THE INFLUENCE OF AGE ON CERVICAL 3D-KINEMATICS DURING AXIAL ROTATION IN HEALTHY SUBJECTS AND PATIENTS WITH NECK PAIN: AN ANALYSIS OF COUPLED MOTIONS BY MEANS OF ELECTROMAGNETIC TRACKERS

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INTRODUCTION

Coupled motions of the Spine are defined as all motions that take place in association with the main motion one intends to produce[1]. Range of motion is related to age [2-4]. However, age effects on the kinematics of coupled motions in the cervical spine are not completely understoud [5,6]. Motion analysis using objective parameters enables a quantificaton of the complexity of the kinematics of coupled motions [7].

METHODS

Cervical axial rotation was registered in 84 participants by means of an electromagnetic tracking device (Flock of Birds-Ascension Technologies-USA). End range active axial rotation mobilizations to both sides were performed three times consecutively by each participants.
The age of the subjects varied from 20 to 82 years (mean 51.8 years) including 57 men and 27 women. The group consisted of 57 asymptomatic healthy volunteers and 27 symptomatic patients with a-specific non-acute neck pain.
The data were mathematically processed in Mathcad (®2001) and analyzed with SPSSv14 statistical software.
Raw data were transferred to Euler angles in a 3 degrees of freedom approach focusing on the rotational motion components. Six different parameters were calculated quantifying the 3D-kinematics. The Range of Motion (ROM) of the main axial rotation motion (R) component as well as the range of the lateral bending (L) and flexion-extension (F) components were calculated as the range between the maximal excursions. The cross-correlation ($Cc=(\Sigma RL)/(\sqrt{\Sigma R^2 \Sigma L^2})$) expresses the strength of the relationship between the main axial rotation component and the coupled lateral bending component. Ipsi-lateral or contra-lateral coupled motion patterns are expressed by the sign of the cross-correlation value. Cross-correlation was also calculated taking in account the phase shift that may take place between main and coupled motion components (= cross-correlation with shift).
The ratio ((stdev L / stdev R) * 100) expresses the relative value of the main motion component in relation to the coupled motion component. The relationship between age and kinematics parameters was analyzed by means of Pearson correlations using a 5% confidence interval ($p<.05$).

RESULTS AND DISCUSSION

Table 1 summarizes the results indicating parameter values for all subjects and for subgroups as well as their relationship with age. The results indicate only significant but moderate relationships between age and the range of motion of the main axial rotation component during active cervical axial rotation. Correlations between age and ratio are statistically significant in some subgroups but too low to be of any value.

Table 1: mean values of kinematic parameters and *Pearson R values for correlation with age*

	Total	Asympt	Sympt	Ipsi-lat	Contra-lat
Number (n)	84	57	27	64	20
ROM axial rot (R)	125.27	132.01	111.06	127.05	119.58
Corr ROM-R/age	*-0.65**	*-0.71**	*-0.60**	*-0.63**	*-0.50**
ROM lat bending (L)	13.75	14.36	11.87	15.28	8.84
Corr Rom L/age	*-0.09*	*-0.18*	*0.17*	*-0.16*	*-0.11*
Ratio	9.22	9.27	9.10	9.77	7.38
Corr Ratio/age	0.23*	0.20	0.30	0.13	0.48*
Shift in %	7.63	4.64	13.95	5.23	15.31
Corr Shift/age	*0.08*	*0.13*	*0.01*	*0.16*	*-0.03*
cross-correlation (Cc)	0.64	0.71	0.61	0.76	0.42
Corr. Cc-age	***0.03***	***-0.07***	***-0.34***	***0.04***	***-0.16***
Cc + shift correction (CcS)	0.76	0.79	0.70	0.80	0.64
Corr. CcS/age	*0.02*	*0.00*	*0.36*	*0.01*	*0.13*

CONCLUSIONS

The parameters used in this study have been shown to adequately quantify kinematic aspects of motion coupling[7]. However no other relation could be demonstrated with age, but the one with Range of the main axial rotation motion. As this relationship is equal strong in both symptomatic and asymptomatic subjects, it is probably due to the effect of age related changes rather than to degeneration and pathology. Lack of a relationship between the amount of coupled motion also resulted from the comparison of the peak values of the main motion and coupled motion components (8).

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