AVAILABILITY OF MOBILITY MEASUREMENT IN NECK USING ELECTROMAGNETIC TRACKING DEVICE

C-C Yang*, C-H Yang*, C-H Yang**, L-Y Guo*

*Faculty of Sports Medicine, College of Medicine, Kaohsiung Medical University, Kaohsiung, Taiwan

**Department of Physical Therapy, Tzu-Chi College of Technology, Hualien, Taiwan

E-mail: yuen@kmu.edu.tw

Introduction

Three-dimensional neck range of motion (ROM) is an important approach to assess cervical abnormalities. However, most clinical instruments only provide single-plane, static joint position information. Electromagnetic tracking system has been found to be quite accurate and easy to use, and it is one of the few instruments suitable for measuring relative three-dimensional neck kinematics[1].

The current study aimed to measure neck ROM using a dynamic method and to investigate joint combined motions by means of three dimensional electromagnetic tracking system.

Materials and Methods

Twenty-three young healthy subjects (11 males and 12 females) were recruited in this experiment. Subject ages ranged from 20 to 24 with a mean age of 21.4 years. A six-degree-of- freedom electromagnetic tracking device (Liberty, Polhemus Inc, USA) at a measurement frequency of 120 Hz was used. The system consists of a transmitter and three receivers; one is stylus receiver and the other two are taped tightly on the forehead and the midpoint between incisura jugularis and processus xiphoideus respectively.

Subjects were seated on a wooden chair so that their thoracic spine maintained contact with backrest. Seven anatomical bony landmarks were recorded by stylus receiver subsequently, and the reference coordinate systems of head and truck could be determined. The coordinate systems of head was made up by nose-bridge, the mid-point of chin, and protuberantia occipitalis externa.; the coordinate system of truck was made up by processus xiphoideus, incisura jugularis, processus spinosus of the seventh cervical spine body, and processus spinosus of the eighth thoracic spine body[2].

Subjects were instructed to perform a set of movements as far as they can in the neck without moving their shoulders, including of extension; flexion; side bending to left and right; rotation to left and right. The receivers could record the consecutive position and orientation data. Therefore, the relative joint angles can be calculated by mathematic Euler angle using Matlab program. Moreover, subjects performed a combined movement with full neck flexion and rotation to represent the ROM of upper cervical spine (Figure 1). Reliability was evaluated by the intraclass correlation coefficient (ICCs).

(A)

(B)

Figure 1 Range of motion measurement for rotation to right in neutral position (A) and in a position of full neck flexion (B)

Results and Discussion

The mean and standard deviation of ROM have showed in Table 1 and Table 2. Review of the past literatures, the results of ROM of neck in this experiment are similar[3]. Besides, some

combined motions were found while subjects performed primary movement, particularly in sidebending direction with greater than 15° of rotation.

The ICCs of the primary movement for extension is 0.86; for flexion is 0.79; for left side bending is 0.92; for right side bending is 0.83; for rotation to left is 0.79; for rotation to right is 0.79; and for rotation to left in full flexion is 0.93; for rotation to right in full flexion is 0.90. All ICCs were above 0.79 and categorized as highly and moderately reliable.

Table 1 The mean and standard deviation of ROM
(unit: degree)

ROM	Extension	Flexion	Left side bending	Right side bending
Extension/	62.7	53.0	12.0	10.5
Flexion	(14.8)	(10.5)	(8.3)	(5.6)
Side	5.5	6.0	44.0	40.3
Bending	(3.1)	(3.7)	(8.1)	(9.1)
Rotation	6.4	6.3	15.5	19.3
	(3.5)	(4.3)	(7.2)	(9.1)

Table 2 The ROM of rotation to left and right between in full flexion and in neutral position (unit: degree)

ROM	Left rotation in neutral position	Right rotation in neutral position	Left rotation in full flexion	Right rotation in full flexion
Extension/	9.6	9.9	55.9	58.0
Flexion	(4.8)	(4.5)	(10.4)	(14.6)
Side	8.4	9.7	12.1	12.1
Bending	(4.6)	(4.6)	(5.6)	(5.1)
Rotation	65.5	64.5	46.3	45.4
	(9.3)	(11.2)	(9.8)	(12.7)

Conclusions

This non-invasive method may be a reliable alternate as an assessment tool in the clinical settings. It may provide in-depth and complete information in the process of movements such as combined motion. For clinicians, it could provide accurate diagnosis for neck abnormalities.

References

- [1]Jordan, K., et al., The reliability of the three-dimensional FASTRAK measurement system in measuring cervical spine and shoulder range of motion in healthy subjects. *Rheumatology* (Oxford), **39**(4): 382-8, 2000.
- [2]Koerhuis C.L., Winters J.C., Van Der Helm F.C.T., Hof A.L. Neck mobility measurement by means of the "Flock of Birds" electromagnetic tracking system. *Clinical Biomechanics*, **18**: 14-18, 2003.
- [3]Adrian Lindsay Morphett, Colin M.C., BappSc (Chiro), Don Lee, The use of electromagnetic tracking technology for measurement of passive cervical range of motion: a pilot study. *J Manipulative Physiol Ther*, **26**:152-9, 2003.