TORSIONAL RIGIDITY OF LONG SCOLIOTIC CONSTRUCTS: HOOKS VERSUS SCREWS

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INTRODUCTION:

The treatment of early onset scoliosis with a posterior hook construct and posterior fusion is often complicated by the crankshaft phenomenon, which is the gradual increase in rotational deformity due to continued anterior growth in the presence of a posterior fixation. Anterior fusion, in combination with a posterior hook construct solved the crankshaft problem and is considered the gold standard for scoliosis treatment. It has been hypothesized however, that a pedicle screw fixation alone can provide similar results in torsional rigidity as the gold standard. If this holds true, it would provide a simple one step procedure to potentially correct a scoliotic curve and prevent the crankshaft phenomenon.

In this study the torsional rigidity of scoliotic constructs were tested in two phases. The first was to test the hypothesis, that pedicle screw fixation provides as much stiffness, if not more, than anterior fusion and hook fixation. The addition of cross-connectors was also examined to determine if they provide additional rigidity. The second phase looked at the screw construct and the effect of having a pedicle screw on one side compared to both sides of T7, the usual apex of a scoliotic curve.

METHODS:

Cadaver spines from T4-T11 were used in this study; five for phase one and six for phase two. Each spine was potted at T4 and T11with the distal end being held in an angle vise to accommodate for the natural curvature of the spine. Due to the orientation of the facet joints along the thoracic spine, torsion is coupled with lateral bending. Therefore, the angled vice was attached to a X-Y linear bearing, which would accommodate for the coupled motion by allowing the spine to align to the center of the MTS torque actuator. A picture of the experimental set-up can be seen in Figure 1. A 20 N compression force was maintained, while a torque of +/- 2 N-m was applied sinusoidally at 0.25 Hz.

In phase one, each spine was tested intact, then with the hook fixation, followed by the pedicle screw fixation. Then both hook and screw constructs were tested with cross-connectors at T4-T5 and T10-T11. Next, T6-T9 was fused and both constructs were tested; again with and without cross-connectors. In phase two each spine was tested with one screw at T7 and then with two screws at T7; both times with and without cross-connectors. Figure 2 shows a diagram of the different constructs.

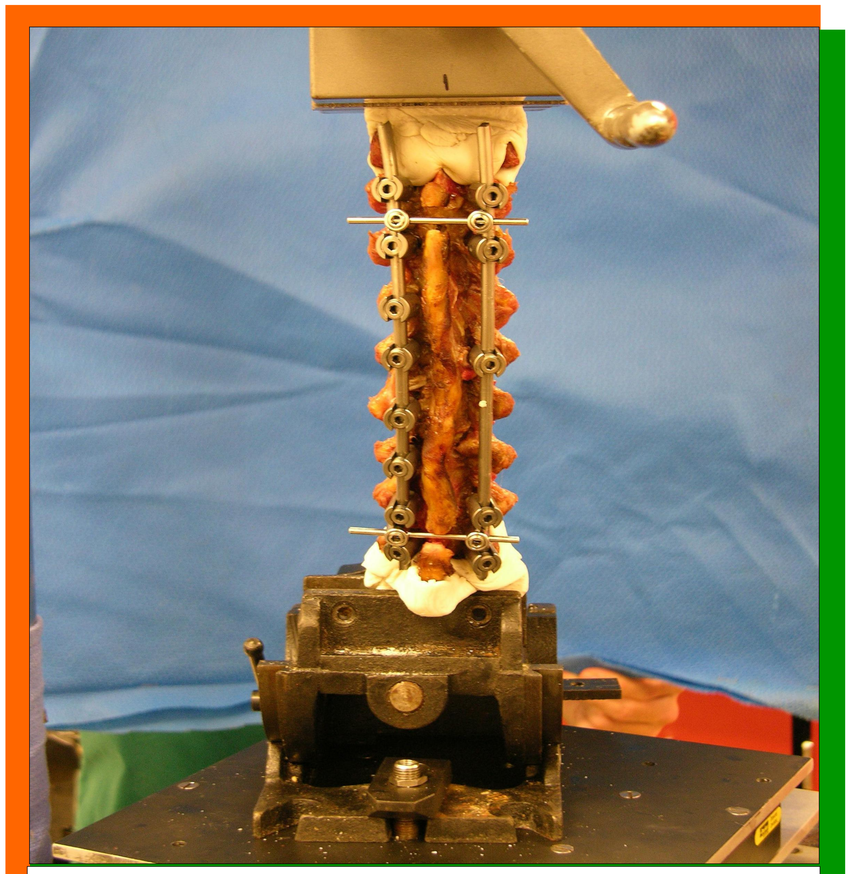

Figure 1: Experimental set-up with screws.

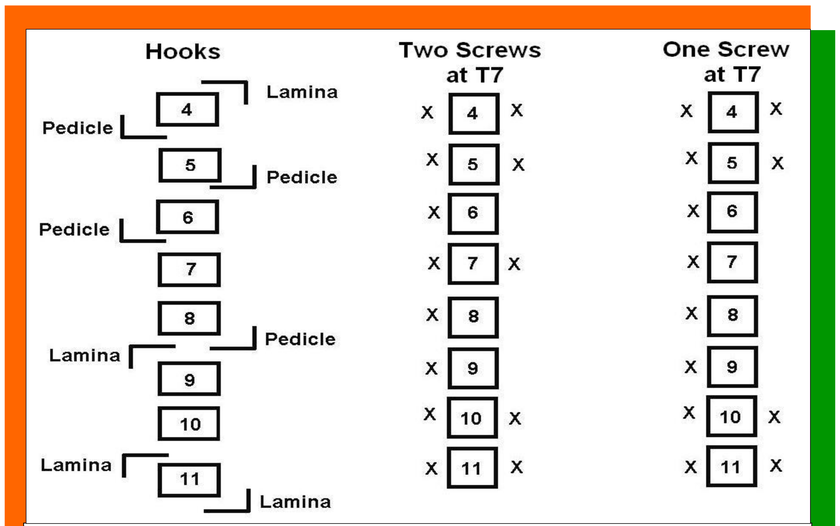

Figure 2: Placement of hooks and screws.

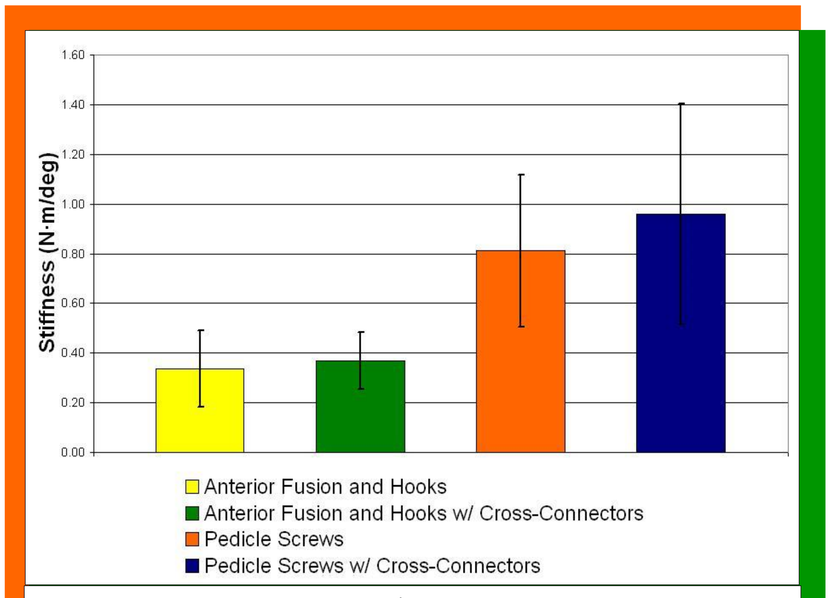

Figure 3: Phase One Data

RESULTS:

Phase one results validated our hypothesis showing a significant increase of 58.52% in torsional stiffness with the pedicle screw fixation over the anterior fusion and hook construct (p=0.0170). It was found that cross-connectors increased torsional stiffness; in the anterior fusion and hooks construct an 8.56% increase was seen, however it was not significant (p=0.1179). Interestingly, the pedicle screw construct without cross-connectors was still significantly stiffer than the anterior fusion and hooks construct with cross-connectors, by 54.64% (p=0.0199). The pedicle screw construct with cross-connectors had a 15.43% increase in stiffness compared to without (p=0.0409). When both constructs had cross-connectors, the pedicle screw construct showed an increase in torsional stiffness by 61.64% (p=0.0234). Refer to Figure 3 for graphical comparisons.

Phase two results showed a slight increase in stiffness of 1.68% with two screws at T7 compared to one, however it was not significance (p=0.1372). Though again, it was found that the addition of cross-connectors made a significant difference in torsional stiffness. An increase of 24.93% (p=0.0019) with two screws at T7 and 22.00% (p=0.0005) with one screw at T7 was found with the addition of cross-connecters. Furthermore, it was also found that one screw at T7 with cross-connectors had a 20.67% increase in stiffness over two screws at T7 without cross-connectors (p=0.0012).

DISCUSSION:

Through this study we were able to obtain biomechanical data that demonstrates the pedicle screw construct provides more torsional rigidity than the former "gold standard" of anterior fusion and hooks. This seems to reinforce the premise that pedicle screws have purchase across all three columns of the spine, passing closer to the center of vertebral rotation, thus providing better torsional rigidity. Additionally, cross-connectors were found to play a role in increasing torsional rigidity. Cross-connectors limit the relative vertical shearing motion of each long rod, which thus causes limited torsional movement.

ACKNOWLEGEMENTS:

This project was supported in part by DePuy Spine Inc., DePuy International Ltd. and the Max Biedermann Institute for Biomechanics.