3D ARTHROKINEMATIC ANALYSIS OF COUPLED ROTATIONS IN THE ATLANTO-AXIAL JOINT DURING AXIAL ROTATION AND LATERAL BENDING

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INTRODUCTION

Three dimensional analysis of segmental motion coupling was only studied sparsely and in pure moment analysis. The present study focuses on the in vitro registration of upper cervical segmental coupled motions during manual induced axial rotation and lateral bending. The aim of the study was to create a suitable setup for collecting qualitative information on the kinematics of the atlanto-axial joint during planar induced movements, and to compare patterns of motion coupling.

METHODS

Seven cervical spine specimens were taken from embalmed human cadavers from the occiput to the first thoracic spine. Each specimen was clamped on a rigid stand to hold T1 in such a way that the cervical spine was fully free to move. 3D electromagnetic tracking sensors were fixed on the occiput, C1 and C2. Subsequently, each specimen was moved in the main planes of motion. The position and orientation of each sensor were collected by an electromagnetic tracking device (Flock of birds-Ascension technologies). At a later stage, the positions of local anatomical landmarks were digitized with a 3D drawing stylus (3DX-Microscribe). The individual sensor data were used to describe coupled motions by means of the parameters of the finite helical axes (Spoor and Veldpaus, 1980; Woltring et al., 1994) for discrete sampling ranges of the movements between the different bones. The anatomical data were used for the definition of local bone embedded co-ordinate systems. To analyze the 3D arthrokinematics of the atlanto-axial joint, the finite helical axes were related to a co-ordinate system based on the centre line through the transverse processes of C1 and C2 and the midpoint of the anterior side of the arcus of C1 and corpus of C2. The results are analyzed by the finite helical angles representations

RESULTS AND DISCUSSION

The results show that main planar axial rotation and lateral bending motions include 3-dimensional coupled motions. Tabel 1 shows that the coupling pattern during axial rotation is coupled controlateral lateral bending in 5 out of 7 specimens (fig.1). During lateral bending the coupled rotation is ipsilateral in 6 out of 7 specimens.

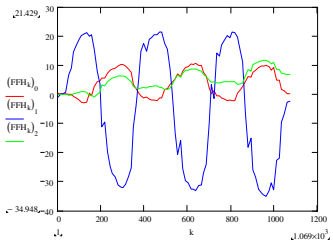

Fig 1. : Cumulative finite helical angles C1-C2 during axial rotation (spec 7) (FFH_1)$_0$≈flexion-extension; (FFH_1)$_1$≈ axial rotation; (FFH_1)$_2$≈ lateral bending

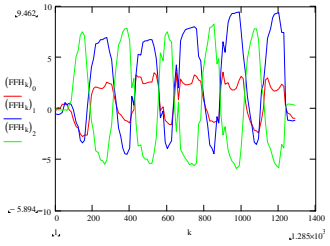

Fig 2. : Cumulative finite helical angles C1-C2 during lateral bending (spec 7) (FFH_1)$_0$≈flexion-extension; (FFH_1)$_1$≈ axial rotation; (FFH_1)$_2$≈ lateral bending

CONCLUSIONS

These results indicate that the experimental setup is suitable for the analysis of coupled rotations in the upper cervical spine. The results of the arthrokinematic analysis of manual induced planar motions are parallel to the findings of an experimental setup applying controlled forces and moments (Panjabi et al., 1993).

REFERENCES

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Tabel 1: patterns of motion coupling at the atlanto-axial joint during axial rotation and lateral bending

specimen	*Axial rotation*	Patterns of coupled motions	Direction of coupled motion	Max ROM of main motion	*Lateral bending*	Patterns of coupled motions	Direction of coupled motion	Max ROM of main motion	ROM of major motion component
1		R >> L ≥ F	CONTRO	56°		R ≥ F > L	IPSI	4°	7°
2		R >> L > F	IPSI	56°		R > F ≥ L	IPSI	5°	11°
3		R >> L > F	CONTRO	49°		R > F > L	IPSI	3°	8°
4		R >> L >> F	IPSI	50°		L ≥ R > F	IPSI	15°	
5		R >> F > L	CONTRO	35°		R > F > L	IPSI	3,5°	10°
6		R >> F > L	CONTRO	55°		L ≥ R > F	CONTRO	13,5°	
7		R >> L > F	CONTRO	50°		F > R > L	IPSI	5°	10°