MECHANICAL EVALUATION OF POSTERIOR WIRING AS SUPPLEMENT TO ANTERIOR CERVICAL PLATE FIXATION

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INTRODUCTION

Anterior plating has recently become widely used to stabilize the cervical spine as the procedure directly addresses the pathological disc and facilitates decompression and stabilization with the same exposure. However, studies have shown that anterior plate fixation is less effective than many posterior surgical constructs in treating flexion-distractive injury (1-3). Unstable cervical pathology occasionally necessitates supplemental posterior stabilization in addition to anterior plating. Previous studies using flexion-distraction injury model (3) or corpectomy model (2-5) have proven that in the presence of posterior ligament and/or facet injuries, posterior plating in combination with anterior plating provides superior fixation than either approach alone. It is unclear if supplementing anterior plating with posterior interspinous wiring would provide similar biomechanical advantages. The objective of this study is to determine if posterior interspinous wiring contributes to the rigidity of a motion segment that has been plated anteriorly, and to determine the effects of this combined instrumentation on the adjacent segment behaviors.

METHODS

Six fresh human cadaveric cervical spines were retrieved for the study. The disco-ligamentous specimens were potted in dental cement, exposing the segments from C3 to C7. A six-axis load cell (Model MC3, AMTI, Watertown, MA) was mounted in series to the inferior vertebra to verify the moments and forces applied. Two miniature pressure transducers (1.5mm diameter and 0.3mm thickness, Precision Measurement Co., Ann Arbor, MI) were implanted in each of the two adjacent discs through a 14-gauge cannulated needle. One sensor was located centrally in the region of the nucleus pulposus, and the other was situated peripherally in the lateral annulus fibrosis. Flexion, extension, left and right lateral bending, and left and right torsion loads with a maximum magnitude of 2.5 Nm were applied to the C3 in five steps. Unconstrained three-dimensional range of motion at the operative level and two adjacent levels was recorded with a three-camera motion analysis system (VICON 370, Oxford Metrice, Oxford, UK). Each spine was tested in four stages: 1) intact, 2) anterior discectomy of C5-C6 and interbody grafting with allograft bone plug, 3) interbody grafting with anterior plate, and 4) interbody grafting with anterior plate and posterior interspinous process wire. The segmental motions at the four stages were compared. Effects of each procedure on the segmental motion and disc pressure of the adjacent segments were also evaluated. Statistical analysis included repeated measures ANOVA and post-hoc tests, and a significant level of p<0.05 was used.

ESSENTIAL RESULTS

With anterior plating, range of motions at C5-C6 decreased from those with interbody grafting in all directions: 60% in flexion, 52% in extension (Figure 1), 30% and 40% in left and right lateral bending (Figure 2), and 20% and 23% in left and right axial rotation (Figure 3). All were statistically significant except in axial rotation, where p<0.08. When comparing anterior plating with combined anterior plating and posterior interspinous process wiring, the deduction in C5-C6 segment motion was 49% in flexion (p<0.05), 48% in extension (p<0.003), and 33% and 39% in left and right axial rotation (p<0.05). Further reduction in the left and right lateral bending was not significant (18% and 12% respectively).

At the two adjacent segments, changes in range of motion from anterior plating to combined anterior plating and posterior wiring were less than 5% in all directions. No significant increase of the intradiscal pressure was observed in the adjacent discs.

DISCUSSION

Combined anterior and posterior plating has been shown to provide greater stability, compared to either single approach alone, in a single level corpectomy model with concomitant posterior destabilization. In certain clinical situations anterior plating of the cervical motion segment alone may not be adequate, and additional stability, especially in flexion direction, is required. Our results show that supplemental posterior wiring with anterior plating works just as effective as the supplemental posterior plating, and further reduces the segmental motion by about 50% in flexion and extension, 33-39% in axial rotation. Findings from this study also shows that increased rigidity from the combined approach does not significantly alter the kinematics and loading conditions of the adjacent discs.

REFERENCES


![Figure 1. Range of motion for flexion and extension at C5-C6.](image1.png)

![Figure 2. Range of motion for left and right lateral bending at C5-C6.](image2.png)

![Figure 3. Range of motion for left and right axial rotation at C5-C6.](image3.png)