CONSIDERATIONS FOR THE USE OF C7 TRANSLAMINAR SCREWS IN CERVICOTHORACIC INSTRUMENTATION

Anup Gandhi, Swathi Kode, Ryan Ilgenfritz, Joseph Smucker, Doug Fredericks, and Nicole Grosland
1Department of Biomedical Engineering, 2Center for Computer Aided Design, 3Department of Orthopaedics and Rehabilitation
The University of Iowa, Iowa City, IA
email: nicole-grosland@uiowa.edu web: http://www.ccad.uiowa.edu/mimx

INTRODUCTION

The unique bony anatomy of the C7 vertebrae poses a challenge for instrumentation at the caudal aspect of the cervical spine and cervicothoracic junction. Although widely used at C7, cervical pedicle screws placement is a challenge due to the close proximity of the vertebral artery and neurological structures [1].

Due to similar anatomic constraints, the use of translaminar screw fixation has become popular in the upper cervical spine (at C2) and upper thoracic spine (at T1 and T2) [3, 4]. Biomechanical analyses of such instrumentation has demonstrated the ability to control motion along multiple axes in order to provide a stable mechanical environment for fusion at these highly mobile segments [5]. Extrapolation of this data to clinical use at the C7 level has begun to develop in the literature, however, there is a current lack of objective data to support the safe use of C7 translaminar screws in patients [6].

The objective of this study was to determine experimentally the applicability of C7 translaminar screws in cervicothoracic instrumentation via a biomechanical analysis.

METHODS

Eight C2 and six C7 vertebrae were harvested from nine human cadaveric spines (4 male and 5 female) for this study. In preparation for biomechanical testing, the specimens were thawed to room temperature and denuded of all soft tissue.

Bilateral crossing translaminar screws were placed in each C2 and C7 vertebrae (Figure 1) using previously described techniques [3, 4]. Based on radiographic measurements of C7, 3.5mm diameter x 20mm long titanium poly-axial screws (Stryker Orthopaedics, NJ) were selected as the standard screw size and used universally in all specimens.

Figure 1: C7 vertebra implanted with bilateral translaminar screws axially aligned for pullout.

Each specimen was potted in PMMA and mounted on a material testing machine (858 MTS Mini Bionix II; Eden Prairie, MN). The specimen was cyclically loaded (± 50N) at the rate of 1Hz for 5,000 cycles, parallel to the cranial-caudal axis of the vertebrae using a custom designed fixture. The displacement of the screw head was recorded after the first cycle and every 50 cycles thereafter. After cyclic loading, the screws were pulled in line with their central axis at a rate of 2.5 mm/min until an abrupt change in the slope of the load-displacement curve was noted (Figure 1). The peak load to failure (Newtons) and the mode of failure was recorded.
Following the testing of the C7 translaminar screws, bilateral pedicle screws were placed in each C7 vertebrae under direct visualization[2]. Biomechanical data was then obtained for each C7 pedicle screw using the aforementioned laminar screw protocol.

A student t-test was used to analyze the pullout strength measurements. For all statistical analysis, significance was set at p<0.05 value.

RESULTS AND DISCUSSION

A total of twelve C7 crossing laminar screws were placed without complication or laminar cortical breach, in a total of six specimens. Four of the six C7 specimens had failure of the bony lamina-lateral mass junction before failure at the screw-bone interface. In these instances, the fracture occurred during load to failure testing of the first screw, making testing of the second screw not possible. The load at which fracture occurred in these specimens was recorded as “pull-out strength” for the single screw that was tested. Similar occurrences were not encountered during testing of the C7 pedicle screws or the C2 laminar screws. The mean load to failure after cyclic loading was 452.9±206.24 N for the eight C7 laminar screws tested.

A total of sixteen C2 crossing laminar screws were placed without complication or laminar cortical breach, in a total of eight specimens. The mean load to failure after cycling was 384±284 N for the sixteen C2 laminar screws tested.

A total of ten C7 pedicle screws were placed without complication or pedicle cortical breach, in a total of five specimens that had previously undergone testing with C7 laminar screw fixation. The mean load to failure after cycling was 585±411.6 N for the ten C7 pedicle screws tested.

Student t-test showed no statistically significant difference in load to failure values between C7 and C2 laminar screws (p=0.506), or load to failure between C7 laminar screws and C7 pedicle screws (p=0.391).

Figure 2: Mean screw pullout strength after cyclic loading.

CONCLUSIONS

Biomechanical analysis performed in this study suggests that C7 translaminar screws are at least as strong as similar screw fixation at C2. According to biomechanical trends in this study, the load to failure for the C7 laminar screws was less than that exhibited by the C7 pedicle screws. However, there was no statistically significant difference between the C7 laminar screws and C7 pedicle screws. Additional work needs to be completed in order to safely apply this data to clinical practice. Hence, we plan to investigate the applicability of this technique by testing multilevel constructs.

REFERENCES


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