CT and Biomechanical Analysis of Occipitocervical Stability Afforded by Three Fixation Techniques

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Introduction: With a majority of neck flexion/extension occurring at the Occipital/C1 junction, the mobility creates an environment which is difficult to immobilize and fuse. Therefore, additional methods of gaining further biomechanical stability have been pursued. Occipital condyle screws appear to be a novel technique which demands biomechanical consideration. It has the potential to achieve fixation anterior to the axis of rotation while offering a point of fixation in line with the C1/C2 screws. Therefore, the objective of our study was to compare the segmental stability and ROM of standard occipitocervical screw/rod and plate constructs versus a new technique which incorporates occipital condyle fixation.

Methods: Ten fresh frozen human cadaveric occipitocervical spines were radiographically evaluated to rule out spinal pathology and DEXA scanned for bone mineral density. Spinal segments were tested intact to establish physiologic baseline range of motion. Following intact analysis all specimens were instrumented bilaterally with C1 lateral mass screws and C2 pedicle screws. Additional occipital instrumentation was tested in random order under the following conditions: 1) Standard Occipitocervical plate/rod system, 2) Occipital condyle screws alone, 3) Occipital condyle screws with the addition of an eyelet screw placed into the occiput bilaterally. Each reconstruction was tested using a custom made 6 degree-of-freedom spine simulator configured with a MTS 858 MiniBionix II testing machine (MTS Systems Inc., Minneapolis, MN) under axial rotation (±1.5Nm), flexion / extension (±1.5Nm), and lateral bending (±1.5Nm). Following non-destructive ROM testing, specimens were evaluated under computed tomography (CT). Finally, all specimens underwent destructive forward flexion failure comparing the standard occipitocervical plate rod/system to the occipital condyle screws with eyelet screws.

Results: During range of motion testing, all reconstructions significantly reduced occipitocervical range of motion compared to intact specimens under all methods of loading. There was no significant difference in occipitocervical (Occ to C1) axial rotation and flexion-extension range of motion between the standard occipitocervical plate/rod system (Group 1) and the occipital condyle screws with one eyelet screw bilaterally (Group 3) (p=0.707 and p=0.271, respectively) (Figure 1). Furthermore, the occipital condyle screws alone (Group 2) did allow significantly
more flexion-extension compared to Group 1. Interestingly, the two groups with occipital condyle screws (Groups 2 and 3) had significantly less lateral bending compared to Group 1 (p=0.038 and p=0.025, respectively). During CT analysis, the mean occipital condyle width was 10.8 mm (range 9.1-12.7 mm) and the mean condylar length was 24.3 mm (range 20.2-28.5). Upon destructive testing, there was no significant difference in forward flexion failure between Groups 1 and 3 (p=0.348). The mean torque to failure was 39.7 +/- 20.2 Nm in Group 3 and 30.3 +/- 6.1 Nm in Group 1.

Conclusions/Significance: With instrumentation across the mobile occipitocervical junction, our results indicate similar stability can be achieved with occipital condyle screws/eyelet screws compared to the standard occipitocervical rod/plate system. The occipital condyle screw constructs have the potential for decreased dissection and prominence postoperatively while offering similar biomechanical stability.

Figure 1: Occiput to C1 Range of Motion Following Reconstruction

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