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Clinical research study

# Benign heart murmurs as a predictor for complications following total joint arthroplasty



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## ABSTRACT

**Background:** There is scant literature examining the predictive role of heart murmurs in the absence of suspected structural heart disease on complications of non-cardiac surgery. We hypothesize the detection of heart murmurs in the absence of structural heart disease will help identify patients at risk for complications following total joint arthroplasty (TJA) surgery.

**Method:** This was a prospective cohort of patients undergoing TJA over a twenty-month period. The study was performed at a single academic institution with four subspecialty surgeons.

Patients undergoing primary TJA who were over eighteen years old, gave informed consent, and had adequate documentation were included in the study. Patients with a preoperative murmur or a newly discovered postoperative murmur were compared against patients with no murmur.

Surgery-related complications, performance with physical therapy, and discharge to a non-home facility were measured in each group.

**Findings:** 345 (63%) eligible patients were included. 20 (5.8%) patients had a documented preoperative murmur and 36 (10.4%) patients had a new postoperative murmur. No patient had concern for major structural heart disease. Preoperative murmurs independently predicted development of acute kidney injury (OR 7.729,  $p < 0.001$ ; RR 1.36). Preoperative murmurs also predicted likelihood to be discharged to a non-home facility (OR 2.97,  $p = 0.03$ ; RR 1.87). New postoperative murmurs independently correlated with decreased performance with physical therapy (OR 0.466,  $p = 0.045$ ; RR 0.664).

**Interpretation:** Detection of heart murmurs both preoperatively and postoperatively is a low cost strategy to identify post-TJA surgical patients at risk for postoperative acute kidney injury, decreased physical performance, and discharge to non-home facilities. These patients may benefit from early fluid resuscitation and renally-dosed post-operative medications.

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## 1. Introduction

Growing demand, increasing healthcare costs, and higher financial penalties for complications of non-cardiac, elective surgery has amplified interest in low-cost strategies to identify patients at risk for post-operative complications.<sup>1</sup> The cardiac exam is a low-cost screening method that may be a potential tool

for identifying at-risk patients.<sup>2,3</sup> Heart murmurs associated with major structural heart defects are correlated with high complication rates following non-cardiac surgery,<sup>3–5</sup> and current guidelines set forth by the American Heart Association and American College of Cardiology (AHA/ACC) recommend echocardiography if there is ‘moderate probability’ for structural heart disease associated with a murmur.<sup>5,6</sup> Although patients without suspected structural heart defects are usually deemed safe for elective surgery, there is no literature assessing the significance of low-grade, asymptomatic heart murmurs in patients with low-suspicion for structural disease.<sup>3</sup> These murmurs are often considered benign and do not affect surgical planning. However, it is estimated that over 30% of

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elderly patients have systolic murmurs<sup>3,7</sup> and an unknown number of patients have transient murmurs following surgery, both with unknown significance regarding surgical outcomes. Total joint arthroplasty (TJA) represents a subset of elective surgeries that are notable for increasing demand, high costs, and bundled payments. By 2033 the demand for total knee arthroplasty and total hip arthroplasty is predicted to increase by 174% and 673%, respectively compared to 2007 numbers<sup>2,8</sup> and Medicare & Medicaid Services has made a goal of including half of all Medicare payments for TJA under a new payment model, such as bundled payments by 2018.<sup>9</sup> Furthermore, TJA is a high-volume, reproducible surgery that allows for easy study comparison.

The purpose of this study was to prospectively assess the correlation between heart murmurs without suspicion of major structural heart defects and postoperative outcomes in TJA patients. Based on a pilot study, we hypothesized that heart murmurs would be associated with increased acute kidney injury (AKI) and decreased physical capacity following TJA.

## 2. Methods

This study was conducted with the approval of our Institutional Review Board. No outside funding was received. Written consent was given by all subjects, and no compensation was offered. This was a single-institution prospective cohort study including patients from four surgeons. Inclusion criteria were patients who underwent elective primary total hip or total knee arthroplasty between 4/1/14 and 12/15/15, were over the age of 18, spoke English, and provided informed consent. Patients were excluded if they had a planned ICU admission, were pregnant or incarcerated, or had inadequate documentation of the postoperative physical exam.

Pre-operative patient data collected included age, gender, body mass index (BMI), comorbid conditions, presence of preoperative murmur, and whether or not an echocardiogram was performed. Co-morbid conditions were stratified for analysis to diabetes, obstructive sleep disorder, pulmonary (asthma, pulmonary hypertension, chronic obstructive pulmonary disease

(COPD)), Cardiac (chronic heart failure, coronary artery disease, atrial fibrillation, pacemaker, conduction disease, transplant), history of cerebral vascular accident, endocrine (sarcoidosis, autoimmune diseases, thyroid abnormalities, adrenal abnormalities, pituitary axis abnormalities), hematologic (history of deep venous thrombosis (DVT), history of pulmonary embolism (PE), diagnosed bleeding disorders), chronic kidney disease, and liver disease (active hepatitis, cirrhosis). All patients were screened by a medical professional prior to surgery including a cardiac exam. As per our standard practice, patients with medical comorbidities that excluded them from a reasonably safe outcome did not receive a TJA and were not included in the study.

Post-operative, prospective data was collected during the inpatient hospital stay from the time of surgery until discharge. This data included surgery type, presence of postoperative murmur, postoperative complications, urine output, distance walked with physical therapy, and discharge location to home or non-home facility. Measured complications included myocardial infarction, atrial fibrillation, stroke, deep vein thrombosis, pulmonary embolism, acute kidney injury (AKI), and blood transfusion. AKI was defined as an increase in serum creatinine of 50% above baseline or increase of 0.3 mg/dL within 24 h.<sup>6</sup> All study patients underwent complete physical examination by a Hospitalist attending within 24 h following surgery and included whether or not a murmur was heard on exam.

Patients with heart murmurs were categorized into two groups: those with murmurs detected during the preoperative examination and those with newly detected murmurs postoperatively.

**Table 1**

Patients with pre-operative murmurs demographics.

Variable	No Murmur (325)	Pre-op Murmur (20)	Pvalue
THA	130 (40%)	6 (30%)	0.374
Male	130 (40%)	4 (20%)	0.075
Age	61.01 (51.04–70.98)	68 (57.16–78.84)	0.003
BMI	32.6(24.91–40.25)	32.7(25.7–39.7)	0.828
Comorbidities: DM	49 (15.1%)	6 (30%)	0.077
OSA	44 (13.5%)	4(20%)	0.418
Pulmonary	49 (15.1%)	4(20%)	0.553
Cardiac	41 (12.6%)	7(35%)	0.005
Stroke	12 (3.7%)	1 (5%)	0.766
Endocrine	72 (22.2%)	3(15%)	0.452
Heme	23(7.1%)	1(5%)	0.723
Renal	18 (5.5%)	2 (10%)	0.407
Liver	20 (6.2%)	0(0%)	0.253

These two groups were then compared with respect to postoperative outcomes, including total distance walked with physical therapy, likelihood to be discharged to a non-home facility, and postoperative complications. Of note, fifty feet is the distance insurance companies use to determine if a patient is eligible for discharge to a non-home facility and this cutoff was used to stratify distance walked with physical therapy.

Descriptive analyses were carried out using Student's *t*-tests and Chi-square analyses for continuous and binary variables respectively. Univariate logistic regression analysis was used to determine correlation between murmurs and measured outcomes. Univariate logistic analysis was then used to identify potential confounding variables of murmurs for identified statistically significant outcomes. Finally, multivariate regression analysis was performed to determine the independent correlation between murmurs and poor outcomes. Odds ratios were used for analysis as the unconstrained properties of odds ratios allow for more robust comparisons in a binary multivariate model. However, as relative risk is more easily clinically applicable, appropriate for prospective analysis, and makes potential future study comparison easier,<sup>10</sup> relative risk was also reported for significant univariate outcomes.

A power analysis based on an initial pilot study of 150 patients determined that a sample size of 286 was needed to reject the null hypothesis with a 0.05 significance level and a power of 90% for AKI. All statistical analysis was performed with SPSS Statistics 23 (IBM, Armonk, NY).

**Table 2**

Patients with new post-operative murmurs demographics.

Variable	No Murmur (309)	PostNoPre (36)	Pvalue
THA	125 (40.5%)	11 (30.6%)	0.25
Male	124 (40.1%)	10 (27.8%)	0.15
Age	61.2 (50–87–71.53)	63.6 (71.6–55.6)	0.18
BMI	32.59 (24.95–40.24)	32.59 (25.13–40.06)	1
Comorbidities DM	48(15.5%)	7(19.4%)	0.544
OSA	44(14.2%)	4(11.1%)	0.608
Pulmonary	49(15.9%)	4(11.1%)	0.455
Cardiac	44(14.2%)	4(11.1%)	0.608
Stroke	11 (3.6%)	2 (5.6%)	0.552
Endocrine	64 (20.7%)	11(30.6%)	0.175
Heme	22(7.1%)	2(5.6%)	0.727
Renal	19 (6.1%)	1(2.8%)	0.413
Liver	18 (5.8%)	2(5.6%)	0.948

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