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Risk Factors and Effect of Acute Kidney Injury on Outcomes Following Total Hip and Knee Arthroplasty

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Introduction

- **Acute Kidney Injury**
- Abrupt decrease in kidney function due to structural or functional damage¹:
 - Several etiologies: ischemia, nephrotoxicity, obstruction, etc.
 - Known to significantly complicate clinical course and worsen outcomes in hospitalized patients
- **AKI After TJA**
 - 2- 15% of THA and TKA patients²
 - Potentially avoidable complication related to negative outcomes
 - longer LOS, increased readmission rates, and increased healthcare costs³
 - Can lead to CKD²
- **Risk Factors for AKI**
 - Increased age, CHF, postoperative hypotension, and hepatic failure⁴⁻⁶
 - In post-cardiac surgery patients, anemia has been reported to be a risk factor for AKI⁷⁻¹⁰ → medullary hypoxia¹¹
 - Gharaibeh et al reported that for every 5-kg/m² increase in BMI, patients had a 40% increase risk of AKI post-THA¹²

Introduction

- There remains limited information regarding the association of modifiable risk factors and AKI post-TJA
 - Anemia, length of surgery, blood loss, antibiotics, etc.
- How can surgeons better identify and proactively mitigate modifiable risk factors of AKI?
 - Risk reduction can lead to improved outcomes and lower costs

Purpose & Hypothesis

- **Purpose:**
 - 1) To determine the effect of AKI on short-term outcomes
 - 2) to identify risk factors for developing AKI following THA and TKA
- **Hypothesis:**
 - 1) AKI has significant adverse effects on short-term outcomes metrics including length of stay, discharge, and complications
 - 2) Increased BMI and inadequate intraoperative renal perfusion are **modifiable** risk factors associated with postoperative AKI

Methods: Overview

- **Study design:** Retrospective Case Control
- **Data source and collection:** Rothman Orthopedic Institute Database
- **Population/study sample:** Patients undergoing THA or TKA between 2005 and 2017 with minimum 2-year f/u
- **Intervention:** THA or TKA
- **Comparison group:** Patients who developed AKI vs. Patients who did not post-op
- **Outcome:** 1) Risk factors for the development of AKI and 2) AKI effect on post-operative pt. outcomes vs. controls

Methods: Data Collection

- **Data Collection**
 - Demographics
 - Operative Variables
 - Surgical time, antibiotic prophylaxis, EBL, Hgb
 - Medical comorbidities
 - CHF, dementia, CKD, DM, etc.
 - Outcomes Measures
 - Complications, LOS, discharge to facility, readmission, 90-day mortality
 - Creatinine level measurement (pre/post)
 - AKI defined as increased in serum creatinine by 50% or 0.3mg/dl on postop day 1 from preop measurements

Methods: Analysis

Statistical analyses

- performed to identify significant risk factors in patients who developed AKI and its effect on post-operative outcomes as compared to control
 - Continuous variables → Mann-Whitney test
 - Categorical variables → Chi-square analysis
 - Independent effect of AKI on secondary outcomes → Multivariate regression

Results: Risk Factors

Demographics

- 20,800 patients who underwent unilateral primary THA (n=10,601) or TKA (n=10,199) from 2005 to 2017
- 814 (3.9%) patients developed AKI vs. 19, 986 patients did not develop AKI

Patient Risk Factors

- Patients who developed AKI had significantly higher:
 - Age (66.4 vs 63.4, $p<0.001$)
 - BMI (31.8 vs 30.0, $p<0.001$)
 - Rates of 10 of the 17 assessed comorbidities (Appendix 1)

Operative Risk Factors

- Patients who developed AKI had:
 - Significantly lower Preoperative Hgb levels (13.1 vs. 13.5, $p<0.001$).
 - more likely to undergo TKA (55% vs 49%, $p=0.002$)
 - Significantly longer operative times (90 vs. 79 min, $p<0.001$),
 - less likely to receive TXA (14% vs. 22%, $p<0.001$),
 - Received greater intraoperative RBC transfusion units (2.1 vs 0.4, $p=0.015$)

Results: Outcomes

Clinical Outcomes

- Patients developing AKI had significantly higher:
 - rates of all in-hospital complication types except for gastrointestinal complications
 - greater LOS (3.6 vs 2.8 days, $p<0.001$)
 - discharge to facility rates (37% vs 23%, $p<0.001$)
 - 90-day mortality rates (1% vs. 0.1%, $p<0.001$)
 - 1-year PJI rates (1.8% vs. 0.7%, $p=0.001$)

Multivariate Analysis

- AKI significantly increased
 - LOS by 0.26 days (95% CI 0.14-0.38, $p<0.001$).
 - Risk of in-hospital complications (OR=1.73, 95% CI 1.45-2.07, $p<0.001$)
 - Risk of being discharged to a facility (OR=1.26, 95% CI 1.05-1.53, $p=0.012$)

Conclusions

- AKI has significant adverse effects on short-term outcomes metrics including length of stay, discharge to a facility, and increased rate of in-hospital complications
- While most risk factors for developing AKI may not be modifiable, efforts to reduce BMI preoperatively and maintaining adequate renal perfusion (anemia, estimated blood loss, and length of surgery) intraoperatively may aid in mitigating this risk.

Future Directions

- Future studies should be performed to determine if employing strategies to address modifiable risk factors pre- and intra-operatively reduce the incidence of AKI in patients undergoing TJA
- Treatment of anemia prior to TJA may be beneficial to prevent AKI
- Efforts to limit blood loss, such as using TXA, which demonstrated a protective effect in our analysis, may be effective in reducing risk of AKI

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Appendix.

Appendix 1. Patient Demographics and Comorbidities by groups of 'AKI'

	No <i>N=19986</i>	Yes <i>N=814</i>	p-value
Patient Age	63.4 (11.3)	66.4 (11.1)	<0.001
Body Mass Index	30.0 (5.73)	31.8 (6.20)	<0.001
Sex			<0.001
Female	11171 (55.9%)	367 (45.1%)	
Male	8815 (44.1%)	447 (54.9%)	
Medical Comorbidities			
Anemia	6777 (34.1%)	433 (53.4%)	<0.001
AIDS	17 (0.09%)	3 (0.37%)	0.041
Congestive Heart Failure	336 (1.68%)	50 (6.14%)	<0.001
Chronic Pulmonary Disease	2392 (12.0%)	125 (15.4%)	0.004
Cerebrovascular Disease	230 (1.15%)	20 (2.46%)	0.001
Dementia	27 (0.14%)	5 (0.61%)	0.008
Diabetes Mellitus	252 (1.26%)	22 (2.70%)	0.001
Hemiparesis	6 (0.03%)	1 (0.12%)	0.244
Malignancy	218 (1.09%)	14 (1.72%)	0.132
Metastatic Disease	45 (0.23%)	3 (0.37%)	0.437
Myocardial Infarction	844 (4.22%)	67 (8.23%)	<0.001
Mild Liver Disease	90 (0.45%)	6 (0.74%)	0.280
Moderate-Severe Liver Disease	12 (0.06%)	2 (0.25%)	0.102
Peptic Ulcer Disease	73 (0.37%)	5 (0.61%)	0.234
Peripheral Vascular Disease	261 (1.31%)	24 (2.95%)	<0.001
Chronic Kidney Disease	315 (1.58%)	74 (9.09%)	<0.001
Connective Tissue Disease	650 (3.25%)	32 (3.93%)	0.334
Charlson Comorbidity Index	0.40 (0.88)	0.84 (1.43)	<0.001

Appendix.

**Appendix 1
(continued).
Patient
Demographics
and
Comorbidities
by groups of
'AKI'**

	No <i>N=19986</i>	Yes <i>N=814</i>	p-value
Tobacco Use			<0.001
Current	1830 (9.16%)	52 (6.39%)	0.007
Former	6821 (34.1%)	333 (40.9%)	<0.001
None	11334 (56.7%)	429 (52.7%)	0.024
Illicit Drug Use			0.203
No	19557 (97.9%)	798 (98.0%)	
Former	250 (1.25%)	13 (1.60%)	
Yes	178 (0.89%)	3 (0.37%)	
Preoperative Creatinine (mg/dL)	0.90 (0.30)	1.11 (1.11)	<0.001
Preoperative BUN (mg/dL)	17.7 (6.30)	20.2 (8.05)	<0.001
Preoperative Hemoglobin (g/dL)	13.5 (1.41)	13.1 (1.62)	<0.001

Appendix.

Appendix 2. Outcomes by groups of 'AKI'

	No <i>N=19986</i>	Yes <i>N=814</i>	p-value
Postoperative Creatinine	0.87 (0.27)	1.59 (1.28)	0.000
Postoperative BUN	13.2 (5.62)	23.3 (9.32)	<0.001
Postoperative Hemoglobin	10.4 (1.43)	9.82 (1.49)	<0.001
Complication	3416 (17.1%)	267 (33.0%)	<0.001
Cardiovascular Complications	656 (3.28%)	45 (5.53%)	0.001
DVT/PE	152 (0.76%)	15 (1.84%)	0.001
Pulmonary Complications	148 (0.74%)	18 (2.21%)	<0.001
GI Complications	1153 (5.77%)	41 (5.04%)	0.422
GU Complications	300 (1.50%)	90 (11.1%)	<0.001
Neurological Complications	182 (0.91%)	17 (2.09%)	0.001
Infectious Complications	210 (1.05%)	17 (2.09%)	0.009
Discharge to Facility	4666 (23.4%)	301 (37.4%)	<0.001
Length of Stay	2.76 (2.37)	3.59 (2.59)	<0.001
Readmission	793 (3.97%)	42 (5.16%)	0.108
90-day Mortality	28 (0.14%)	8 (0.98%)	<0.001
1-year PJI	143 (0.72%)	15 (1.84%)	0.001

Appendix.

Appendix 3. Relative Variable Importance