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The Effect of Chronic Kidney Disease on Total Hip Arthroplasty

Alexander Miric, MD [a], Maria C.S. Inacio, PhD [b], Robert S. Namba, MD [c]

[a] Southern California Permanente Medical Group, Department of Orthopaedic Surgery, Los Angeles, California
[b] Kaiser Permanente, Surgical Outcomes and Analysis Unit, Clinical Analysis, San Diego, California
[c] Southern California Permanente Medical Group, Department of Orthopaedic Surgery, Orange County, Irvine, California

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ABSTRACT

Patients with chronic kidney disease (CKD) undergoing total hip arthroplasty (THA) were evaluated for risk of revision, surgical site infection (SSI), thromboembolic events, mortality and readmission. 20,720 primary TKA cases were included (smaller sample for readmission evaluation, N = 9322). The prevalence of CKD among THA patients was 6.1% (N = 1269). After adjustment for age, gender, race, general health, and diabetes, CKD patients were at 1.4 (95% confidence interval 1.1–1.8) increased risk of readmission within 90 days. The adjusted risks for revision (overall, aseptic, and septic), SSI (deep and superficial), deep vein thrombosis, pulmonary embolism, and mortality (30-day, 90-day, ever) were not significantly different between patients with CKD and those without CKD. However, increased risk for 90-day readmission underscores that CKD patients are a fundamentally different population of patients.

Multiple studies have illustrated the profound effect renal disease can have on the outcome of total hip arthroplasty (THA) [1–9]. Chronic kidney disease (CKD) is characterized by a progressive loss of renal function (staged 1–5) over a period of time that ranges from at least three months to years. Patients with CKD possess multiple co-morbidities and experience greater perioperative morbidity. And CKD patients undergoing THA typically experience a more complicated postoperative course with greater likelihood of post-operative mortality and higher rates of infection and other complications [1,2,4–7,9].

Prior studies of CKD patients undergoing THA, however, have almost exclusively focused on patients with end-stage kidney disease (ESKD) — a severe, end-stage form of the disease (stage 5) [1–9]. ESKD patients require dialysis and many are awaiting renal transplantation. Typically older, these patients are often also in need of THA for osteoarthritis. Hip avascular necrosis is also frequently diagnosed as ESKD patients have often been treated with renal disease modifying drugs that can have adverse effects on the hip joint [3,7]. It remains unclear whether the risks associated with ESKD and THA also apply to patients with earlier stages of CKD.

There is evidence suggesting lesser forms of the disease may have a demonstrable effect on individuals undergoing THA surgery. Patients with CKD are more likely to have associated medical problems [6,10–14] and the disease itself has been reported as both a covariate and as an independent risk factor for adverse surgical outcome [15–22]. This includes infection, blood transfusions, medical complications, readmission and mortality. Furthermore, total joint arthroplasty (TJA) patients may be at additional risk for kidney mediated complications as even individuals free of kidney disease have previously demonstrated decreased renal function as they recover from this surgery [23].

The rising prevalence of CKD in the United States has been described as “epidemic” [24] with almost 10% of the population over the age of 20 having CKD [11]. As this population of patients has grown so has the number of THA performed in this country. The intersection of this growing population of CKD patients who require THA may lead to an increasing number of perioperative complications, and this may have a profound impact on patients, surgeons and the health care system. For this reason, we have studied this growing patient population. The purpose of this study was to describe the patient characteristics and surgical outcomes of patients with CKD undergoing THA and to evaluate the association of CKD with the surgical outcomes of THA procedures in a community based sample of patients. Specifically we evaluated whether CKD is associated with the risk of surgical site infection (SSI), thromboembolic events, mortality and readmission post-THA.

Materials and Methods

Study Design, Data Collection, and Study Sample

A retrospective analysis of a prospectively followed cohort of primary THA patients was conducted. All patients registered in a Total Joint Replacement Registry (TJRR) from 01/01/2006 to 12/31/2010 were included in the study sample. The TJRR data collection methodology, coverage, and participation have been previously

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Reprint requests: Alexander Miric, MD, Southern California Permanente Medical Group, Department of Orthopaedic Surgery, Los Angeles, 4760 Sunset Blvd, Los Angeles, CA 90027.

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published [27–29]. The TJRR covers an integrated healthcare system present in 7 geographical regions in the United States (Northern California, Southern California, Ohio, Mid-Atlantic, Pacific Northwest, Hawaii, and Colorado) and covers 9.2 million individuals. Intra-operative information (techniques, implants, procedures, surgical indications, intra-operative findings) is collected at the point of care by the surgeon using paper forms, mailed to the TJRR data repository center and manually entered. Patient demographic information, anthropometric measures, co-morbidities, and outcomes associated with the procedures are reported by the surgeons. These data are supplemented using the electronic health records available at the institution. The TJRR reported 90% THA voluntary participation in 2010 [28]. Loss of follow up among the TJRR cohort is monitored and tracked using the integrated healthcare system membership and mortality data.

All primary elective THAs for any diagnosis performed in the two largest geographical regions (Northern California and Southern California) during the study period were eligible for the study. Other regions were not included due to limited data on patient co-morbidities used in this study. Patients who underwent revision THA and conversion procedures were excluded from the sample. The final sample included 20,720 primary THAs performed by 224 surgeons in 36 hospitals.

Exposure

CKD was the exposure of interest in this study. Presence of CKD was determined using the Elixhauser co-morbidity algorithm [30,31]. Using this validated International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) diagnostic code algorithm, all patients were categorized as either having CKD or not. Further categorization of the patients into stage 3, stage 4 or stage 5 CKD was performed using the specific ICD-9-CM codes within the algorithm.

Outcomes

The outcomes evaluated included revision (overall, aseptic, or septic), SSI (deep and superficial), thromboembolic events (deep vein thrombosis (DVT), pulmonary embolism (PE)), mortality (ever, 30-day, and 90-day) and readmission (90-day). Revision, SSI, DVT and PE are reported to the TJRR by surgeons and providers or are identified through screening of the patients' electronic health records using validated algorithms or standardized criteria and subsequently adjudicated by trained clinical content experts [32,33]. Revision was defined as any subsequent surgery after the primary THA requiring the exchange of an implant. Reasons for revision were also recorded by the clinical content expert, and for this study were categorized as septic (infection related), aseptic (non-infectious), and any. SSIs were confirmed using the Centers for Disease Control and Prevention (CDC)/National Healthcare Safety Network definitions [34]. A superficial SSI was attributable to the THA up to 30 days post-operative and a deep SSI up to 365 days post-operative. DVTs and PEs were attributed to the THA procedure up to 90 days after the surgery date. Mortality was obtained from a membership services database within the integrated healthcare system, which tracks vitality data from the patients' medical records and is periodically updated by the Social Security Administration. Readmission was defined as any emergency room, urgent care, or inpatient visit requiring hospitalization starting from the day of discharge after the index THA procedure through a period of 90 days after the surgery.

Covariates

Patient demographics (age, gender, race), patient BMI (categorized into normal/overweight (<30 kg/m^2), obese (30–34 kg/m^2) and morbidly obese (≥35 kg/m^2)), patient co-morbidities (diabetes status, congestive heart failure, valvular disease, peripheral vascular disease, alcohol abuse, hypertension), procedure diagnosis (osteoarthritis, osteonecrosis, rheumatoid arthritis, post-traumatic arthritis, and other), and general health status (as measured by the American Society of Anesthesiologist (ASA) score) for the sample were evaluated. The operative time and length of hospital stay were also evaluated.

Statistical Analysis

Frequencies, proportions, medians and interquartile ranges (IQR) were used to describe the study sample. Chi-square tests (and Fisher's exact test where appropriate) were employed for categorical variable comparison, Student t-tests for normally distributed continuous variables (age and BMI), and Wilcoxon rank sum test for non-parametric continuous variables (operative time and LOS). The crude incidence of revision, SSI, DVT, PE, mortality (30-day, 90-day and any), as well as 90-day readmission was calculated for the sample by CKD status and then by CKD stage stratum. Readmission and length of stay data were available for a smaller sample within the study (01/01/2009–12/31/2010); therefore, the denominator for these analyses (N = 9322) was different than the rest of the analysis. Bivariate logistic regression models were used to assess odds ratios (OR) and 95% confidence intervals (CI) of the likelihood of the non-time dependent outcomes (septic revision, SSI, DVT, PE, 30 and 90-day mortality, and readmission). Cox proportional hazard models were used to assess hazard ratios (HR) and 95% confidence intervals for the risk of the time dependent outcomes (septic revision and mortality). Proportional hazard assumptions were evaluated using survival function versus survival time graphs. Cases were censored if they left the integrated healthcare system before the end of the study period, had the event of interest, or died. Covariates were explored as possible confounders of the association between CKD and the likelihood of the non-time dependent events and time dependent events. Variables not confounding the association and judged not clinically important were not included in the final models. Final models were adjusted for age, gender, race, ASA score, and diabetes. The study sample was missing CKD data on 2057 (9.9%) cases. To handle these missing data and other missing data in our sample we performed multiple imputations to create 10 versions of the analytic data set and then used Rubin's combining rules to calculate the final parameter estimates and confidence intervals from the 10 output sets [35]. The imputation model used included all other covariates as well as the event indicator [36]. Models using only completed cases were employed to examine consistency and robustness of the estimations of models with imputed data. Data were analyzed using SAS (Version 9.2, SAS Institute, Cary, NC, USA) and $P < .05$ was used as the threshold for statistical significance.

Results

A total of 20,720 THA cases were included in the study sample. CKD was confirmed on 6.1% (N = 1269) of the THA cases and not present in 83.9% of the total sample (N = 17,394). The status of CKD was not confirmed in 9.9% (N = 2057) of the THA cases. The overall sample was comprised of individuals who were mostly white (76.1%), and had median age of 66 years (IQR 58–74) and a median BMI of 28.3 (IQR 25.0–32.4). The study sample was also composed of more women than men (57.5% vs. 42.5%). During the study period 633 (3.1%) THAs were lost to follow up (N = 514, 3.0% of the non-CKD group and N = 18, 1.4% of the CKD group) and 543 (2.6%) expired (N = 452, 2.6% of the non-CKD group and N = 50, 3.9% of the CKD group). Significantly higher percentages of individuals with CKD were found in categories of patients with the following characteristics: an ASA score > = 3 (66.2% vs. 35.5%, $P < .001$), congestive heart failure (10.7% vs. 2.3%, $P < .001$), valvular disease (6.8% vs. 2.8%, $P < .001$), peripheral vascular disease