Posterior cervicothoracic junction fixation: a biomechanical comparison

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Introduction: The transition from the highly mobile and lordotic cervical spine to the relatively stiff and kyphotic thoracic spine places great demands on posterior instrumentation at the cervicothoracic junction (CTJ). However, because of the difficulties in anterior surgical access to the CTJ, posterior Cervial pedicale screws are known to provide excellent fixation but are potentially dangerous and technically demanding to insert. Lateral mass screws are safer and easier to insert but have less fixation strength and must often be short at C_7 to accommodate its thin alteral mass. We searched for other methods to augment the stability of C_7 lateral mass fixation. The purpose of this study was to compare the relative stiffness of posterior CTJ reconstruction with pedicle screws at T_1 (T_1 – PS) plus one or other of the following five configurations at C_7 and C_6 C_7: 1) pedicle screws at C_7 (C_7 – PS), 2) lateral mass screws at C_7 (C_7 – LM) , 3) lateral mass screws at augmented with wiring (C_7 – LM + W), 4) lateral mass screws at C_6 and C_7 (C_6C_7 – LM) and 5) lateral mass screws at C_6 and C_7 augmented with wiring. (C_6C_7 – LM+W)

Methods: Twelve cadaveric cervical specimens were divided into 3 groups. The first two groups (A and B) (4 specimens each) were potted to allow motion at C_7 – $T_1$and the third group (C) (4 specimens) was potted to allow motion at C_6 – T_1. All specimens then were tested intact on an MTS mini – Bionix machine in seven loading modes: 1) compression (50 N); 2) flexion (1.5 Nm) ; 3) extension (1.5 Nm) ; 4) left and 5) right lateral bending (1.5 Nm each) ; 6) left and 7) right torsion (10 each). Each loading sequence was repeated three times and a load deformation curve obtained each time; from these curves, stiffness values obtained were obtained. Next, each specimen was subjected to an injury of distractive flexion, Stage 3 of Allen at C_7 – T_1 , and then tested again according to the seven loading modes after each of the following constructs were applied : in group A 1) C_7 – LM , T_1 –PS , 2) C_7–LM , T_1- PS plus Bohlman triple wiring : in group B, C_7 –PS, T_1-PS; and in group C,1) C_6C_7-LM, T_1-PS, 2) C_6C_7 – LM, T_1 – PS plus Bohlman triple wiring. The stiffness values were normalized

against the corresponding values obtained for the same loading mode tested for the intact specimen.

Results: In axial compression loading, the specimens constructed using C_7 – PS, T_1 – PS showed significantly ($p < 0.001$) greater stiffness than the other four constructs. In extension, there are no significant differences between any of the five constructs. In flexion, lateral bending and axial torsion, C_7– PS, T_7 – PS and C_6C_7 – LM, T_1 –PS with or without wiring provided significantly ($p < .05$) greater stiffness than C_6 – LM, T_1– PS with or without wiring. Except compression loading, there are no significant differences between C_6 –PS, T_1 – PS and C_6C_7 – LM, and T1 – PS with or without wiring. None of the constructs showed a significant increase in stiffness when augmented with wiring. (C.f. C_7 –LM, T1-PS with and without wiring, and c.f. C_6C_7 –LM, T_1-PS with and without wiring)

Discussion: Posterior fixation with pedicel screws at C_7 and T_1 provides a stiffer construct than lateral mass screws at C_7 and pedicle screws at T_1 for single level fixation at the CTJ, even when supplemented by wiring. But when extended one more level of lateral mass to C6 the stiffness of the construct is comparable to C_7T_1 pedicle screw fixation. (Except in compression) Posterior spinous process wiring did not increase the stiffness of lateral mass fixation.

Conclusion: Pedicel screws fixation provides the stiffest fixation for stabilizing the cervicothoracic spine. Two – level lateral lateral mass screws fixation (with or without wiring) offers a fixation that approximates the stiffness of a one-level pedicle screws fixation.