• BIOMECHANICAL COMPARISON OF FIVE DIFFERENT ATLANTO-AXIAL POSTERIOR CERVICAL FIXATION TECHNIQUES.

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Introduction: Previous investigations have demonstrated that three-point fixation, using bilateral transarticular screws in combination with posterior wiring, provide the most effective resistance to minimize motion about C1-C2. However, transarticular screws are technically demanding and require considerable experience. Posterior wiring techniques affording one point of fixation, such as Brooks and Gallie, have indicated failure rates of ~15%, which are considered secondary to structural bone graft failures. The present study was undertaken to compare five different reconstructions of the atlanto-axial complex. The primary objective in the present study was to determine whether non-bone graft dependent one-point-fixation could afford stability levels equivalent to three-point reconstruction.

Methods: Eight human cervical specimens (C0-C4) (age range 70-94 yr., mean 78.1) were utilized in the current study. Non-destructive biomechanical testing was performed, including axial rotation (+1.5Nm, 50N preload), flexion/extension (+1.5Nm) and lateral bending (+1.5Nm) loading modes. Following intact spine analysis, fracturing the odontoid process destabilized each specimen. Each specimen was then reconstructed in the following order: [1] Supralaminar hooks over C2 in combination with C1 claw (HC) [2] Pedicle screws in C2 in combination with C1 claw (PC) [3] Bilateral C1-C2 transarticular screws (Magerl) (M) [4] Bilateral C1-C2 transarticular screws combined with a posterior wire fixation according to Gallie using structural bone graft (MG) [5] Bilateral C1-C2 transarticular screws in combination with the C1 claw (MC). Unconstrained three-dimensional segmental motion were measured using an optical motion analysis system (Optotrak 3020). Range of motion (ROM degree, Euler angles) at C1-C2 and the level above and below were normalized to the intact condition and statistically compared using a One-Way Analysis of Variance and Scheffe’s post-hoc test at 95% confidence.

Results: Under axial rotation, all C1-C2 reconstructions indicated significantly lower ROM levels than the intact spine (p<0.001.). The two and three-point reconstructions using transarticular screws (M) provided lower ROM than the one-point reconstructions: PC vs. M, MG, MC and HC vs. MG and MC (p<0.05) (Figure 1). During flexion/extension, lower ROM levels were observed in one and three-point fixations when compared to intact spine at p<0.05 (Figure 2). In lateral bending, no significant differences between the six groups were indicated, although the trend was that reconstructions including transarticular screws afforded less ROM than one-point reconstructions.

Discussion / Conclusions: Three-point reconstruction using bilateral transarticular screws in combination with the C1-claw device (MC), proved to markedly reduce motion in all planes compared to one and two-point fixations. The one-point fixation constructs – HC and PC – which do not rely on structural bone-graft, resulted in less stability compared to the three-point reconstructions. An interesting finding was that adjacent level range of motion during rotation seemed to increase following reconstruction, although no significant differences were observed. The findings of the present study may explain why bone-graft-dependent posterior wire fixation fail in ~15% of cases, and provides a strong argument for the use of three-point fixation in surgical management of C1-C2 instability. The current study substantiates the use of three-point fixation as the treatment of choice for C1-C2 instability. When used in combination with transarticular screws, the C1 claw device provides an alternative to posterior wiring reconstructions.

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C1-C2 Reconstruction Techniques

![C1-C2 Axial Rotation - Range of Motion](image1)

Figure 1: Axial Rotation Range of Motion: * Indicates significant difference from the intact condition; # from Magerl-Gallie and Magerl-Claw; $ from Magerl, Magerl-Gallie and Magerl-Claw. Error bars represent one standard deviation and significance is indicated at p<0.05

![Flexion-Extension Stiffness](image2)

Figure 2: Flexion-Extension Stiffness; * Indicates significant difference from the intact condition. No other significant differences observed. Error bars represent one standard deviation and significance is indicated at p<0.05

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