Analysis of Anterior Cervical Discectomy and Fusion Kinematics when Supplemented with Facet Screw Instrumentation

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SIGNIFICANCE:
Increasing stiffness in multi-level ACDF constructs has the potential to promote osseous fusion at the treated levels. Evaluation of methods to increase this stiffness and corresponding fusion rate can lead to improved patient comfort, safety, and reduced re-operation frequency.

INTRODUCTION:
One-level anterior cervical disectomy and fusion (ACDF) operations are capable of attaining high clinical fusion rates (~95%). However, maintaining a multi-level ACDF construct with adequate rigidity to promote intervertebral fusion is much more challenging. Reduction in motion at the fusion site has been found to decrease the risk of nonunion [1]. Recent hypotheses have predicted that reinforcing multi-level ACDF procedures with transarticular screws across the posterior facet joints can reduce the acute range of motion (ROM) of the treated cervical structure. However, this biomechanical stability concept has not been rigorously addressed. It is our hypothesis that transarticular screws will limit motion in the setting of multilevel anterior cervical surgery, and a kinematic analysis of cadaveric cervical spines subsequent to a three-level ACDF reinforced with unilateral and bilateral trans-facet screws was performed to test this hypothesis.

METHODS:
Eight fresh-frozen, cadaveric, human osteoligamentous cervical spines (C2-T1) were used in this study. Pure 1.5 N-m moments were effected in the axial rotation, flexion & extension, and lateral bending directions at C2 with a robotic actuator while T1 was rigidly affixed to a force sensing transducer. Euler angles were calculated using a standard stereophotogrammetric methodology, allowing intervertebral rotations to be compared between each surgical arrangement.

Each spine was subjected to four treatment configurations: 1) Untreated, 2) standard multi-level ACDF between C4 -C7, 3) ACDF with a Unilateral (left side) facet screw between C4-C7, and 4) ACDF with Bilateral facet screws between C4-C7 (Figure 1). The ACDF instrumentation consisted of the 3-level ATLANTIS VISION® anterior cervical plate (Medtronic Spinal and Biologics, Memphis, TN) with fixed angle screws at the caudal level, variable angle screws at the more superior levels, and VERTE-STACK®PERIMETER™ XS polyether ether ketone (PEEK) spacers (Medtronic Spinal and Biologics, Memphis, TN). The TOWNLEY™ TRANSFACETPEDICULAR Screw Fixation System (Medtronic Spinal and Biologics, Memphis, TN) was employed to achieve the facet fixation. Experienced spine surgeons performed all surgeries. A post-hoc, one-way ANOVA tested statistical differences where a p-value of less than 0.05 was classified as significant.

RESULTS:
Each treatment application resulted in an increase in stiffness and subsequent reduction in ROM at the treated levels; the average reduction in ROM (over all treated levels for all bending directions) versus the Untreated case was 74.9%, 87.7%, and 93.5% for the ACDF, Unilateral facet fixation, and Bilateral facet fixation groups, respectively. Bilateral facet fixation significantly decreased ROM over ACDF for all treated levels in all rotational directions. Compared to the ACDF variant, Bilateral facet fixation was the only treatment to uniformly offer a statistically-significant decrease in ROM (Figure 2).

DISCUSSION:
Application of Bilateral facet screw instrumentation was shown to significantly decrease acute ROM over a standard ACDF operation. Thus, the implementation of Bilateral facet screw arrays appears to be a suitable mechanism for enhancing the acute stability of an ACDF procedure.

REFERENCES: