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Clinical Study

Low-density versus high-density thoracic pedicle screw constructs in adolescent idiopathic scoliosis: do more screws lead to a better outcome?

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Abstract

BACKGROUND CONTEXT: Thoracic pedicle screw (TPS) constructs have improved curve correction measurements compared with hook and hybrid constructs in the treatment of adolescent idiopathic scoliosis (AIS), but the optimal implant density, or the number of screws per level, remains unknown in the treatment of flexible thoracic curves.

PURPOSE: To determine how implant density affects clinical outcome, radiographic outcome, and cost in the treatment of Lenke Curve Type I AIS.

STUDY DESIGN: A retrospective clinical study.

PATIENT SAMPLE: Ninety-one consecutive AIS patients with Lenke Type I curves who underwent surgical correction with a minimum follow-up of 24 months.

OUTCOME MEASURES: Radiographic outcomes included assessment of preoperative and 2-year postoperative thoracic Cobb angle, T5–T12 kyphosis, and curve flexibility. We also assessed SRS-22 outcome measures and thoracic angle of trunk rotation (ATR) before surgery and at the 2-year postoperative time point. The cost of each construct was also evaluated.

METHODS: Bivariate analysis was conducted between implant density and the following factors: percent correction of the major curve, ATR, and change in kyphosis. The correlation between curve flexibility and percent correction of the major curve was determined. Patients were then divided into two groups: the low-density (LD) TPS group defined by implant density below the mean number of screws per level for the entire cohort (less than 1.3 screws per level) and the high-density (HD) TPS group defined by implant density above the mean number of screws per level (more than 1.3 screws per level). Independent sample *t* tests were used to compare demographic data as well as radiographic and clinical outcomes at baseline and at follow-up between the two groups.

RESULTS: Sixty-one female and 30 male patients met inclusion criteria. No significant correlations were found between implant density and the following parameters: percent correction of the major curve ($p=.25$), ATR ($p=.75$), and change in T5–T12 kyphosis ($p=.40$). No correlation was found between curve flexibility and percent correction of the major curve ($p=.54$). The LD group consisted of 57 patients, whereas the HD group had 34 patients. There were no differences between the HD group and the LD group in regard to major curve correction, change in T5–T12 kyphosis, or change in ATR. Total implant costs were significantly higher in the HD group ($13,272 vs. $10,819; $p<.01$). The SRS-22 image domain and overall score improved at 2 years within both groups, but there were no group differences in any of the SRS-22 domains or the overall score.

FDA device/drug status: Not applicable.

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The disclosure key can be found on the Table of Contents and at www.TheSpineJournalOnline.com.

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CONCLUSIONS: We identified no clinical, radiographic, perioperative, or complication-related advantage of constructs with higher TPS implant density in this patient cohort with flexible idiopathic scoliosis. Cost was significantly higher with HD constructs in comparison with LD constructs. Optimal implant density chosen by the surgeon should rely on a number of factors including curve magnitude and rigidity, bone density, and desired correction.

Keywords: Adolescent idiopathic scoliosis; Thoracic pedicle screws; Implant density; Curve correction

Introduction

Pedicle screw constructs have become increasingly popular in the treatment of patients with spinal deformity. In patients with adolescent idiopathic scoliosis (AIS), thoracic pedicle screw (TPS) constructs have been shown to improve radiographic outcomes compared with traditional hook and hybrid constructs [1–5]. Thoracic pedicle screw constructs can lead to improved coronal and axial curve correction, decreased number of fusion levels, and reduced revision rates [1–5]. In addition, they have been shown to decrease the need for anterior surgery for severe deformity and improve pulmonary function values [6,7].

Thoracic pedicle screw constructs present a unique set of risks compared with hook and hybrid constructs. The risks of neurologic and vascular complications when using TPSs are common concerns because of the proximity of neurovascular structures in the thoracic spine. However, most reports indicate that pedicle screw placement in the thoracic spine can be performed accurately and safely [2,4,8–11]. Other issues associated with TPS constructs include postoperative hypokyphosis and increased cost [4,12]. Even with these concerns, many still consider pedicle screw fixation as the state-of-the-art in spinal deformity correction [13]. Although the use of TPS constructs has become common in the treatment of thoracic scoliosis, the details of pedicle screw instrumentation are still debated. Placement of screws bilaterally at every level improves construct stiffness; however, the optimal implant density, or the number of screws per level, remains unknown in the treatment of flexible thoracic curves [11,14]. Given the expense of pedicle screws, decreasing the number of screws would improve the surgical efficiency and potentially reduce costs associated with spinal instrumentation.

Our study compared high-density (HD) TPS constructs with low-density (LD) TPS constructs in the treatment of AIS patients with Lenke Type I curves. Our aim was to determine if a greater average number of screws per level lead to improved clinical or radiographic outcome. We hypothesized that LD TPS constructs would show no difference in clinical or radiographic outcome for flexible thoracic scoliosis compared with HD constructs but would decrease cost.

Materials and methods

Patient identification and surgical technique

Consecutive patients from a single surgeon's practice between 2001 and 2007 were evaluated. Patients were identified by retrospectively querying the surgeon's operative database. Permission was previously obtained from institutional review board to enter pertinent demographic, clinical, intraoperative, and radiographic data for each patient encountered in the surgeon's practice into this database. Patients with a diagnosis of Lenke Curve Type I AIS, a surgical procedure of posterior spinal fusion with TPS instrumentation, aged between 10 and 21 years, and a minimum 24-month follow-up were identified. A TPS construct was defined as either less than or equal to two hooks in the construct or a construct in which a minimum of 80% of the anchors were screws.

Polyaxial screws were used for approximately the first two-thirds of the patients identified and then a mix of uniaxial and polyaxial screws became the preferred choice. Screws were typically placed in an anatomic position as opposed to the straight-ahead technique. Pedicle screws placed in an anatomic position followed the true trajectory of the pedicle from a more superior position posteriorly to an inferior position anteriorly. A straight-ahead technique positioned the screw obliquely across the anatomic axis of the pedicle and parallel to the vertebral end plates. The difference in the number of screws per level in the study can be attributed to the evolution of surgical technique during the years of the study. As previously reported, increasing experience with TPS instrumentation led to an increased number of total screws placed, decreased blood loss, and decreased operative times [15]. Initially, when levels were ''skipped'' (ie, no pedicle screw was placed), it was done in non-apical zones on both the convexity and concavity. Later in the series, if a pedicle screw was not placed in a given level, it would only be in a non-apical zone on the convexity. A mix of standard-, high-, and ultra-strength stainless steel