The Safety and Strength of a Novel Medial, Partial Nonthreaded Pedicle Screw
A Cadaveric and Biomechanical Investigation

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Study Design: Cadaveric and biomechanical study. Objective: The aim of this study was to assess the safety and pullout strength of novel, partial nonthreaded thoracic pedicle screws compared with conventional screws.

Summary of Background Data: The perforation rate of the pedicle screws has been reported as high as 41%. Nerve injury and irritation can result from the compression of malpositioned screws on neural structures.

Methods: Ten fresh cadavers were studied. Screws, 5.0 and 6.0 mm, were inserted from T1 to T6 and T7 to T12, respectively. Pedicle perforations and fractures were recorded upon screw insertion and final positioning (nonthreaded portion facing medially) after a wide laminectomy. Pullout strength of novel and conventional screws was then tested using an Instron machine in an artificial bone substitute.

Results: A total of 240 thoracic pedicle screws were inserted. Of them, 88.8% (213 screws) were fully contained during screw insertion. There were 3.8% (12 screws) grade 1 medial perforations and 6.2% (15 screws) grade 1 lateral perforations during screw insertion. Upon final positioning, 91.3% (225 screws) were fully contained. All grade 1 perforations, which occurred during insertion, were converted to grade 0. No dural or nerve root injuries occurred. Pedicle split fractures were noted in 6.7% (16 screws). The use of medial, partial nonthreaded screws reduced the overall perforation rate from 11.2% to 6.2%. The mean pullout load for the 5.0 mm fully threaded screw versus medial, partial nonthreaded was 14.0 ± 10.1 N (12.78-15.81 N) and 13.36 ± 4.2 N (12.53-14.01 N) respectively, whereas from pullout load averaged 21.26 ± 13.4 N (18.84-23.5 N) and 20.5 ± 20.1 N (18.84-23.5 N). The difference was not statistically significant.

Conclusions: The use of medial, partial nonthreaded pedicle screws reduced the medial perforation rate from 50% to 0%; however, the pullout strength was not significantly reduced. The use of this novel screw can potentially reduce the incidence of nerve injury or irritation after medial pedicle perforations.

Key Words: novel, medial, partial, nonthreaded, thoracic pedicle screw, safety, pullout strength, biomechanical

Clinical use of pedicle screw instrumentation became popular after the 1970s. This method of fixation was soon hailed as a revolutionary step in spine instrumentation with superior biomechanical results and clinical outcomes. However, the safety of pedicle screws, especially in the thoracic spine, still remains debatable owing to the close proximity of the vital neural structures, that is, the spinal cord and nerve roots, to the pedicle screw trajectory.

Various methods have been introduced to achieve a greater safety margin of thoracic pedicle screw placement. Techniques that have been widely investigated include the free-hand, navigated, fluoroscopy with temporary K-wires, and mini-laminotomy techniques. Recently, computer navigation has also been used to increase the accuracy of thoracic pedicle screw insertion. Despite this, the incidence of screw malposition was reported to be as high as 41%.

Nevertheless, clinically significant neurological injury is rare. A neurological deficit is usually due to direct insult on the neural structures (i.e., the spinal cord or nerve root). The consequence of a malpositioned screw is difficult to predict, but the malpositioned screw can cause some degree of compression or irritation to the dural sac or nerve roots. With a reported medullary screw...