CONCURRENT VALIDITY AND TEST-RETEST RELIABILITY OF THE POLHEMUS LIBERTY FOR THE MEASUREMENT OF SPINAL RANGE OF MOTION

Konstantinos T. Kaliarntas, U. Chris Ugbolue, Philip E. Riches, Philip J. Rowe
Bioengineering Unit, University of Strathclyde, Glasgow, Scotland, UK, G4 ONW
Email: konstantinos.kaliarntas@strath.ac.uk , web: www.strath.ac.uk/bioeng

INTRODUCTION

The assessment of the spinal movements and curvature is of importance in both clinical practice and research. Clinical assessment of the spinal range of motion (ROM) is commonly limited to one or two dimensions and usually defines the trunk as a single segment. The Vicon motion analysis system, which is often characterised as 'gold standard', cannot be easily used in the clinical setting since it is not portable and requires post processing expertise. Conversely, the Polhemus Liberty is a three-dimensional (3D) electromagnetic motion capture device which is cheaper, more portable and simpler to use. Earlier versions of this device (Fastrak, Isotrak) have been used for measurement of lumbar ROM [1,2], however, only one sensor was used and the data were not compared against a criterion measure such as Vicon.

The aim of this study is twofold: i) to examine the concurrent validity of Polhemus Liberty with the Vicon for the measurement of spinal ROM and ii) to investigate the test-retest reliability of the Polhemus measures.

METHODS

A convenient sample of ten healthy male participants and two spinal simulation rigs were used for the purposes of this study. Each rig consisted of four adjustable pin-jointed segments together with inter-segment goniometers.

An eight optical camera motion capture system (Vicon 512) was used as the criterion measure. Data from the Polhemus and the Vicon were synchronously captured at 120Hz. The participants performed three repetitions for six gross spinal movements and a short walking task. These measurements were taken from three spinal regions (lumbar, thoracic, cervical) on two occasions, one week apart. Additionally, static and dynamic rig measurements were obtained from different rig segment angle combinations. Vicon data were processed with BodyBuilder (V3.55) and coordinates were filtered with a 4^{th} order, zero-phase shift plug-in Butterworth filter, at a cut-off frequency of 5Hz. A total of 27 reflective markers attached on anatomic landmarks and four marker triads were used to establish four local coordinate systems on the top of each Polhemus source and sensor.

Vicon and Polhemus data files were further manipulated with Matlab 7.7 (The Mathworks Inc.,US). Due to non-normal data, non-parametric statistical analysis was performed using SPSS v17. The Wilcoxon signed rank test was used to determine the statistical significance of the differences of the angles obtained by the two systems. The relationship between these measures was also examined using the Spearman correlation (ρ). The test-retest reliability of the Polhemus measurements was assessed with the determination of the intraclass correlation coefficient (ICC).

RESULTS AND DISCUSSION

Preliminary results revealed a very good agreement between the two systems with no statistically significant differences in most comparisons (Table 1). Polhemus measurements obtained on different days also showed a close correlation (ICC=0.86) (Figure 1).

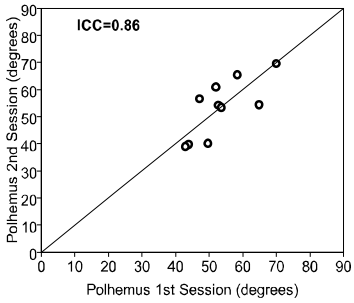

Figure 1: Correlation between values for lumbar flexion measured by the Polhemus on two different days.

These results suggest that the Polhemus Liberty system is a valid and reliable and can be used within a clinical setting for spinal ROM evaluation.

ACKNOWLEDGEMENTS

This research is funded by the State Scholarships Foundation (IKY) of Hellas.

REFERENCES

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Table 1: Comparison of medians (lower, upper quartiles) values for spinal ROM measured by Polhemus & Vicon, showing the correlation coefficients (ρ) and the P-values (significance of the difference between the two systems)

Segment Angle (deg)	Polhemus	Vicon	P-value	ρ
Lumbar				
Forward bending	52.3 (46.3, 60)	54 (45.3, 59.1)	0.110	0.95
Lateral bending (right)	20.8 (17.9, 27.7)	22.7 (19.3, 29)	0.007	0.92
Thoracic				
Forward bending	75.6 (68.1, 83.1)	70.3 (57.9, 81.2)	0.612	0.82
Lateral bending (right)	44 (41.9, 48.4)	43.7 (41.8, 51.3)	0.445	0.89
Cervical				
Forward bending	101.6 (91.7, 110)	97.2 (91.3, 101)	0.21	0.97
Lateral bending (right)	64.5 (61, 75.1)	69 (60, 75.3)	0.508	0.98