AUGMENTATİON OF TRANSPEDICULAR SCREWS WITH SUBLAMINAR WIRING BIOMECHANICAL ANALYSIS OF PULL-OUT STRENGTHS IN A BOVINE MODEL

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Pedicular screws, despite being known as the strongest method of vertebral fixation have a substantial risk of pulling out during surgical manipulations, and at the follow-up examinations, especially in the osteoporotic patients. This study is performed to see whether the pull-out strengths of transpedicular screws could be increased with the addition of sublaminar wiring at the very same spinal segment.

The right side pedicles of eight fresh bovine vertebrae were drilled, tapped, and Isola pedicular screws were placed. These screws were then attached to short segments of rods with connectors. The same procedures were performed for the left pedicles and every connector rod complex were augmented with double sublaminar wires.

The pull-out strengths were measured using Lloyd Universal Testing Machine and load-displacement curves for each screw were obtained. Although sublaminar wiring had some beneficial effects on the pull-out strengths of the screws, no statistically significant ($p = 0.17$) improvement was shown with sublaminar wiring augmentation of pedicular screw fixation.

There are several spinal insrumentation systems used to stabilize unstable spinal segments with transpedicle screws, 2, 5, 6, 7, 8, 10. There are many differences amongst these systems, but pedicular screws remain as a mile stone in the development of modern spinal surgery. Up until the time of this study was completed, no reports investigating to biomechanical effects of the augmentation of transpedicle screws with sublaminar wires could be found. Several biomechaical reports have dealth with screw design (8, 13) depth of screw placement (3, 13), and effect of anterior cortex engagement (13). If the biomechanical strength of pedicle screw increases with the augmentation of sublaminar wiring, then this new technique would be used in the clinical application.

The purpose of this study was to compare the pull-out strengths of pedicle screw alone, and pedicle screw with sublaminar wiring. As there are high level of inter specimen variations in the implant-specimen interface strength, this experiment was performed to compare right and left sides of the same vertebra; on the right side only pedicle screw was placed and on the left side pedicle screw was augmented with sublaminar wires. This design is optimally suited for statistical analysis with Mann-Whitney Two Sample Rank Sum Test. It was postulated that augmentation of pedicle screw with sublaminar wires would increase the poll-out strength of this pedicle screw.

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MATERIALS and METHODS

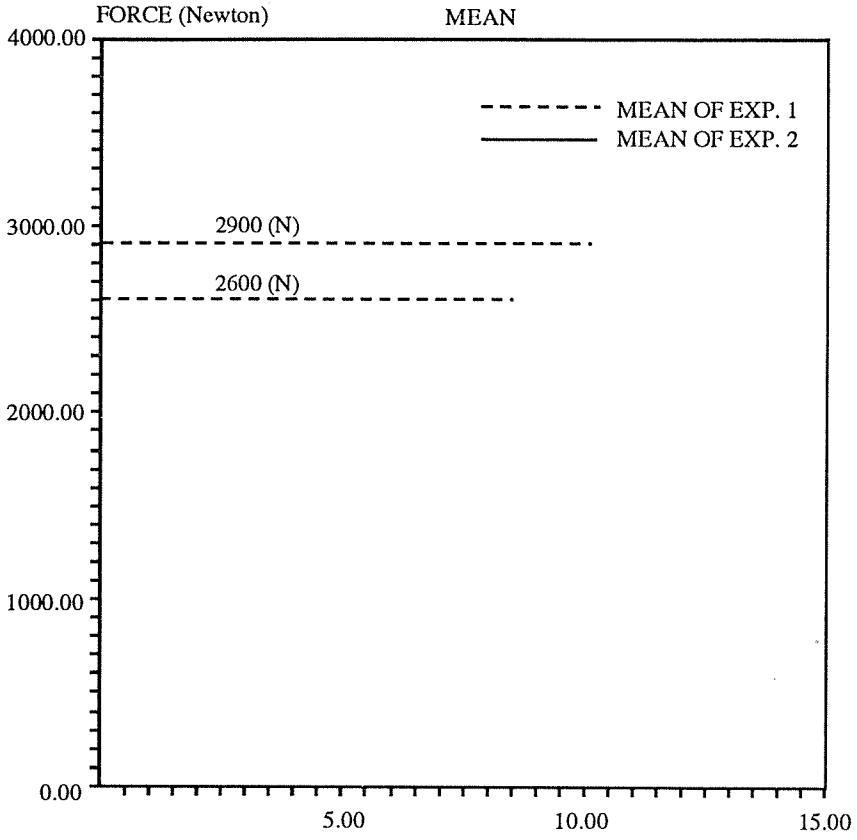
Eight thoracolumbar vertebrae from two fresh bovine cadavers weighing approximately 420 kilograms were used. No diseases of any kind was reported by the veterinarians. The vertebrae used were two T_{11}, two T_{12}, two L_1, and two L_2. Each spinal segment was removed intact at the time of sacrifice, dissected free from the soft tissues, and was immediately frozen at -70 until used in this study. At the time of the study, the specimen was thawed and individual vertebrae sharply dissected from the segment.

Each vertebra was mounted into a metallic clamp in such a way that the orientation of the posterior elements were similar to that occurring in a prone position, as in surgery, With the aid of an image intensifier mounted on a C-arm, the screws were placed into the pedicle, with an initial estimation of the entrance site as the intersection of a transverse line, which bisects the base of the transverse process, and a longitudinal line, which touches the lateral border of the superior articular process (20). 50 millimeter Isola pedicular screws and Isola sublaminar wires (Double Preformed Wire 5000-22 AcroMed Corporation) weire used on the left side. These screws (2026-3250 Corporation) have 7.0 mm thread diameter, 50 mm cancellous thread length, and 88 mm total length. A separate tap (2050-74 AcroMed Corporation) was used. This

screw length was chosen to traverse the pedicle into the vertebral body fully without penetrating the anterior cortex.

A piece of a Küncher rod, which was connected to the jig of Lloyd Universal Testing Machine, was used to stabilize the vertebrae during the experiment. This rod had the same external diameter with the internal diameter of the spinal canal of the corresponding specimen. A loading rate of 300N/sec was applied to each screw or screw-sublaminar wire combination and a load-deflection curve was generated for each specimen on each side. Any break through the pedicle cortex was regarded as failure and the experiment was stopped immediately.

Figure 1:



Standart deviation for Exp. 1: 498.47 N
Standart deviation for Exp. 2: 444.05 N

Results

The pull-out strengths for the eighth specimens were shown in Table 1.

Overall, the mean pull-out strength of screws aughmented with sublaminar wires was 451,25 N higher then the screws without augmentation. Probably because of the low sampling number, this difference was not statistically significant (P = 0.17136) as determined by Mann-Whitney test.

In figure 1, mean curves for the two groups presented together.

Table 1: Pull-Out Strengths of Pedicle Screws with and without Sublaminar Wiring

Specimen No.	Pull-out Strength without Sublaminar Wiring	Pull-Out Strength with Sublaminar Wiring
1	1940 N	2550 N
2	2190 N	2800 N
3	2550 N	3050 N
4	2600 N	3070 N
5	2920 N	3150 N
6	2950 N	3250 N
7	3260 N	3550 N
8	3430 N	4030 N

DISCUSSION

The use of transpedicle screw fixation has become an accepted and increasingly common treatment in the stabilization of thoracolumbar spine. Clinical follow-up studies of patients treated with these instrumentation systems have cited several complications related to the biomechanical behavior of the fixation systems. Failures of implant itself, such as broken pedicle screws (1, 4, 8, 12, 13), clamp loosening (7), and rod failure (9) have been reported. In addition to the failures of the implant systems, failures of the screw-vertebra interface manifested by screw loosening (1, 4, 6, 8, 10), screw pullout, and migration of the screw relative to the bone (1, 4) have also been reported.

We could not found any report investi-

gating the effects of sublaminar wiring to augment a transpedicular screw fixation.

In this study, we tried to find out the effects of supplemental sublaminar wiring to the pull-out strength of a transpedicular screw, but we could not show any statistically significant change between the pull-out strengths of the transpedicular screws without sublaminar wires and transpedicular screws with sublaminar wires, although there was a mean increase of 451.25 Newtons.

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