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After Adjusting for Preoperative Confounders, is there an Increased Risk of Perioperative Complications in Dialysis Dependent Total Hip Arthroplasty Patients?

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Abstract

Background: The prevalence of chronic kidney disease (CKD) is estimated to rise to 16.7% in the United States population, increasing the probability that dialysis-dependent (DD) patients will undergo total hip arthroplasty (THA) during their lifetime. Few studies have controlled for pertinent preoperative confounders to assess dialysis dependence on shortterm THA outcomes. Aims and Objectives: This study aims to examine the effects dialysis has on overall THA outcomes in DD THA recipients and matched non-DD patients after adjusting for preoperative confounders. Study Design: Retrospective Database Study. Setting: National Surgical Quality Improvement Program (NSQIP). Materials and Methods: Patients were identified with the NSQIP database between 2008 and 2016, resulting in a total of 139,776 patients. Patients were then propensity score-matched based on demographics, functional status, and lab values, yielding 310 DD and 310 non-DD patients. Statistics: Generalized regression models were conducted to assess dialysis dependence on perioperative outcomes. Results: Patients who underwent dialysis had a significantly longer mean hospital length of stay compared to the matched cohort of non-dialyzed patients, once adjustments for residual differences in preoperative hematocrit were made (5.88 vs. 3.95 days; p<0.001). Receiving dialysis was not an independent risk factor developing a superficial surgical site infection (SSI) (p=0.947), a deep SSI (p=0.334), or urinary tract infection (p=0.999) up to 30 days post-THA. However, receiving dialysis was a risk factor for postoperative blood transfusion (odds ratio [OR]: 1.55; p=0.012). Dialysis dependence was not a risk factor for wound dehiscence (p=0.999), cardiac arrest (p=0.200), or myocardial infarction (p=0.722). In addition, dialysis dependence was not associated with an increased risk of deep vein thrombosis (p=0.999), pulmonary embolus (p=0.885), or stroke (p=0.999) within 30 days of the index procedure. Moreover, dialysis status did not confer an increased risk of 30-day return to the operating room (p=0.999). However, patients who underwent dialysis were found to be at an increased risk for readmission within 30 days of the indicated procedure (OR: 1.83; p=0.044), have a higher risk of 30-day mortality (OR: 3.95; p=0.002) and had lower odds of being discharged to home (OR: 0.44; p<0.001). Conclusion: Dialysis dependence did not predict higher incidences of common complications. However, DD patients had longer stays, more transfusions, higher readmissions, and higher mortality. While these complications are serious, this opens the door to assess how DD patients can be better preoperatively optimized to minimize risk.

Keywords: total hip arthroplasty, THA, dialysis, chronic kidney disease, complications.

INTRODUCTION

Despite the effectiveness of total hip arthroplasty (THA), preoperative comorbidities have the potential to negatively impact patient outcomes ^[1, 2]. The presentation of such an impact may cause lower satisfaction scores, higher complication rates, or higher revision rates, increasing the burdens placed on the healthcare system ^[3–7]. These burdens are progressively detrimental, as recent healthcare reforms place more emphasis on value-based care and pose greater financial risks to hospital systems ^[8–10]. Therefore, it is imperative to understand the role patient comorbidities, such as chronic kidney disease (CKD), play in influencing THA-related outcomes, as it may help healthcare providers optimize preoperative care and postoperative monitoring.

Currently, the prevalence of CKD is estimated to be 15% in the United States (US), accounting for up to 6.7% of all Medicare expenditures ^[11, 12]. Moreover, studies project the prevalence of CKD to increase to 24.3%% of the US population by 2035, increasing the likelihood that CKD patients will undergo THA during their lifetime ^[1, 13, 14]. Many aspects of care exclusive to CKD patients, such as increased bleeding

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tendency, immunocompromised status, and weak bone secondary to renal osteodystrophy, must be properly addressed prior to undergoing THA. Failure to address these problems has been demonstrated to increase the risk of perioperative complications, periprosthetic joint infections, implant failures, and necessitate early revision commonly seen in this population ^[15–19]. Such concerns are even greater for dialysisdependent (DD) patients, as their susceptibility to CKD-related complications is not mitigated by the removal of toxic blood urea through dialysis, a procedure which also increases their risk of sepsis and bacteremia, which may further complicate their management ^[20–22].

Studies have evaluated postoperative outcomes for CKD patients who undergo THA ^[15, 18, 23]. However, few have attempted to isolate the effect of dialysis dependence on the short-term outcomes of THA, failing to control for pertinent confounders like race, ethnicity, preoperative hematocrit, and platelet count. Thus, this study aims to study the effects receiving dialysis has on overall THA outcomes after adjusting for preoperative confounders. More specifically, we assess lengths of hospital stay (LOS), infections, short-term complications, readmissions, and discharge destination in DD patients who undergo THA.

MATERIALS AND METHODS

Data acquisition

The National Surgical Quality Improvement Program (NSQIP) database was utilized for this study. Information gathered for this database is prospectively collected by trained reviewers at over 700 participating hospitals and follows patients for 30 days postoperatively. Due to the public availability of this database, this study was deemed exempt from internal review board approval.

Patient selection

The database was queried from 2008 to 2016 for patients who underwent a primary THA procedure using the Current Procedural Terminology (CPT) code 27130 (Arthroplasty, acetabular and proximal femoral prosthetic replacement [total hip arthroplasty], with or without autograft or allograft). Patients were selected for the dialysis cohort if they received any type of dialysis within the two weeks prior to the index procedure, as recorded in the NSQIP database. Any total hip arthroplasty procedures labeled "non-elective" were excluded from analysis. This resulted in a total of 139,776 patients (mean age: 64.8 years, 55% female).

Data and Statistical Analysis

To match dialyzed patients to non-dialyzed patients, propensity score matching was performed using the following predicted variable values: age, body mass index (BMI) (kg/m²), gender, race, Hispanic ethnicity, history of diabetes, concurrent steroid use, history of chronic dyspnea, history of disseminated cancer, weight loss \geq 10% of total body weight in the six months prior to index procedure, preoperative international normalized ratio (INR), preoperative platelet count, preoperative hematocrit count, and preoperative functional status. To prevent bias from missing variable data, multiple imputations for variables with 15-30% missing values were conducted prior to matching ^[24, 25]. The nearest 1:1 neighbor match was performed with the variables listed previously. This yielded 310 DD patients, who were match to 310 non-dialyzed patients, for a total of 620 patients included for analysis. The standardized mean difference threshold to determine residual imbalances was set as 0.1 [26]. Preoperative hematocrit remained unbalanced after matching and was adjusted for analysis (Figure 1). Primary endpoints analyzed included the following: total hospital LOS, 30-day incidence of superficial surgical site infection (SSI), 30-day incidence of deep SSI, postoperative urinary tract infection (UTI), postoperative blood transfusions, postoperative wound dehiscence, cardiac arrest, myocardial infarction (MI), 30-day incidence of postoperative deep vein thrombosis (DVT), pulmonary embolism (PE), stroke, 30-day return to the operating room, 30-day readmission related to index procedure, 30-day all-cause mortality, and probability of discharge to home. A general regression model was generated to assess the possible effects of dialysis on these endpoints. For incidences less than 15, penalized regression models were utilized. All statistical analysis was performed using R software version 3.4.1. The threshold for significance was established at p<0.05.



Figure 1: Adjusted and unadjusted covariate balance for the matched cohortsn

RESULTS

Patients who underwent dialysis had a significantly longer mean hospital LOS compared to the matched cohort of non-dialyzed patients, once adjustments for residual differences in preoperative hematocrit were made (5.88 vs. 3.95 days, 95% confidence interval [CI] for mean difference: 1.29 to 2.58; p<0.001) (Table 1).

Receiving dialysis was not an independent risk factor developing a superficial SSI (odds ratio [OR]:1.15, 95% CI: 0.00115 to 0.0218; p=0.947), a deep SSI (OR: 5.21, 95% CI: 0.0000734 to 0.00331; p=0.334), or a UTI (OR: 0.38, 95% CI: 0.0025 to 4.87; p=0.999) up to 30 days post-THA (Table 1). However, receiving dialysis was a risk factor for postoperative blood transfusion (OR: 1.55, 95% CI: 1.10 to 2.18; p=0.012). Dialysis dependence was not a risk factor for wound

dehiscence (OR: 0.35, 95% CI: 0.000136 to 0.0124; p=0.999), cardiac arrest (OR: 2.26, 95% CI: 0.66 to 9.64; p=0.200), or MI (OR: 12.49, 95% CI: 0.00359 to 0.000422, p=0.722). In addition, dialysis dependence was not associated with an increased risk of DVT (OR: 14.80, 95% CI: 0.00110 to 0.000499; p=0.999), PE (OR: 1.18, 95% CI: 0.0000975 to 0.000157; p=0.885), or stroke (OR: 13.04, 95% CI: 0.00000568 to 0.0000113; p=0.999) within 30 days of the index procedure. Moreover, dialysis status did not confer an increased risk of 30-day return to the operating

room (OR: 2.16, 95% CI: 0.19 to 0.00577; p=0.999).

However, patients who underwent dialysis were found to be at an increased risk for readmission within 30 days of the indicated procedure (OR: 1.83, 95% CI: 1.03 to 3.34; p=0.044), have a higher risk of 30-day mortality (OR: 3.95, 95% CI: 1.58 to 11.69; p=0.002) and had lower odds of being discharged to home (OR: 0.44, 95% CI: 0.33 to 0.59; p<0.001) (Table 1).

	Odds ratio	95% Confidence interval	p-value
Mean length of stay (days)	5.88	1.29 to 2.58	<0.001
Superficial SSI	1.15	1.52 x10 ⁻³ to 2.18 x 102	0.947
Deep SSI	5.21	7.34 x10 ⁻⁵ to 3.31 x 10 ³	0.334
Urinary tract infection	0.38	2.5 x 10 ⁻³ to 4.87	0.999
Transfusion	1.55	1.10 to 2.18	0.012
Wound dehiscence	0.35	1.36 x 10 ⁻⁴ to 1.24 x 102	0.999
Cardiac arrest	2.26	0.66 to 9.64	0.200
Myocardial Infarction	12.49	3.59 x 10 ⁻³ to 4.22 X 10 ⁴	0.722
Deep vein thrombosis	14.80	1.10 x 10 ⁻³ to 4.99 x 10 ⁴	0.999
Pulmonary Embolism	1.18	9.75 x 10 ⁻⁵ to 1.57 x 10 ⁴	0.885
Stroke	13.04	5.68 x 10 ⁻⁶ to 1.13 x 10 ⁵	0.999
30-day return to OR	2.16	0.19 to 5.77 x 10 ³	0.999
30-day readmission	1.83	1.03 to 3.34	0.044
30-day all-cause mortality	3.95	1.58 to 11.69	0.002
Home discharge	0.44	0.33 to 0.59	<0.001

SSI: surgical site infection; OR: operating room

DISCUSSION

The number of CKD patients requiring dialysis continues to rise, as does the demand for THA ^[1, 13, 14]. The economic and postoperative difficulties of performing THA in CKD patients are best understood by arthroplasty surgeons. The risks associated with THA in this cohort have been a concern, but it is possible that dialysis-dependent (DD) patients may have a risk profile similar to patients that are not DD when controlling for preoperative confounders. This study utilized a comprehensive national surgical database to isolate and assess the effects of dialysis dependence on 30-day outcomes in THA patients. Our results showed DD patients had a longer hospital stay, an increased risk of receiving a blood transfusion, an increased risk for 30-day readmission and 30-day mortality, and lower odds of discharge to home. Our results did not show any direct association with other 30-day outcomes. These findings demonstrate that while DD patients are at increased risk for some complications, they are not at increased risk to experience many of the common postoperative adverse events.

This study is not without limitations. First, this is a retrospective study, and as such, cannot provide the same level of evidence as a randomized control trial in our assertions. However, through propensity score matching and coarsened exact matching, observational studies can be quasi-randomized. This method allowed our study to adjust for known confounders and assess just the effect of DD on THA outcomes. Our study is also limited by the time frame captured in this database. Events occurring after 30 days are not recorded, which limits the examined time period. Despite these limitations, the evidence presented by this study may aid providers in clinical decision-making regarding DD patients and possible surgical optimization.

Previous studies have investigated the outcomes of DD patients undergoing THA. A recent study by Patterson et al. [23] performed a retrospective multiple cohort analysis of 129,370 NSQIP patients who underwent primary total joint arthroplasty (TJA). They identified 306 DD patients in the THA cohort, and found that they were significantly more likely to be male, live in a facility, be functionally dependent, smoke, have a lower BMI, have anemia, have uremia, have hypoalbuminemia, have a history of cardiovascular or pulmonary disease, and receive general anesthesia (all p<0.05). After adjusting for demographic variables, comorbidities, and anesthesia, DD patients were significantly more likely to die (relative risk [RR]: 2.8, 95% CI: 1.3 to 6.1; p=0.012), experience an adverse event within 30 days (RR: 1.1, 95% CI: 1.1 to 1.2; p=0.001), require intensive care unit-level postoperative care (RR: 9.8, 95% CI: 3.9 to 24.3; p<0.001), have a greater LOS (RR: 1.5, 95% CI: 1.3 to 1.6; p<0.001), and be discharged to a skilled care facility (RR: 1.3, 95% CI: 1.1 to 1.5; p<0.001) when compared to non DD patients. There was no increased RR for thromboembolic complications, major cardiac events, local or systemic infectious complications, reoperations, or readmission for 30 days after primary elective THA for DD patients (all p>0.05). This study is somewhat reflective of our results, although it failed to control for relevant variables, such as race, as well as hematocrit, platelet count, and INR, most of which could be preoperatively managed.

Other studies have evaluated outcomes in arthroplasty patients who are DD. Ponnusamy *et al.* ^[15] utilized the National Inpatient Sample in a retrospective review of 2,006,522 THA patients, of whom 1251 were DD. When compared to non-DD patients, DD patients were younger (DD: 63 years vs. non-DD: 65 years; p=0.048), less likely to be female (49.3 vs. 56.5%; p=0.019), and used Medicare (84.3 vs. 53.9; p<0.0001). Dialysis-

dependent patients also had significantly longer LOS (5.9 days vs. 3.8 days; p<0.0001), higher mortality (1.88 vs. 0.13%; p<0.0001), and higher complication rate (9.98 vs. 4.97%; p=0.0001). Patients that were DD also had a higher transfusion rate (43.65 vs. 26.48%; p<0.0001) and were more likely to undergo a subsequent procedure during hospitalization (1.12 vs. 0.08%; p<0.0001). Dialyzed status was demonstrated to be an independent risk factor for greater mortality (OR: 6.66, 95% CI: 2.66 to 16.66) and complications (OR: 1.53, 95% CI: 1.01 to 2.33). Again, these results have features that agree with ours, but the authors did not adjust for patient demographics or preoperative lab values, which can lead to correlation of more adverse outcomes than may truly be attributable to DD.

Another study by Rozell *et al.* ^[8] prospectively evaluated 273 THA patients for risk factors predisposing patients to longer LOS and risk of 90-day readmissions. They revealed that CKD was an independent risk factor for LOS greater than 3 days in both univariate (OR: 4.00, 95% CI: 2.34 to 6.86; p<0.001), and multivariate analysis (OR: 3.05, 95% CI: 1.50 to 6.20; p=0.002). The disease was also found to be one of the most common medical comorbidities associated with readmission within 90-days of the index procedure. However, this study did not stratify the comorbidities according to disease severity and did not account for preoperative lab values that affect patients with CKD.

Although our results did not support this theory, studies have shown that patients with chronic renal failure (CRF) may be more prone to infection. Erkocak et al. [27] found this when assessing CRF patients who underwent TJA. They identified 359 CRF patients, and matched them 1:2 to control TJA patients, additionally assessing a subset of 50 CRF patients with end-stage renal disease (ESRD) undergoing hemodialysis. There were no significant differences in infection and mortality between nondialysis CRF patients and the controls. However, of the ESRD patients, 20% developed SSI (p=0.001), with 8% of them being periprosthetic infections (p=0.01). Inpatient mortality was higher among DD patients compared to non-dialysis CRF patients (p=0.001), and multivariate analysis revealed that ESRD patients receiving dialysis had a significantly higher risk for developing an infection (OR: 7.54, 95% CI: 2.83 to 20.12, p<0.001) and of dying in-hospital (OR: 10.46, 95% CI: 1.67 to 65.34; p=0.01). However, the number of patients in the dialysis cohort was limited, and is a subset of the larger CRF cohort. Additionally, they failed to control for neither disease severity, nor adjustable preoperative factors. Our study removes the variation of disease specific factors by control-matching, then using these factors in our analysis to give a true estimate of the effect of dialysis on the measured outcomes.

CONCLUSION

The number of DD patients who require a THA is expected to increase. Although there has been trepidation to operate on these patients based on previous reports, the present study demonstrates that compared to similar patients undergoing THA, dialysis dependence does not predict higher incidences of many common complications such as DVT, SSI and MI. However, our findings demonstrated longer stays, more transfusions, higher readmissions, and higher mortality that were attributable to the chronic disease state of dependency on dialysis. These complications are serious, but with the optimization of preoperative INR, hematocrit, and platelets, it may be possible to reduce the risk of adverse outcomes. This study opens the door to assess how better optimization of dialysis dependent THA patients may improve postoperative outcomes. Future studies should assess 90-day outcomes, as well as prospectively improving preoperative conditions for patients on dialysis that require a THA. Dialysis patients have been demonstrated to have increased risk for negative outcomes in total hip arthroplasty. However, the present study examined the short-term outcomes for these patients, finding dialysis dependence does not solely predict higher incidences of many common complications such as DVT, SSI and MI. Although, being dialysis dependent does increase the likelihood of longer stays, transfusions, readmissions, and mortality. This study adds to the literature by delineating the short-term risk for patients, giving providers insight on which aspects of care they should focus on postoperatively.

Conflicts of Interest

RED receives research support from Orthofix, Inc, Stryker, United Orthopedics, Flexion Therapeutics, and TissueGene outside the submitted work. All other authors have no conflicts of interest to disclose.

Authors' Contribution

Nequesha S. Mohamed, MD: conception of idea, writing, data interpretation and analysis

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