Cervical Range of Motion Following Anterior Cervical Decompression and Fusion Procedures

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Introduction

Anterior cervical decompression and fusion (ACDF) is a well-established surgical treatment option for compressive pathologies associated with radiculopathy and/or myelopathy. This procedure allows surgeons direct access to the anterior aspect of the neural structures permitting thorough decompression, and when combined with a bone graft and plating instrumentation, results in excellent fusion rates and improvement of pain scores and neurologic status. However, despite good clinical outcomes, the effects of this operation on patients’ cervical range of motion (CROM) are not well defined. Therefore, the purpose of this research study was to compare the CROM of subjects following an ACDF surgical procedure to age-matched pre-operative (symptomatic) and healthy (asymptomatic) control cohorts and to elucidate differences in CROM as a function of postoperative time and number of fused levels. It is hypothesized that CROM of subjects following an ACDF procedure - 1) will be greater than the pre-operative cohort, 2) will be less than the healthy control cohort, 3) will increase as time passes post-operatively, and 4) will decrease with increasing number of fused levels.

Materials and Methods

The study involved a total of N=95 subjects (ages 40 - 65): n = 11 pre-operative subjects, n = 16 healthy control subjects and n = 68 ACDF surgical patients (21, one-level; 22, two-level, 15 three-level, and 10 four-level augmented with posterior hardware for increased stability). The pre-operative (symptomatic) cohort consisted of patients scheduled for an ACDF procedure within 1 month of surgery and the healthy (asymptomatic) control subjects were volunteers with no prior history of neck pain. Post-operative ACDF subjects were recruited (IRB # 0501106) in conjunction with routine visits to their respective surgeon. Their CROM was tested using the Cervical Motion Analyzer (CMA)5,6, which consisted of a magnetic tracking system (Nest of Birds), and a head mounted virtual reality display (i-glasses). Active head movements (6-DOF) relative to the torso were recorded via a programmable visual interface controlled by a personal computer. Subjects executed three to five cycles of the primary motions (flexion/extension (F/E), axial rotation (RAR/LAR), and lateral bending (RLB/LLB)) followed by combined motion testing in which the patient axially rotated to a user defined location (approximately 75% of maximum) and then performed three to five flexion/extension cycles. The data was grouped according to post-operative timecourse (3-6 months, 6-12 months, and 12+ months) and number of fused levels. A Student’s t-test (p = .05) was used to determine significant differences between the study groups.

Results

The timecourse data, plotted in Figure 1, indicated a trend of post-operative motion restoration at 3-6 months and 6-12 months compared to the pre-operative cohort, but in general the motion was not restored (p<0.05) to the level of the healthy cohort. At 12+ months there was a trend of decreased motion compared to the earlier post-operative time points. The combined motion timecourse data was plotted relative to maximum primary flexion/extension in Figure 2 and demonstrated a reduction in flexion/extension with greater percentage of maximum axial rotation for all groups except the pre-operative cohort. The healthy cohort also exhibited a trend of less combined flexion w/r/t axial rotation but more combined extension w/r/t axial rotation. The influence of the number of fused levels was plotted in Figure 3. Overall, there was a trend of decreasing CROM with increasing number of involved levels.

Discussion

This study utilized a novel CROM measuring system to actively track the subject’s primary and combined motions. The results of this study can be directly compared to the study published by Hilibrand et al. in 2006. Unlike the 2006 study, this study included an age-matched healthy cohort and segmented the post-operative results into clinically relevant recovery periods, but overall, the timecourse findings were similar. The fact that the 12+ month data was lower than earlier time points could be attributed to recurrent pain or complications, but this could not be confirmed. Additionally, this study found that with increasing number of fused levels there was decreasing CROM, which was contrary to Hilibrand’s findings. This finding would indicate that at least some of the motion is lost and not transferred to adjacent segments, as was previously suggested. These differences could be attributed to difference in methodology (larger patient population, active vs. passive motion, testing system, etc.) Future work looking at segmental kinematics is ongoing in our laboratory.

The combined motion data is novel and may be more representative of common motion paths experienced during activities of daily living. Interestingly, the pre-operative group did not exhibit the characteristic drop in flexion/extension with increasing axial rotation and the healthy cohort exhibited opposite responses compared to the post-operative group for flexion vs. extension. The clinical significance of these findings requires further investigation, but it is theorized that combined motions may be mechanistically different than their primary counter parts.

A longitudinal prospective study is ongoing in our laboratory, designed to address the limitations of this study (cohort study design, patient satisfaction survey such as NDI).

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References