Navigated vs. Conventional Pediatric Spinal Deformity Surgery: Navigation Independently Predicts Reoperation and Infectious Complications

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INTRODUCTION:
Navigation (NAV) has been increasingly utilized to treat degenerative disease, with positive radiographic and clinical outcomes. However, short-term analysis on treating pediatric deformity with NAV is limited, particularly using large nationally-represented cohorts. This is the first large-scale database study to compare short-term outcomes between navigated and conventional pediatric deformity surgery. The objective of this study was to evaluate for 30-day readmission, reoperation, and morbidity, predictors of outcomes, and value per minute of operative time for pediatric patients undergoing navigated and conventional deformity fusion.

METHODS:
This is a retrospective database study using the 2012-2018 pediatric-NSQIP datasets. Patients ≤18-years old with posterior-only deformity surgery were included. Patients were identified using CPT codes 22800-22804, with CPT 61783 identifying navigated cases, and were excluded if they had preoperative infection, open wound, cerebral hemorrhage, CPR, transfusion, or inotropic support, or underwent anterior, revision, tumor, or non-elective/urgent surgery. Primary outcomes were 30-day readmission, reoperation, and morbidity. Secondary outcomes were associated predictors, specific complications, and total mean RVUs and RVUs-per-minute. Univariate and multivariate regression analyses were used to compare readmission, reoperation, morbidity, and specific complications between navigated and conventional surgery, and to control for significant predictors and baseline differences between patients. Reasons for reoperation were obtained from ICD and CPT codes.

RESULTS:
There were 23,887 pediatric patients with posterior deformity surgery, and 16,950 (356 with NAV) who met inclusion and exclusion criteria. NAV cases had greater preoperative hematocrit (40.5 vs. 39.9, p=0.005) and OR time (352 vs. 284 min, p<0.001). NAV cases had similar RVUs (58.4 vs. 60.1), but fewer RVUs-per-minute (0.21 vs. 0.23, p<0.001) (Table 1).

Navigation had greater rates of reoperation (6.2 vs. 3.1%, p=0.001), morbidity (75.6 vs. 67.5%, p=0.001), deep-wound infection (2.5 vs. 0.8%, p=0.003), transfusion (73.6 vs. 65.9%, p=0.002), and sepsis (2.2 vs. 0.7%, p=0.007). Readmission rates were similar in the NAV and conventional groups (5.9 vs. 3.9%, p=0.055). In multivariate analysis, NAV independently predicted reoperation (OR=1.920, p=0.019, CI95: 1.115-3.306) (Table 2), deep-wound infection (OR=2.926, p=0.009, CI95: 1.305-6.563), and sepsis (OR=3.192, p=0.010, CI95:1.324-7.693).

Obesity (OR=2.472), developmental delay (OR=1.926), OR time (OR=1.002), hospital stay (OR=1.040), and total RVUs (OR=1.005) predicted reoperation (p<0.001). African American race (OR=1.193, p=0.002), Hispanic ethnicity (OR=1.401, p<0.001), seizure (OR=1.384, p=0.004), OR time (OR=1.005, p<0.001), and total RVUs (OR=1.009, p<0.001) predicted morbidity. Female gender was protective against readmission (OR=0.787, p=0.021).

DISCUSSION AND CONCLUSION:
Despite controlling for patient-related and procedural factors, NAV independently predicted a 92% increased-odds of reoperation and a 2.9-times and 3.2-times increased-odds of deep-wound infection and sepsis, respectively. Navigation no longer predicted morbidity or transfusion in multivariate analysis. Readmission remained statistically similar between navigated and conventional pediatric deformity surgery. Navigated surgery took longer and yielded fewer RVUs-per-minute than did conventional surgery. Reoperation most often occurred for wound-related events, suggesting an increased-risk of infectious-related events with NAV (Figure 1). Factors such as increased OR personnel, intraoperative O-arm spins, and frequent relocations into substerile rooms, and increased setup time may ultimately increase the risk of infection in navigated cases. These factors extend beyond the reach the NSQIP dataset. As such, future research should be aimed at identifying and reducing the risk of infection in navigated pediatric deformity surgery. Further, the findings of African American race and Hispanic ethnicity as predictors of morbidity suggest that there may be socioeconomic factors that influence outcomes in pediatric fusion. The significance of this study is highlighted by the promotion and increased usage of computer assisted technologies aimed at improving outcomes in spine surgery. On a national scale, the results of the present study demonstrate that NAV is not only less efficient and associated with a lower value per operative time, but that it also independently predicts poorer 30-day outcomes.