TNT: Using Technique ‘N’ Technology to Improve Safety and Outcomes in Posterior Spinal Fusion for Adolescent Idiopathic Scoliosis

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INTRODUCTION: Pedicle screw insertion in scoliosis is challenging due to 3-dimensional deformity and abnormal pedicle morphology. Freehand or fluoroscopic guidance was frequently utilized, until technological advancements led to the adaptation of computer assisted screw insertion. These involve changing the technique from a ‘tactile feedback’ to ‘screen-based guidance’. While improvement in screw accuracy has been documented, an increase in radiation exposure, surgical time, blood loss, with increased risk of infection can occur. Our institution adopted a TNT, or technique ‘n’ technology, approach that combines freehand technique with CT-based navigation technology for confirmation and navigation for challenging pedicles.

METHODS: Retrospective chart review of 564 AIS patients between 2015 and 2023 from a single institution and 326 AIS from NSQIP 2012-2018 database undergoing posterior spinal fusion.

Part I: 206 patients were operated on using the TNT approach (TNT Group). 297 were operated on using freehand anatomic with occasional fluoroscopy assistance (FOFA Group). 61 patients were operated on solely relying on CT-based navigation technology (Navigation/CAN Group). Radiographic measurements, and clinical outcomes including radiation dose, blood loss, operative time, and 30-day complications were compared.

Part II: 206 TNT patients were compared to 326 AIS patients from the NSQIP database that were operated on using computer-assisted navigation between 2012 and 2018 (CAN Group). Operative time, length of stay, and 30-day complications were compared.

Continuous data is presented as medians and interquartile ranges while categorical data is presented as frequencies and percentages. Fisher’s Exact and Kruskal-Wallis tests were used for statistical analysis.

RESULTS: Part I: Radiation dose for Navigation patients was 24.3 mGy, compared to 14.6 mGy for TNT, and 2.3 mGy for FOFA ($p < 0.001$). Radiation time was 20.4 seconds for Navigation, 18.4 seconds for the TNT group, and 20.4 seconds for FOFA ($p < 0.001$). Operative time was significantly shorter for the TNT patients with an average of 233.0 minutes versus 251.0 minutes for FOFA and 291.0 minutes for Navigation ($p < 0.001$). TNT patients had significantly less blood loss than FOFA and Navigation patients ($p=0.03$). There were no differences in rate of transfusions or complications.

Part II: TNT Group had a mean operative time of 233.0 minutes compared to 323.0 minutes for the NSQIP Navigation group ($p < 0.001$). TNT patients had significantly shorter length of stay (3 vs. 4 days, $p<0.001$). Navigation and TNT patients had similar complication rates.

DISCUSSION AND CONCLUSION: As novel technology allows for better anatomic bone visualization, surgeons should implement these innovations into their technique accordingly, while maintaining surgical control. TNT adopts technology into the surgical approach, rather than restructuring the surgical approach itself. This hybrid technique allows surgeons the familiarity and efficiency of freehand approach to keep surgical time, blood loss, and radiation dose at a minimum, while also providing the benefit of intra-op screw confirmation and navigation when needed. TNT provides accuracy, efficiency, and safety for both the surgeon and the patient.