Società Italiana di Fisioterapia (S.I.F.) - 3rd National Congress - Napoli, Italy - 2013, May 24th-25th

A novel approach to describe cervical kinematics

Marco Barbero [1], Erik Cattrysse [2], Ron Clijsen [3,4], Corrado Cescon [1]

[1] University of Applied Sciences and Arts of Southern Switzerland, Department of Health Sciences, Manno, Switzerland.
[2] Arthrokinematics research group, Faculty of Medicine and Pharmacy, Department of Experimental Anatomy, Vrije Universiteit Brussel, Belgium
[3] University of Applied Sciences and Arts of Southern Switzerland, Department of Health Sciences, Landquart, Switzerland
[4] University College Physiotherapy, Thim Van Der Laan AG, Landquart, Switzerland

BACKGROUND AND AIM

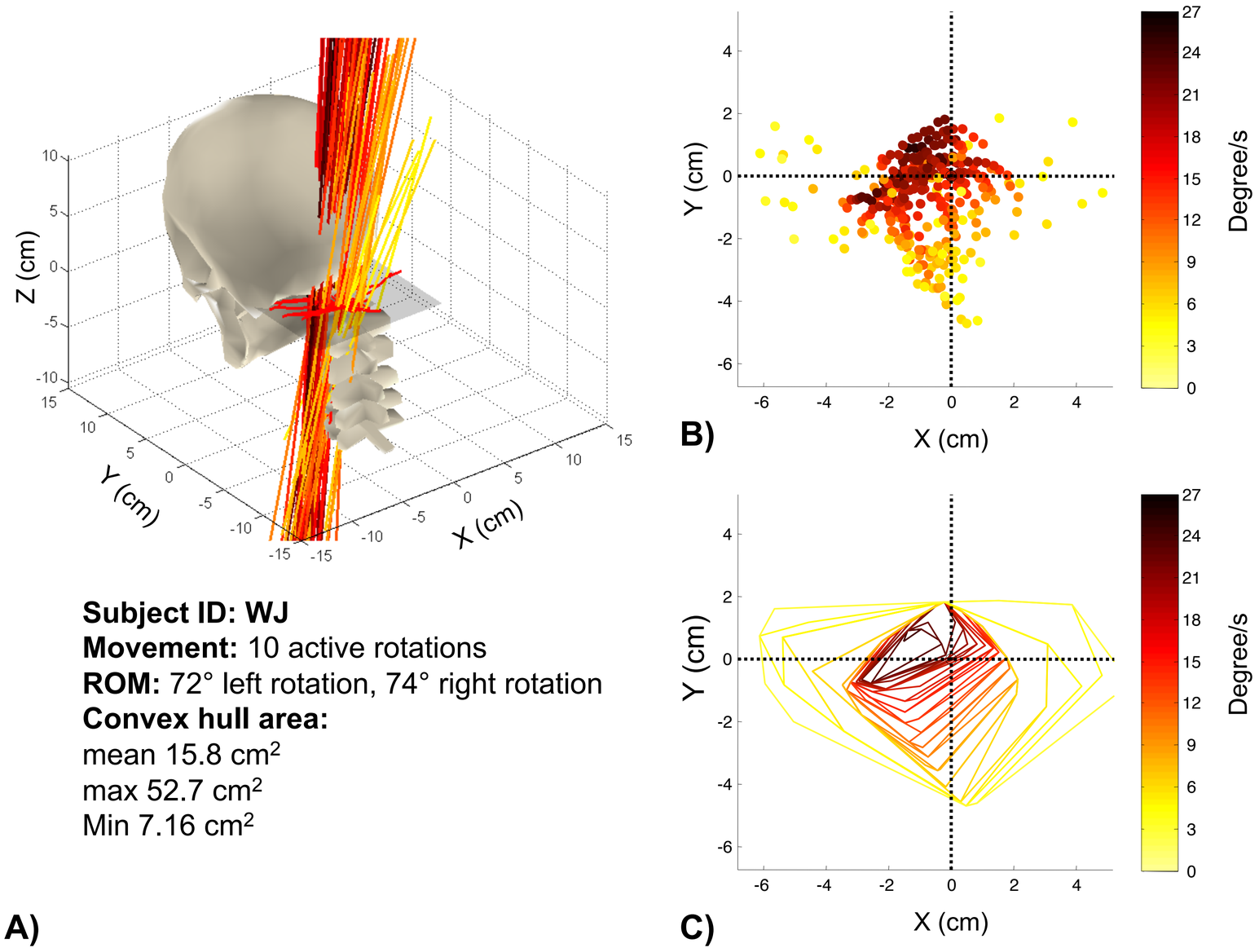
The helical axis approach can provide a comprehensive three-dimensional description of joint motion. An instantaneous helical axis (IHA) changes its spatial position and orientation during movement and the infinitesimal spatial motion of a joint segment is expressed as the combination of a translation along this axis and a rotation around it.
An analysis of the IHA behaviour during movements has an important potential application in the description and differentiation of functional and dysfunctional joint movements. Currently most studies exploring the clinical application the IHA produce excellent qualitative results, but quantitative results are often lacking. The aim of this study is to provide a representation of the IHA as a function of the angular velocity allowing a further quantitative analysis.

MATERIALS AND METHODS

Cervical kinematics was registered with a non-invasive electromagnetic device (Polhemus-G4). One sensor was positioned on the subjects' forehead and one on the chest. The subject was asked to perform a series of head rotations at a natural spontaneous speed. The intersections of the IHA with a standardized coronal plane were computed and analyzed with the convex hull technique using different thresholds for angular velocity.

RESULTS

The IHA behavior and their intersections with the coronal plane during repeated active rotations are displayed with a three-dimensional visualization (Fig.1A). Intersections of IHA with the coronal plan are shown in Fig. 1B. Convex hull areas on the coronal plane according to different angular velocity threshold are shown in Fig. 1C.



Cervical spine kinematics of a subject is displayed using IHA during repeated active rotation. IHA are colored according to their angular velocity (Degree/s). A) Positions, orientations and intersections with the coronal plane of IHA are showed using a three-dimensional visualization. B) Intersections of IHA with the coronal plan C) Convex hull areas on the coronal plane according to different angular velocity thresholds.

Figure 1

DISCUSSION AND CONCLUSION

A variability of IHA during rotation can be observed. As expected, at lower angular velocities the IHA are spread in a larger area because of the noise of the sensors which has a larger impact on their computation. Nevertheless, at higher velocity, most of the IHA intercept the coronal plane in a restricted area and the convex hull is minimal (figure 1C). The IHA behavior is more stable at higher angular velocity. Any quantity analysis of the IHA should consider a proper angular velocity threshold. The IHA behavior assessed with the convex hull technique shows an interesting potential for clinical application. A reliability investigation on a larger sample is required.

REFERENCES

Baeyens, JP. Measurement of three-dimensional intra-articular kinematics: methodological and interpretation problems. *Ergonomics*, 15;48(11-14):1638-44, 2005.
Dugailly PM. In vitro 3D-kinematics of the upper cervical spine: helical axis and simulation for axial rotation and flexion extension. *Surg Radiol Anat*, 32(2):141-51, 2010.
Panjabi, MM. Centers and angles of rotation of body joints: a study of errors and optimization. *J of Biomech*, 12(12), 911–920, 1979.
Woltring, H.J. et al. Finite centroid and helical axis estimation from noisy landmark measurements in the study of human joint kinematics. *J of Biomech*, 18(5), 379–89, 1985.

ACKNOWLEDGEMENT: Thim van der Laan Foundation for funding the study.

e-mail: marco.barbero@supsi.ch

v-card

poster