admission costs after THA compared with non-transplant patients.

The rate of solid organ transplant (kidney, liver, heart, lung, pancreas—in order of prevalence) in the United States has doubled since 1990 [1]. In 2010, there were approximately 30,000 solid organ transplant procedures [1]. Not only is solid organ transplant becoming more common, but life expectancy of its patients and organ allograft survival are also increasing [1-6]. Improved organ allocation, donor selection, surgical technique, technology, refined corticosteroid and immunosuppressive regimens, and better diagnosis and treatment of complications have contributed to the greater success of these transplants [2,7].

As these post-transplant patients grow older, some of them present to clinic requiring total hip arthroplasty (THA) to treat bone disease and enhance quality of life and activity. Additionally, transplant medications have some potentially serious side effects, which

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can manifest as avascular necrosis in multiple joints including the hip and femoral head [8-10]. Intensive immunosuppressive therapy, metabolic disorders, and post-transplant medications may place transplant patients at higher risk of adverse events after THA [8,11-13]. Due to the infrequency of THA among transplant patients, current studies in the literature have small sample sizes and examine mainly renal transplant patients [8,12,14-20].

The objective of this study was to analyze the perioperative outcomes of THA in solid organ transplant recipients in the United States, comparing comorbidities, acute hospital complications, mortality, length of stay (LOS), and admission costs for THA patients with and without a history of solid organ transplant. A large national administrative database over 14 years was used to provide sufficient statistical power.

Materials and Methods

The present study was deemed exempt from approval by our hospital's institutional review board as it used nonidentifiable information obtained from a publicly available national database.

Data Source

This study represents a retrospective cross-sectional secondary data analysis of the 1998-2011 Nationwide Inpatient Sample (NIS) files. Developed as a part of the Healthcare Cost and Utilization Project (HCUP) and sponsored by the Agency for Healthcare Research and Quality, the NIS represents the largest all-payer inpatient care database in the United States [21]. Each annual sample contains patient-level data for approximately 7-8 million inpatient stays from over 1000 hospitals, representing a 20% stratified random sample of hospitals within each characteristic stratum. Numerical weights are included to provide national estimates of the data. Over 100 clinical and nonclinical data elements are available, including demographics, hospital characteristics, primary and secondary diagnoses, inpatient procedures, insurance type, discharge status, LOS, and total charges.

Study Population

All primary THA procedures performed from 1998-2011 were queried from the NIS using International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) procedure code 81.51 (n = 3,175,456; weighted frequency; Fig. 1). Elective primary adult cases were identified by sequentially excluding the following patient types: “nonelective” (ie, emergency, urgent, newborn, trauma center, other) admission types, primary diagnosis of femoral neck fracture, primary diagnosis suggestive of previous and/or bilateral lower extremity arthroplasty, primary or secondary diagnoses indicating lower extremity malignancies and/or metastatic cancer, primary or secondary diagnoses indicating lower extremity pathologic fracture, and age less than 18 years (totaling n = 387,708 excluded; Fig. 1). The remaining 2,787,748 THA patients were classified by transplant history status. THA patients with a history of kidney, heart, lung, liver, and/or pancreas solid organ transplant (ICD-9-CM diagnosis codes V42.0, V42.1, V42.6, V42.7, and V42.83, respectively) were identified. A control group of non-transplant THA patients was formed by excluding discharge records with any diagnosis suggestive of transplant, including that of the solid organs as well as tissue, bone, cornea, marrow, stem cells (Fig. 1).

Outcomes

The goal of this analysis was to examine the relative rates, resources used, and immediate risk associated with THA among patients with and without a history of solid organ transplant. First, the total prevalence of and annual trends in primary THA status after solid organ transplant were estimated. Overall comorbidity status between the 2 patient cohorts was summarized using the van Walraven modified Elixhauser composite score [22]. Additionally, the unadjusted and adjusted association between history of transplant and acute hospital complications, mortality, LOS, and admission costs were examined. A variety of hospital complications, modified from those published by Lin et al [23], D'Apuzzo et al [24], and Memtsoudis et al [25], were identified using specific definitions. Appendix 1 outlines the list of complications included and their respective diagnosis codes, procedure codes, or column value. “Any complication” was defined as one or more of these complications. Admission costs were calculated by multiplying the total charges by a hospital-specific cost-to-charge ratio provided by HCUP and were inflation-adjusted to 2014 dollars [26].

Covariates

Covariates for statistical models included patient demographics (ie, age group, sex, race, and insurance), hospital characteristics (ie, geographic region, urban/rural, size, and teaching status), and patient comorbidities. The covariates were defined as recorded by HCUP with a few category modifications to facilitate model formation [21]. Age was categorized as follows: 18-40 years, 41-50 years, 51-60 years, 61-70 years, 71-80 years, 81-90 years, and ≥91 years. Race was categorized as White, Black, Hispanic, and other. Because approximately 25% of the discharge records did not have a race value, we created an additional race category and captured it as “unknown race.” Insurance status was categorized as Medicare, Medicaid, private, self-pay, and other. Comorbidities were identified and classified using the most recent revision of the Agency for Healthcare Research and Quality Elixhauser ICD-9-CM coding algorithm (version 3.7) [27], an expansion of the original Elixhauser coding [28]. Cardiac arrhythmias was also calculated (omitted from version 3.7) in order to include in the van Walraven modified Elixhauser composite score outcome. Three comorbidities were excluded from multivariable regression model analyses. Metastatic cancer was an exclusion criterion and thus was not present in our cohort. Liver disease and renal failure categories were excluded from multivariable data analysis because their coding definitions include the respective transplant codes (V42.0, V42.7) and would present collinearity issues if included. Hospital urban/rural designation was based on metropolitan statistical area designation before 2004, and based on Core Bases Statistical Area designation from 2004 onward. The cut points for hospital bed size vary by geographic location, urban-rural designation, and teaching status [21].

Statistical Analysis

All analyses were performed using SAS System for Windows, version 9.3 (SAS Institute Inc, Cary, NC). The distribution of data and descriptive statistics were calculated for all baseline variables included in the analyses. National frequency estimates were obtained using the discharge weights, accounting for the NIS-stratified sampling scheme and clustering by hospital. Association between each baseline variable and transplant history was tested. Overall unadjusted complication rates, mortality, LOS, and admission costs were compared between transplant and non-transplant THA groups. Additionally, annual trends in LOS and admission costs were examined. Costs were adjusted for inflation based on real gross domestic product chained to 2014 dollars. Univariate comparisons were made using Pearson's chi-squared test for categorical variables and Student *t*-test for continuous variables.