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Complications and Mortality in Chronic Renal Failure Patients Undergoing Total Joint Arthroplasty: A Comparison Between Dialysis and Renal Transplant Patients

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A B S T R A C T

Background: In total joint arthroplasty (TJA) literature, there is a paucity of large cohort studies comparing chronic kidney disease (CKD) and end-stage renal disease (ESRD) vs non-CKD/ESRD patients. Thus, the purposes of this study were (1) to identify inhospital complications and mortality in CKD/ESRD and non-CKD/ESRD patients and (2) compare inhospital complications and mortality between dialysis and renal transplantation patients undergoing TJA.
Methods: We queried the Nationwide Inpatient Sample database for patients with and without diagnosis of CKD/ESRD and those with a renal transplant or on dialysis undergoing primary or revision total knee or hip arthroplasty from 2007 to 2011. Patient comorbidities were identified using the Elixhauser comorbidity index. *International Classification of Diseases, Ninth Revision*, codes were used to identify postoperative surgical site infections (SSIs), wound complications, deep vein thrombosis, and transfusions.
Results: Chronic kidney disease/ESRD was associated with greater risk of SSIs (odds ratio [OR], 1.4; $P < .001$), wound complications (OR, 1.1; $P = .01$), transfusions (OR, 1.6; $P < .001$), deep vein thrombosis (OR, 1.4; $P = .03$), and mortality (OR, 2.1; $P < .001$) than non-CKD/ESRD patients. Dialysis patients had higher rates of SSI, wound complications, transfusions, and mortality compared to renal transplant patients.
Conclusion: Chronic kidney disease/ESRD patients had a greater risk of SSIs and wound complications compared to those without renal disease, and the risk of these complications was even greater in CKD/ESRD patients receiving dialysis. These findings emphasize the importance of counseling CKD patients about higher potential complications after TJA, and dialysis patients may be encouraged to undergo renal transplantation before TJA.

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Chronic kidney disease (CKD) and end-stage renal disease (ESRD) are major health problems that affect approximately 5% of the population [1]. Despite initial medical management, some of these patients may ultimately require renal dialysis or a renal transplant. Improvements in surgical techniques and immunosuppressive therapy have increased the number of annual organ transplantations and patient survival rates [2]. This population is also at an increased risk for requiring total joint arthroplasty (TJA) secondary to musculoskeletal complications stemming from either long-term dialysis or chronic use of the immunosuppressive therapy needed after renal transplantation [3,4]. With the number of TJA procedures increasing annually [5], the orthopedic community may be confronted with a subsequent increase in CKD/ESRD patients. Thus, knowledge of how CKD/ESRD may affect TJA outcome and mortality is vital.

Previous cardiac surgery literature suggests that CKD may be associated with greater bleeding and transfusion requirements [6]. In the setting of noncardiac surgeries, a meta-analysis showed that CKD is an independent risk factor for postoperative death [7]. Prior studies on TJA in CKD patients have reported increased complications and inferior results, including higher rates of loosening and dislocations [8-10]. Previous literature on TJA in renal failure patients undergoing hemodialysis have shown increased mortality rates, deep vein thrombosis (DVT), and deep wound infections [11,12]. Renal transplant patients have also been associated with increased TJA complications including hemorrhage, aseptic loosening, late infections, and dislocations [13-15]. However, TJA literature comparing complications and outcomes between transplant and dialysis patients is scarce and conflicting [15,16]. Furthermore, most previous studies include small cohorts, analyzed either

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total hip arthroplasty (THA) or total knee arthroplasty (TKA) patients separately, or concentrated on a single population of CKD/ESRD patients either on dialysis or renal transplant patients.

Therefore, the purposes of our study were to identify and compare inhospital complications and mortality (1) between CKD/ESRD and non-CKD/ESRD patients, (2) renal dialysis and non–dialysis-dependent CKD/ESRD patients, and (3) dialysis and renal transplant patients.

Materials and Methods

Nationwide Inpatient Sample (NIS) data from 2007 to 2011 were used to identify CKD/ESRD and non-CKD/ESRD patients who underwent hip or knee arthroplasty (primary or revision). The addition of a new *International Classification of Diseases, Ninth Revision* (*ICD-9*), code (403.90; hypertensive CKD, unspecified) to the definition of renal comorbidity led to a significant increase in renal failure rates after 2006. Therefore, to ensure consistency in the definition of renal comorbidity, our analyses excluded data before 2007. Because the NIS database has been sufficiently deidentified, this study was exempt from institutional review board review.

Total joint arthroplasty patients were identified using *ICD-9* codes 81.51 for primary THA, 81.53 and 00.70-00.73 for revision THA, 81.54 for primary TKA, and 81.55 and 00.80-00.84 for revision TKA. We then identified CKD/ESRD patients in our TJA cohort using the *ICD-9* codes listed in Appendix A. In our CKD/ESRD group, we identified patients receiving dialysis using the *ICD-9* code 39.95 and patients with a history of renal transplant using *ICD-9* code V42.0. The CKD cohort included CKD stages III to V (*ICD-9* codes 585.3-585.5 and 403.0-404.93), renal transplant patients, dialysis patients, and ESRD patients (*ICD-9* code 585.6). We were unable to separate the CKD/ESRD cohort into individual groups based on the severity of CKD (stages III-V) due to significant overlap between patients.

For all patients, patient demographics (age, sex, and race), insurance type, hospital type (urban academic, urban private, or rural), hospital size (small, medium, or large), region (Northeast, Midwest, West, and South), hospital length of stay (LOS), and inhospital mortality were obtained. *International Classification of Diseases, Ninth Revision*, codes were used to identify postoperative surgical site infections (SSIs), wound complications, DVT, and transfusions (Appendix A). Patient comorbidities were identified using the Elixhauser comorbidity index [17]. The Elixhauser comorbidity index has frequently been used in previous studies using NIS data and seems to be one of the best comorbidity indices for predicting outcome of patients in administrative databases. Therefore, we decided to use this comorbidity index in our analyses.

Statistical Analysis

Multivariate logistic regressions were used to determine if presence of CKD/ESRD is an independent predictor of SSI, wound complications, transfusions, DVT, and inhospital mortality. To further analyze the effect of CKD/ESRD on the rate of inhospital complications and mortality, we divided the CKD/ESRD group into dialysis and non–dialysis-dependent groups. A full regression model was created for each complication, transfusion, and mortality incorporating all possible factors, including demographics, comorbidities, hospital region, setting and size, year of surgery, type of TJA (primary vs revision), and type of joint (hip vs knee). Moreover, renal transplant and dialysis groups were also compared using multivariate logistic regressions controlling for the same confounders. Hospital LOS was compared between different groups using the Wilcoxon test. Kaplan-Meier curves were used to compare the LOS in CKD/ESRD and non-CKD/ESRD cases. All analyses were performed using R 3.0.2 (R Foundation for Statistical Computing, Vienna, Austria) using the "rms" package to perform the logistic regression. $P < .05$ was considered statistically significant.

Table 1
Comparison of Characteristics of Patients in CKD and ESRD vs Non-CKD/ESRD Groups.

	CKD/ESRD Patients	Non-CKD/ESRD Patients
Number	38,308	978,378
Age (y)	71.9 ± 10.6	65.6 ± 11.3
Females	51.4%	61.0%
Ethnicity		
White	79.1%	84.8%
African American	12.5%	7.2%
Hispanic	4.2%	4.4%
Asian	1.9%	1.2%
Native American	0.4%	0.5%
Other	1.9%	1.9%
Hospital setting		
Rural	10.0%	11.6%
Urban academic	46.2%	46.7%
Urban private	43.8%	41.7%
Region		
Northeast	15.1%	17.5%
Midwest	29.5%	26.9%
South	35.3%	36.0%
West	20.1%	19.6%
Hospital size		
Small	14.4%	17.4%
Medium	24.2%	24.3%
Large	61.4%	58.3%
Insurance type		
Medicare	76.6%	53.5%
Medicaid	2.2%	3.1%
Private	19.2%	39.4%
Self-pay	0.3%	0.6%
No charge	0.1%	0.1%
Other	1.6%	3.3%

Results

Patient Demographics

A total of 38,308 CKD/ESRD and 978,378 non-CKD/ESRD patients with a history of lower extremity TJA were identified. The number of CKD/ESRD patients who underwent TJA increased annually by 13.5% (95% confidence interval [CI], 12.59%-14.46%; $P < .001$) during the study period from 2007 to 2011. Table 1 demonstrates characteristics of patients in CKD/ESRD and non-CKD/ESRD groups. Respectively, 3.7% and 3.5% of primary THA and primary TKA cases and 6.1% and 5.6% of revision hips and revision knees were CKD/ESRD cases. Overall, revision patients had higher rates of CKD/ESRD compared to primary TJA cases. Fig. 1 depicts prevalence of Elixhauser comorbidities in CKD/ESRD and non-CKD/ESRD cases. Almost all other 28 items of the Elixhauser comorbidity index were found more frequently in CKD/ESRD compared to non-CKD/ESRD patients, with the most common being diabetes with complications (10.1% vs 1.2%, respectively) and congestive heart failure (12.9% vs 2.4%, respectively). Table 2 summarizes the influence of nonrenal comorbidities on inhospital complications and mortality. The influence of hospital size and region on inhospital complications and mortality are summarized in Table 3.

Total Joint Arthroplasty in CKD/ESRD Compared to Non-CKD/ESRD Patients

In multivariate analysis, non–dialysis-dependent CKD/ESRD patients undergoing TJA (both primary and revision) were associated with a significantly increased risk of SSIs (odds ratio [OR], 1.40; 95% CI, 1.25-1.45; $P < .001$), wound complications (OR, 1.12; 95% CI, 1.02-1.23; $P = .01$), transfusions (OR, 1.39; 95% CI, 1.33-1.46; $P < .0001$), DVTs (OR, 1.38; 95% CI, 1.04-1.84; $P = .025$), and inhospital mortality (OR, 2.11; 95% CI, 1.81-2.46; $P < .001$) compared to patients without CKD/ESRD. Chronic kidney disease/ESRD patients on dialysis were associated with an even greater risk of SSIs (OR, 4.06; 95% CI, 2.55-6.47; $P < .0001$), wound complications (OR, 1.72; 95% CI, 1.07-2.75; $P = .025$), transfusions (OR, 1.53; 95% CI, 1.28-1.82; $P < .0001$), and inhospital mortality

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