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Cardiac Risk Factors and Complications After Spinal Fusion for Idiopathic Scoliosis in Children



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ARTICLE INFO

Article history:

Received 11 January 2018

Received in revised form

13 August 2018

Accepted 11 September 2018

Available online xxx

Keywords:

Congenital heart disease

Spinal fusion

Pediatrics

ABSTRACT

Background: Cardiac risk factors pose challenges in pediatric posterior spinal fusion (PSF). Differences in risk according to etiology of cardiac disease are unclear. We investigated outcomes of PSF according to presence of congenital heart defect compared to cardiomyopathy.

Methods: Elective PSF for idiopathic scoliosis in patients aged 0-18 y was identified in the 2012-2015 National Surgical Quality Improvement Program-Pediatric. Cardiac risk factors were classified as: no cardiac risk factors or minor cardiac risk factors without congenital heart defect; minor cardiac risk factors because of congenital heart defect; major cardiac risk factors because of congenital heart defect; major cardiac risk factors because of cardiomyopathy. Multivariable logistic regression compared surgical site infection, wound dehiscence, hospital length of stay ≥ 30 d, and unplanned readmission across these categories.

Results: The analysis included 5395 girls and 1691 boys, aged 14 ± 2 y. Among these, 140 patients had minor cardiac risk factors because of congenital heart defect, 144 had major cardiac risk factors because of congenital heart defect, and 20 had major cardiac risk factors because of cardiomyopathy. Rates of any complication were significantly higher among patients with cardiomyopathy (40%) compared to patients with major cardiac risk factors because of congenital heart defect (10%), minor cardiac risk factors because of congenital heart defect, or other minor or no cardiac risk factors (5%; chi-square $P < 0.001$). In multivariable analysis of 6829 patients, cardiomyopathy predicted greater odds of unplanned readmission compared to no or minor cardiac risk factors (OR = 5.9; 95% CI: 1.8, 19.7; $P = 0.004$) and compared to major cardiac risk factors because of congenital heart defect (OR = 4.5; 95% CI: 1.1, 17.6; $P = 0.032$).

Conclusions: Cardiomyopathy is a rare but significant risk factor for complications after pediatric PSF, whereas congenital heart defects did not independently contribute to risk of complications after this procedure.

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Introduction

Posterior spinal fusion (PSF) is commonly performed in children to correct spinal deformities of idiopathic,

neuromuscular, or congenital origin.¹ Although PSF is considered generally safe, comorbid conditions may increase the risk of complications after this procedure.² Particularly, perioperative complications and the need for prolonged

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<https://doi.org/10.1016/j.jss.2018.09.029>

hospitalization may be more likely among patients with cardiac comorbidities.³⁻⁵ Previous studies have reported that cardiac risk factors (CRFs) exhibit bivariate associations with increased risk of complications after pediatric spinal surgery but do not independently contribute to the risk of complications after multivariable adjustment for relevant patient and procedure characteristics.^{1,3} However, differences in the risk of complications after PSF according to the etiology of cardiac disease are unclear. For example, CRFs associated with congenital heart disease (CHD) may not increase the risk of postoperative complications in older children and adolescents,⁶ including patients undergoing PSF. Therefore, we used the National Surgical Quality Improvement Program-Pediatric (NSQIP-Peds) registry to explore independent associations between CHD, as compared to cardiomyopathy (CM), and short-term outcomes of isolated PSF for idiopathic scoliosis. Our primary hypothesis was that the presence of a major CRF because of either CHD or CM would be associated with greater risk of postoperative complications after PSF. Our secondary aim was to compare the risk of postoperative complications between CHD and CM as etiologies of major CRF.

Methods

This analysis of the NSQIP-Peds registry was deemed exempt from review by the Institutional Review Board at Nationwide Children's Hospital. Deidentified data were pooled from the 2012-2015 participant use files of the NSQIP-Peds registry, maintained by the American College of Surgeons.⁷ Primary data collection in the NSQIP-Peds was performed by each participating hospital by systematically sampling surgical cases according to current procedural terminology codes and abstracting predetermined measures of demographic, surgical, and postoperative characteristics.^{8,9} For the present analysis, elective cases of isolated PSF in patients aged 0-18 y were identified using current procedural terminology codes 22,800, 22,802, and 22,804. Cases were retained for analysis if idiopathic scoliosis was listed as the indication for the procedure. Following prior analysis of PSF in the NSQIP-Peds registry,¹ patients with open or contaminated wounds, sepsis, or inotropic support before surgery were excluded from the sample. Cases where the presence and etiology of CRF could be classified as described below were included in descriptive analysis. Cases with complete data on study covariates were included in multivariable analysis.

The primary exposure in the study was determined according to the presence and etiology of CRF. Trained coders abstracted CRFs at the time of data entry and classified CRFs as none, minor (e.g., well-controlled or repaired CHD), major, or severe.⁹ Because of the small number of patients with severe CRF, this group was combined with major CRF for analysis.³ The etiology of CRF was determined according to International Classification of Diseases-9 codes as CHD (codes beginning with 745, 746, or 747), CM (codes beginning with 425), or other. Patients were classified according to severity and etiology of CRF as follows: (1) No CRF or minor CRF without CHD; (2) minor CRF because of CHD; (3) major

CRF because of CHD; and (4) major CRF because of CM. This classification scheme excluded one patient who had minor CRF because of CM and seven patients who had major CRF not attributed to either CHD or CM. The primary outcome in the study was the presence of any postoperative complication, defined as 30-d mortality, surgical site infection (SSI), wound dehiscence, prolonged (≥ 30 d) hospital length of stay (LOS), or unplanned readmission within 30 d.¹ Secondary outcomes were each of the specific complications listed above.

Outcome variables and categorical covariates were compared according to severity and etiology of CRF using chi-square tests or Fisher's exact tests where cell counts are < 5 . Continuous covariates were compared across CRF categories using ANOVA. The primary analysis used multivariable logistic regression to test for an independent association between CHD-related and CM-related major CRF and the odds of any postoperative complication. Separate logistic regression models were fitted for each secondary outcome, except where the rarity of a specific complication (e.g., mortality) precluded multivariable analysis. The use of multivariable logistic regression to model composite and individual complication outcomes is standard in analyses of NSQIP-Peds data.^{1,3,6} Model covariates were selected according to prior evidence on predictors of complications after pediatric spinal surgery¹⁻³ and included patient age, gender, race, body mass index-for-age percentile ($< 5\%$, underweight; $5-84\%$, normal weight; or $\geq 85\%$, overweight) and American Society of Anesthesiologists (ASA) status. ASA status was dichotomized as 1-2 versus ≥ 3 to represent the presence of severe systemic disease.³ Additional covariates included the number of levels fused (≤ 6 , 7-12, or ≥ 13), need for perioperative blood transfusion, presence of neuromuscular comorbidity, and operative time. All analyses were performed in Stata/IC 13.1, and two-tailed $P < 0.05$ was considered statistically significant.

Results

The 2012-2015 NSQIP-Peds data included 10,041 cases of elective isolated PSF, of which 7302 were performed for idiopathic scoliosis. After excluding 208 patients who had open or contaminated wounds, sepsis, or inotropic support before surgery and eight patients whose severity and etiology of CRF could not be classified as described above, there remained 7086 cases for descriptive analysis. The study sample included 5395 girls and 1691 boys of average age 14 ± 2 y. The overall complication rate was 5% ($n = 369$). Complications included unplanned readmission ($n = 194$), wound dehiscence ($n = 141$), SSI ($n = 95$), prolonged LOS ($n = 56$), and mortality ($n = 5$). Minor CRF because of CHD was present in 148 cases; major CRF because of CHD was present in 146 cases; and major CRF because of CM was present in 21 cases. Study outcomes and covariates are compared according to CRF severity and etiology in [Table 1](#). The rate of any complication was significantly higher among patients with CM (38%) compared to patients with major CRF because of CHD (11%), patients with minor CRF because of CHD (9%), or patients with other minor or no CRF (5%; $P < 0.001$).

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