Poster #55 2001

Atlantoaxial Arthrodesis by Unilateral Transarticular Screw: A Biomechanical Study
Lois A. Nichols, MD, Debi P. Mukherjee, ScD, Alan L. Ogden, BS, Ray H. Mayeux, BS, Karl K. Bilderback, MD (Shreveport, LA)

INTRODUCTION: Previous studies comparing the stability of C1-C2 fixation by Gallie or Modified Brooks (MB) technique showed that MB posterior wiring improved the stability over that of Gallie and a fusion rate of 96% was achieved. The use of two transarticular screws (TAS) improved the fusion rate to 100%. A recent biomechanical study confirmed the clinical findings that rotation and bending stiffness of C1-C2 constructs fixed with two transarticular screws improved significantly over those fixed by MB. Variant vertebral artery anomaly may prevent the placement of bilateral screws. In these cases wiring alone or wiring augmented by a single screw contralateral to the anomalous vertebral artery may be used. The objective of this biomechanical study was to examine stability of C1-C2 constructs fixed with a unilateral transarticular screw and central posterior wiring with bone graft (similar to Gallie technique). The stability was examined in rotation, bending, flexion, and translation. Stiffness values in the elastic region and degrees of initial laxity (neutral zone) were measured. These results were compared with those from an earlier study where C1-C2 arthrodesis was done with either modified Brooks posterior wiring or two transarticular screws.

METHODS: Cervical spines from six individuals with an average age of sixty-seven years (range 54 to 85 years) were harvested from human cadavers. The specimens were cleaned of skin and soft tissues disarticulating the C5-C6 joint and removing the occiput. The segment between C2 and C5 was potted so that the motion would occur only at the articulation between C1 and C2. The specimens were destabilized by cutting the transverse ligament on both sides and by cutting the tectorial membrane between C1 and C2. The odontoid was easily dislocated from its articulation with the ring of C1 after destabilization. The TAS fixation was performed by placing one screw in either left or right in a random fashion. The holes were tapped and one 3.5-millimeter cortical screw was placed. A wedge shaped lyophilized bone graft was placed posteriorly and held in place by twenty gauge stainless-steel wires. Each specimen was tested for stiffness of C1-C2 articulation.
with respect to rotation, lateral bending (both left and right directions), flexion, and anterior translation. The rotational measurements were performed using the servohydraulic biaxial Instron Tester (Model 8874) at ± 1 degree with an initial axial load of 67N. The lateral bending (right and left) and flexion tests were performed using the uniaxial Instron Tester (Model 4202) by applying a bending load at 3.8 cm from the loading point and displacing one millimeter. Anterior translation was measured by holding C2 and moving C1 anteriorly in the sagittal plane by 1 mm. Each specimen was initially cycled for 5 times and data were taken during the 6th cycle to minimize viscoelastic effects. The stiffness values in the elastic region and the initial laxity (neutral zone displacement at no load) were determined.

RESULTS: The average stiffness values in rotation was 1.44±0.52 N-m/degree. The average bending stiffness values (N-m/mm) were 2.50±1.24 for right bending and 2.90±1.54 for left bending. The average bending stiffness in flexion was 0.832±0.21 N-m/mm. The average translational stiffness was 64.37±26.77(N/mm). All of these stiffness values (except flexion) from the current study were close to those of the constructs fixed by Modified Brooks posterior wiring but lower than those of the constructs fixed by two transarticular screws as reported earlier. In flexion, the average stiffness value of the constructs fixed with unilateral transarticular screw was lower than that of the constructs fixed by either Modified Brooks posterior wiring or two transarticular screws. The initial laxities i.e, neutral zone values (mm) were 0.460±0.07 and 0.465±0.07 for right and left lateral bending respectively, and 0.574±0.17 for bending in flexion. All of these values were higher than the earlier reported values of constructs fixed by either Modified Brooks posterior wiring or two transarticular screws. It is not known how much laxity is allowable in clinical situations. Further clinical studies will be needed to compare the stability of the C1-C2 arthrodesis by using one transarticular screw with those fixed with either Gallie or Modified Brooks posterior wiring.

CONCLUSIONS: The mechanical properties in bending, rotation, and translation for the C1-C2 constructs fixed with one screw were close to those of the constructs fixed by Modified Brooks posterior wiring but lower than those fixed with two transarticular screws in comparison to data reported in an earlier work from the same institution. In flexion, the unilateral screw fixed constructs have lower stiffness than that of either Modified Brooks posterior wiring or two transarticular screws fixed constructs. The initial laxity (displacement in neutral zone) of the construct fixed by one
transarticular screw was higher than that of the construct fixed by either Modified Brooks posterior wiring or two transarticular screws. Further clinical studies are needed to prove the efficacy of C1-C2 arthrodesis by one transarticular screw.