Measurement of the spinal stenosis at and in the presence of a degenerated cervical C5-C6 segment as a function of head-neck posture

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Introduction

Spinal degenerative changes at the lower cervical levels especially C5-C6 is an increasingly common condition in which the spinal canal and cord tend to be compressed by budging discs. In people suffering from this condition an essential question is how the daily repetitive postures of the head-neck relate to a C5-C6 spinal stenosis. Because the standard imaging posture of the C-spine is the neutral and there are no reports on the effects of other postures like flexion, extension, lateral bending, and axial rotation quantitatively, it is unclear if these postures play significant parts of the condition and escape detection. Past research address the flexion and extension postures alone (1-3). Moreover, these studies either rely on healthy volunteers (1), or conclude based on changes in the midsagittal cervical spinal canal diameter (3) or on a qualitative measure of the stenosis severity using an observer-dependent grading system (2). This study reports the Spinal Canal Area (SCA) changes at C5-C6 across the full array of the said head-neck postures in a middle aged adult male volunteer diagnosed with diffuse disc bulge causing a moderate cord compression at C5-C6.

Methods

A middle aged adult male volunteer with diffuse disc bulge and moderate cord compression at C5-C6 was recruited for this MRI study. The volunteer provided an informed written consent after approvals from ethical committees from Kuwait University and Kuwaiti Ministry of Health of the study. A total of 49 scans were acquired with the subject laying supine in a 1.5T MRI machine (GE Medical Systems). These 49 scans consisted of 7 scans per head-neck posture acquired with 15 minute resting periods between scans of different postures and one- to-three day(s) resting periods between 7 repetition scans, to minimize carryover errors in the data. During imaging the subject was instructed to hold his head-neck maximally either flexed, extended, laterally bent to the left, laterally bent to the right, axially rotated to the left, axially rotated to the right, or neutral (straight). Imaging was carried out with a 3D FIESTA sequence, 256 x 256 matrix size, 4.2ms TR, 1.5ms TE, 18cm FOV, and 4 NEX. The percent drop in SCA is assessed based on estimates from two locations in a given head-neck posture; at C5-C6 and another region where the canal appears uncompressed. The SCA was measured from a carefully hand-drawn regions of interests (ROI) around the canal in the axial images and was averaged over the results from the 7 scans obtained per posture. The data was evaluated in a one-way fixed-effect repeated-measures ANOVA design.

Results

ANOVA results showed the effect of head-neck posture on SCA to be significant ($p<0.001$). Figure 1 shows the percent SCA drop as a function of posture. Extension is the least influential of all and right lateral bending the least precise of all. From this figure, it is clear that right lateral bending, flexion, right axial rotation, left axial rotation, and straight postures are more influential than the extension posture by approximately 8 folds, 7 folds, 6 folds, 6 folds, and 4 folds, respectively. Therefore, if extension is treated as the control posture and compared against the data from the rest of the postures in a multiple comparisons of means test, the following is found (Table 1). In this table, right lateral bending ($p = 0.000$), flexion ($p = 0.002$), right axial rotation ($p = 0.009$), and to the least extent left axial rotation ($p = 0.015$) are each significantly different than the extension posture.

Fig. 1

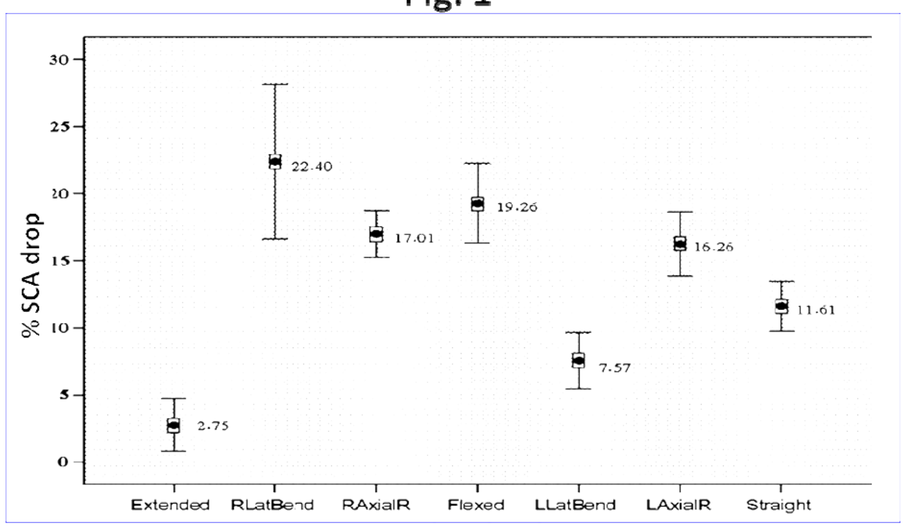

Table. 1

Multiple Comparisons

Dependent Variable: NCper
Dunnett t (2-sided)[a]

(I) HNorient	(J) HNorient	Mean Difference (I-J)	Std. Error	Sig.
Straight	Extended	8.85983	4.22673	.178
Flexed	Extended	16.51233*	4.22673	**.002**
RAxialR	Extended	14.25933*	4.22673	**.009**
LLatBend	Extended	4.81967	4.22673	.729
RLatBend	Extended	19.65283*	4.22673	**.000**
LAxialR	Extended	13.51467*	4.22673	**.015**

*. The mean difference is significant at the .05 level.

a. Dunnett t-tests treat one group as a control, and compare all other groups against it.

Conclusions

The study was able to show that the head-neck posture play a part in influencing spinal canal stenosis at C5-C6 in a middle aged adult subject suffering from degeneration at this segment. Specifically, extension of the neck is the least influential while flexion, axial rotations, and most notably right lateral bending all play significant parts. These preliminary results support extending this investigation to a large sample of patients for a generalized and enhanced understanding of the biomechanical characteristics of this condition.

References

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