



The Impact of Kidney Disease on Acute Tubular Necrosis and Surgical Site Infection After Lumbar Fusion

Jonathan Nakhla¹, Rafael de la Garza Ramos¹, Niketh Bhashyam¹, Andrew Kobets¹, Rani Nasser¹, Murray Echt¹, Gernot Lang², Rodrigo Navarro-Ramirez³, Ajit Jada¹, Merritt Kinon¹, Reza Yassari¹

■ **BACKGROUND:** Kidney disease in spine surgery can be associated with serious complications.

■ **OBJECTIVE:** To investigate the rate of acute tubular necrosis (ATN) and surgical site infection (SSI) after lumbar fusion in patients with kidney disease.

■ **METHODS:** A review of the U.S. Nationwide Inpatient Sample from 2002 to 2011 was performed to identify patients who underwent lumbar fusion for degenerative spine disease or disk herniation. Four groups were established: no kidney disease, chronic kidney disease (CKD), end-stage renal disease (ESRD), and posttransplant. A multivariate analysis was performed to control for age, sex, and comorbidities.

■ **RESULTS:** A total of 268,158 patients met the criteria; 263,757 with no kidney disease (98.4%), 3576 with CKD (1.3%), 586 with ESRD (0.2%), and 239 posttransplant (0.1%). Rates of ATN were 0.1%, 2.9%, 3.6%, and 0.0% for the 4 groups, respectively ($P < 0.001$). Rates of SSI were 0.3%, 0.4%, 1.0%, and 0.0%, respectively ($P = 0.002$). After controlling for patient age, sex, and medical comorbidities, patients with CKD (odds ratio [OR], 5.42; 95% confidence interval [CI], 4.14–7.09; $P < 0.001$) and ESRD (OR, 6.32; 95% CI, 3.89–10.33; $P < 0.001$) were significantly more likely to develop ATN compared with patients without kidney disease. However, CKD (OR, 0.80; 95% CI, 0.20–3.12; $P = 0.754$) or ESRD (OR, 1.96; 95% CI, 0.38–10.00; $P = 0.415$) did not increase the risk for SSI on multivariate analysis.

■ **DISCUSSION:** The rate of ATN significantly increases based on severity of kidney disease. However, patients with transplants have ATN and SSI rates comparable with patients without kidney disease.

INTRODUCTION

Lumbar fusion surgery to address degenerative lumbar spine disease inherently harbors a myriad of postoperative complications, including surgical site infection (SSI) and acute tubular necrosis (ATN).^{1–10} A higher incidence of SSIs has been shown to result in increased pain, revision surgeries, spinal deformity, and length of stay postoperatively.^{3–7,10} De la Garza Ramos et al.¹ found that SSIs were highest in posterior lumbar interbody fusion and anterior lumbar interbody fusion procedures. Furthermore, according to Baldus et al.,⁸ ATN has been documented as a serious complication to surgery for degenerative spine disease. More specifically, rhabdomyolysis that occurred as a result of surgery or as a reaction to the bone graft can lead to ATN in patients undergoing surgery for lumbar spine disease.^{9,11–13} Postoperative ATN is an even more serious concern in patients with preexisting kidney disease, such as chronic kidney disease (CKD), end-stage renal disease (ESRD), or in kidney transplant recipients.^{1,14} Evidence shows that higher rates of SSI are found in patients with renal disease undergoing spinal surgery.¹ The analysis of the incidence of postoperative ATN and SSI in patients stratified by stages of renal disease (CKD, ESRD, or transplant) compared with patients without kidney

Key words

- Acute tubular necrosis
- Chronic kidney disease
- End-stage renal disease
- Renal transplant
- Spinal lumbar fusion
- Surgical site infection

Abbreviations and Acronyms

ATN: Acute tubular necrosis
CKD: Chronic kidney disease
ESRD: End-stage renal disease
NIS: Nationwide Inpatient Sample
SSI: Surgical site infection

From the ¹Department of Neurosurgery, Montefiore Medical Center, Bronx, New York, USA; ²Department Chirurgie, Universitätsklinikum Freiburg, Klinik für Orthopädie und Unfallchirurgie, Freiburg, Germany; and ³Spine Center New York Presbyterian Hospital/Weill Cornell Medical College, New York, New York, USA

To whom correspondence should be addressed: Reza Yassari, M.D., M.S.
 [E-mail: ryassari@montefiore.org]

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disease has not yet been undertaken and is thus the focus of the current study.

METHODS

Study Sample

This retrospective study used the Nationwide Inpatient Sample (NIS) database from the Healthcare Cost and Utilization Project from 2002 to 2011. The NIS is the largest publicly available inpatient health care database in the United States. It contains data from approximately 7–8 million hospital stays each year from a 20% sample of all nonfederal hospitals in the country (<https://www.hcup-us.ahrq.gov/nisoverview.jsp>). Diagnoses, procedures, and complications are recorded in the form of International Classification of Diseases, Ninth Edition, Clinical Modification codes.

For this study, inclusion criteria included all adult patients who underwent lumbar fusion for degenerative spine disease or disk herniation. From these patients, 4 groups were established: 1) patients without kidney disease; 2) patients with CKD without hemodialysis (CKD); 3) patients with ESRD requiring hemodialysis; and 4) a posttransplant group. Patients who underwent lumbar fusion were identified by use of International Classification of Diseases, Ninth Edition Procedural Codes 81.06–81.08 and 81.36–81.38. Patients who underwent fusion for trauma, tumor, or infection and patients younger than 18 years were excluded. Patients with CKD were identified by use of codes 585.1–585.5, 585.9, 403.00, 403.10, and 403.90. Patients with ESRD with dialysis dependence were identified via use of International Classification of Diseases, Ninth Edition codes 585.6, 403.01, 403.11, 403.91, V56.0, V56.1, V56.2, V56.3, V56.31, V56.32, and V56.8.

Collected Data

Collected data included patient age at surgery, sex, race, primary payer information, comorbidities, and in-hospital complications, specifically the occurrence of ATN or SSI. We did not seek patient consent because the data from the NIS database are void from any patient identifiers and deemed exempt from review by our institutional review board.

Statistical Analysis

All analyses were performed in Stata SE 12 (StataCorp, College Station, Texas, USA). Comparisons between groups were made using Student *t* tests for continuous variables and χ^2 test or Fisher exact test for frequencies. Multivariate logistic regression analysis was used to assess the independent effect of comorbid kidney health (no kidney disease vs. CKD, ESRD, and posttransplant) on outcome (ATN and SSI) after lumbar surgery. This analysis controlled for patient age, sex, and comorbidities. Statistical significance was defined as $P < 0.05$.

RESULTS

Demographics

A total of 268,158 patients met inclusion criteria, of whom 263,757 had no kidney disease (98.4%), 3567 had CKD (1.3%), 586 had ESRD (0.2%), and 239 were posttransplant (0.01%) (Table 1). There were statistically significant differences in terms of age, gender, race, primary payer, comorbidities, use of bone

morphogenetic protein 2, and proportion of revision procedures between all 4 cohorts. Patients in the CKD group were the oldest (average age of 70 years) compared with the other 3 groups ($P < 0.001$); the proportion of males was highest for patients with no kidney disease (54.3%), compared with 46.5%, 45.4%, and 47.3% in the CKD, ESRD, and posttransplant groups, respectively ($P < 0.001$).

The highest proportion of African Americans was found to be in the ESRD group ($P < 0.001$). Likewise, patients in the ESRD group had the highest proportion of patients with Medicare or Medicaid ($P < 0.001$) and highest rates of hypertension ($P < 0.001$), anemia ($P < 0.001$), and electrolyte abnormalities ($P < 0.001$).

Outcomes

Outcome measures analyzed for each disease group included length of stay, ATN, and SSI (Table 2). Patients who underwent lumbar fusion surgery with ESRD had significantly longer average length of stay (average stay of 8.5 days), higher rates of ATN (3.6%), and higher rates of SSI (1.0%) than did any other kidney disease group ($P < 0.001$).

Multivariate Analysis

After controlling for patient age, sex, race, insurance status, comorbid conditions, use of BMP and revision procedures, patients with CKD (OR, 7.50; 95% CI, 5.71–9.84; $P < 0.001$) and ESRD (OR, 7.06; 95% CI, 4.03–12.35; $P < 0.001$) were significantly more likely to develop ATN after lumbar fusion compared with patients without kidney disease. The odds of developing ATN were not significantly different between patients with no kidney disease and the posttransplant group (OR, 1.0), as well as between the posttransplant group and the CKD (OR, 1.0) or ESRD (OR, 1.0) groups.

On the other hand, patients with CKD (OR, 0.83; 95% CI, 0.45–1.53; $P = 0.564$), ESRD (OR, 1.34; 95% CI, 0.42–4.24; $P = 0.613$), or posttransplant (OR, 1.0) were not more likely to develop SSI after lumbar fusion.

DISCUSSION

SSI is a well-known complication after lumbar fusion.^{1,15} ATN, on the other hand, is a less common complication, but of particular concern in patients with CKD or ESRD because of the risk of further renal function deterioration.¹⁶ In this study, we sought to examine the impact of elective lumbar fusion surgery on patients with kidney disease, with special focus on the rates of both SSI and ATN. We found that the rates of SSI were not significantly different between groups, but the rates of ATN increased significantly for patients with CKD and ESRD compared with patients without kidney disease. However, more interesting was the fact that the rate of ATN was similar for patients without kidney disease compared with patients who were posttransplant status, suggesting that for patients with a functioning kidney, there does not seem to be a significant risk of acute kidney failure after lumbar fusion.

These findings are similar to Sciubba et al.'s¹⁷ findings on 30-day outcomes after lumbar fusion for patients with kidney disease. Although not directly examining ATN or SSI, these investigators found that patients with worse baseline glomerular

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