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# Reliability of finite helical axis parameters in cervical kinematics

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## BACKGROUND AND AIM

The use of FHA is a stable approach and very common in spacecraft dynamics and graphic imaging, nevertheless it is still little used in clinical context and among medical professionals. The dispersion of the 3D-motion axis has been used previously to express the stability of the motion in cervical kinematics for whiplash patients. The objective of the present study is the evaluation of the reliability of Finite Helical Axis (FHA) parameters for the functional analysis of cervical movements.

## MATERIALS AND METHODS

Thirty-five healthy subjects participated in the study. Cervical movements were registered with the Polhemus-G4, a non-invasive electromagnetic device, which tracks the positions of sensors relative to a source in three dimensions. One sensor was positioned on the subjects' forehead and one on the chest (Fig.1). The subjects were asked to perform three series of movements of the head (flexion-extension, left-right rotation, left-right lateral bending) at a natural spontaneous speed during five different sessions in three days. Data analysis was performed off-line using Matlab®. Seven parameters were evaluated: range of movement (ROM, degrees), angular velocity (rad/s), angular acceleration (rad/s$^2$), angular jerk (rad/s$^3$), energy of the first harmonic of the Fourier transform of the angular position (%), minimum area of the convex hull of the intersection of the FHAs with a plane (cm$^2$) during a movement, and mean value of the distribution of angles between the FHAs during a movement (Fig.2). Subjects were not considered if they had a history of headache or neck surgery or had received treatment for neck or shoulder conditions within the past three months. The study was approved from the Ethical Committee of Southern Switzerland and subjects signed informed consent forms.

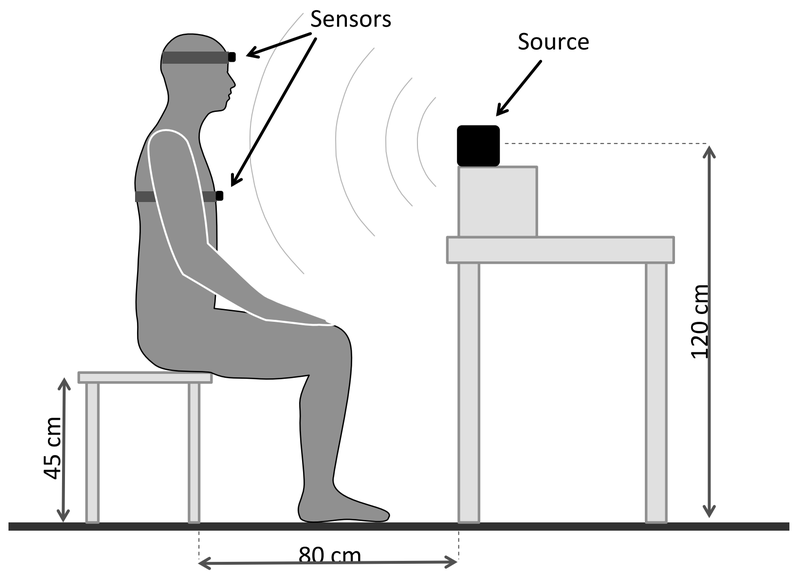


**Figure 1** *Experimental set-up.*

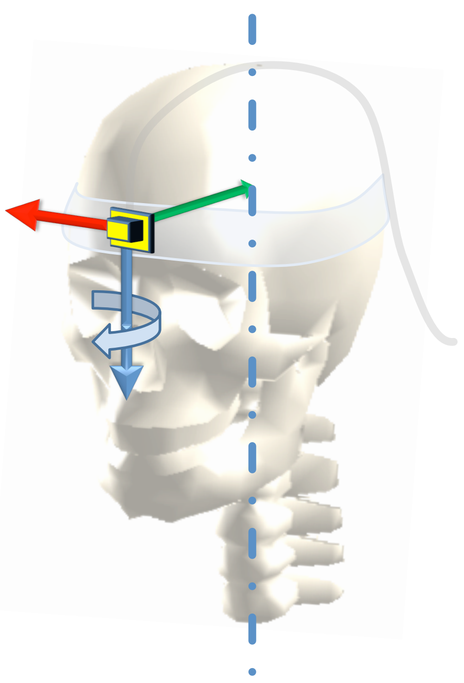


**Figure 2** *Computation of Helical Axis during head rotation.*

## RESULTS

Table 1 shows the intraclass correlation coefficient (ICC) of the seven parameters investigated. The ICCs represent the inter-session reliability of the seven parameters and are shown for the three movements and the 35 subjects.

| | flexion-extension | | left-right rotation | | left-right lateral bending | |
|---|---|---|---|---|---|---|
| | **ICC** | **(Conf. Interv.)** | **ICC** | **(Conf. Interv.)** | **ICC** | **(Conf. Interv.)** |
| ROM | 0.82 | (0.72-0.90) | 0.90 | (0.84-0.96) | 0.93 | (0.88-0.96) |
| Ang vel. | 0.89 | (0.80-0.93) | 0.88 | (0.83-0.96) | 0.96 | (0.89-0.98) |
| Ang accel. | 0.83 | (0.76-0.89) | 0.89 | (0.82-0.94) | 0.93 | (0.81-0.97) |
| Ang jerk | 0.80 | (0.72-0.91) | 0.83 | (0.71-0.94) | 0.89 | (0.74-0.95) |
| Perc 1st harm | 0.56 | (0.40-0.72) | 0.73 | (0.61-0.91) | 0.80 | (0.65-0.92) |
| Area CH | 0.87 | (0.77-0.95) | 0.66 | (0.45-0.88) | 0.86 | (0.79-0.95) |
| Mean Angle | 0.73 | (0.54-0.89) | 0.84 | (0.73-0.95) | 0.87 | (0.69-0.94) |

**Table 1** *Intraclass correlation coefficient (ICC) and the relative confidence interval for the finite helical axis parameters during three cervical movements.*

## CONCLUSIONS

The parameters investigated show different values of ICC with first harmonic energy and convex hull area being highly dependent on the contraction type.

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