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COUPLED CERVICAL MOVEMENT BEHAVIORS DURING A PASSIVE GROSS MOTION DIAGNOSTIC TEST

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Introduction

The purpose of this study was to objectify and analyze selected human 3-dimensional kinematic data occurring during a standard clinical, diagnostic physical examination of head and neck motion. Specifically, we sought to identify the relative amount of coupled motion (lateral flexion (side-bending) and axial rotation) in the head/neck region for three sample groups.

Null Hypothesis

Selected three-dimensional, kinematic data gathered from human subjects will not distinguish between symmetric, asymmetric/asymptomatic and asymmetric/symptomatic clinical head/neck motor behaviors.

Methods and Materials

Screening Methods: Two trained physicians screened a pool of volunteers for the presence of palpable symmetry (equal resistance) or asymmetry (unequal resistance) in response to a standard, medical diagnostic passive gross motion test of right and left lateral flexion for the head and neck.

Based on physician (examiner) agreement, three sample groups were identified with a total of 18 subjects, including both men and women. Seven subjects having symmetric responses to right and left lateral flexion constituted the control group (symmetric). The second group consisted of a pain-free asymmetric group consisting of six subjects. The third group (five subjects) also demonstrated motion asymmetry; however they reported experiencing head and neck pain at the time of the diagnosis. The average age of the subjects was 32.6 years.

Subject cooperation was gained by a simple description of the procedure and the request that they allow the movements without offering resistance. Placement of the examiner's hands was light, so the subjects did not react to uncomfortable pressures. To introduce right lateral flexion, the examiner's right hand was formed to the vertex of the subject's head with the fingers to the left and the palm extended to the right. The examiner's left hand rested lightly over the posterior upper thoracic mid-line to stabilize the shoulders. To compare the responses of right and left lateral flexions, hand placements were reversed to standardize the demand for motion. Criteria for positive findings were palpatory rather than visual.

Test Methods: The senior examiner directed and performed each of the passive diagnostic motions for the kinematic assessments. The test protocol was identical to the screening protocol. The examiner stood behind the subjects to initiate and guide the test motions. Lateral flexions started with the head in a neutral position. The examiner then moved the head/neck by guiding the ear toward the ipsilateral shoulder until a palpable sense of end-

Table 1

SUMMARY TABLE OF AVERAGE SLOPES AND STANDARD DEVIATIONS FOR EACH SUBJECT CATEGORY

Complete Coupled Motion Data: Side-Bending vs. Rotation					
Symmetric		**Asymmetric/ Asymptomatic**		**Asymmetric/ Symptomatic**	
Subject #	Linear Slope	Subject #	Linear Slope	Subject #	Linear Slope
007	-0.1897	005	-0.5375	022	-0.5992
	-0.1507		-0.4857		-0.5667
008	-0.4290	009	-0.3297	023	1.2800
	-0.3996		-0.3069		1.1403
015	-0.0112	014	-0.5988	028	-0.4191
	-0.0193		-0.6216		-0.4331
019	-0.3933	017	-0.3442	033	-0.0630
	-0.3274		-0.2975		-0.0152
024	-0.3654	025	-0.4088	034	-0.1761
	-0.4611		-0.3937		-0.1666
026	-0.4323	031	-0.5108	X	
	-0.3707		-0.4661		
027	-0.8733	X		X	
	-0.8648				
Average:	-0.3749	Average:	-0.4418	Average:	-0.4859
SD:	0.2598	SD:	0.1120	SD:	0.4325

of-range was achieved. The head was then guided back to neutral, the hand placement was changed, and motion to the other side began. A continuous set of three cycles was conducted, with only a slight pause to reposition the hands for the next motion. The initial movement was always directed to the right, ending with lateral flexion to the left. Each series of three cycles was performed twice. All tests were completed within four days of diagnostic screening.

Kinematic data were collected by a five-camera Qualysis 3-dimensional video based measurement system. The Qualysis system gathered head and neck positional data from a headband marker system custom fitted to each subject. The headband held three reflective targets: a frontal one and two lateral ones used to gather the three-dimensional coordinates. Additional data from reflective targets applied to the sternal notch, the mid-sternum and the spinous process of T-6 recorded the possible influence of thoracic motion.

The Qualysis system was calibrated at the start of each test day. Motion data were continuously sampled at 12 Hz. With motions averaging 35 seconds, approximately 420 frames were recorded for each target during each test motion. After individual trials, data were routed to a Macreflex software program to store and compile the 3-dimensional coordinate data for each of the six targets. When all trials were processed and inspected, the data were exported to a specially designed Microsoft Excel® spreadsheet for analysis. Using vector analysis, orthogonal coordinate systems were computed for the head/neck and thorax, and evaluated relative to a laboratory coordinate system. Three angles were computed: lateral flexion (side bending), axial rotation and flexion/extension (in the sagittal plane).

Cross plots of each trial were created to evaluate the degree of coupling between the lateral flexion and rotation. As a measure of the degree of coupling between the primary and secondary motions, the slope values for a best-fit line through the coupled data were analyzed. These values related the magnitude of primary motion relative to secondary motion.

Results

Data analysis indicated an insignificant amount of thoracic motion occurred during the test sequences. Thus, any influence of thoracic motion was dismissed and concentration was placed specifically on the head/neck displacements.

For the head/neck, lateral flexion was the primary motion, producing the largest range; while rotation had the second largest range. Head/neck data demonstrated a high degree of within-subject uniformity, suggesting that our methods of objectifying the 3-dimensional data were reliable and repeatable, Table 1. Analysis of the cross-plots for coupled flexion/rotation motions indicated the symmetric group demonstrated the smallest average linear slope (-0.37). In the experimental groups, the average linear slope for the asymmetric/asymptomatic subjects was -0.44, and the average for the asymmetric/symptomatic subjects was -0.49, Figures 1 and 2.

Discussion

Results indicated a trend for symmetric subjects to exhibit less coupling of rotation during passive lateral flexion of the head/neck as compared to the asymmetric subjects. Specifically, subjects diagnosed by a passive gross motion test as being symmetric (equal resistance to lateral flexion) demon-

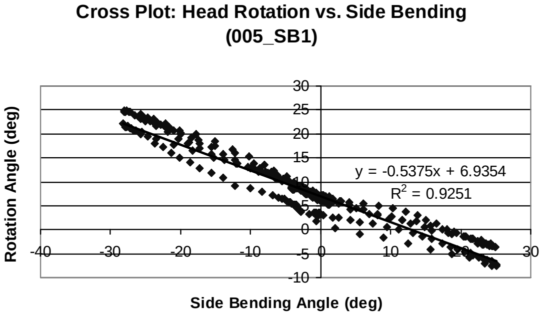

Figure 1: Ratio of Sidebending to Rotation for a Single Subject.

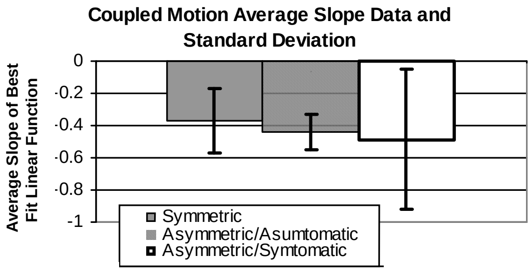

Figure 2 Bar Graphs of Average Slopes.

strated a ratio with larger amounts of lateral flexion relative to rotation, than subjects diagnosed as being asymmetric to the same passive gross motion test. Diagnosed asymmetric subjects however, demonstrated an increased amount of coupled rotation during passive lateral flexion. Based on this trend, we reject the null hypothesis. Instead, we found differences in coupling effects between diagnostic groups for clinical head/neck movement behaviors.

Future steps for this research include repeating the test protocol with a larger sample size in each category to determine statistical differences.

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