

RELIABILITY AND NORMATIVE DATABASE OF THE ZEBRIS CERVICAL RANGE-OF-MOTION SYSTEM IN HEALTHY CONTROLS WITH PRELIMINARY VALIDATION IN A GROUP OF PATIENTS WITH NECK PAIN

Barbara Cagnie, PT, PhD,^a Ann Cools, PT, PhD,^b Veerle De Loose, PT,^c Dirk Cambier, PT, PhD,^b and Lieven Danneels, PT, PhD^b

ABSTRACT

Objective: The first aim of this study was to determine the reliability of the Zebris (Aachen, Germany) ultrasound-based testing of cervical range of motion (ROM). The second aim was to develop a normative database in a healthy sample of 96 volunteers. The third aim was to evaluate, with the Zebris system, the ROM in a sample of patients with chronic neck pain compared to healthy controls to determine if cervical ROM could discriminate between these groups and between subgroups of pain patients (with or without whiplash injury).

Methods: The study participants were 96 healthy volunteers, 14 patients with idiopathic neck pain, and 16 patients with chronic whiplash. Cervical ROM was measured in the 3 planes with the Zebris CMS 70P ultrasound-based motion analysis system. The intra- and interrater reliability of the protocol was tested in 12 volunteers.

Results: Full-cycle measurements showed high reliability (intraclass correlation coefficient, 0.80-0.94) with the SE of measurement ranging from 4.25° to 7.88°. The distribution of ROM measures showed a great individual variation, with a significant age-related decrease in ROM in all directions. Range of motion was reduced in patients with chronic whiplash in all primary movements, compared to healthy subjects, whereas in patients with idiopathic neck pain, only rotation showed reduced ROM.

Conclusion: Results demonstrate a high degree of test-retest reliability in measuring cervical ROM. The use of normative data for ROM when evaluating patients with neck disorders needs to take age into account. The current study has demonstrated that patients with chronic neck pain demonstrate reduced ROM, which differs between patients with idiopathic neck pain and those with chronic whiplash. (*J Manipulative Physiol Ther* 2007;30:450-455)

Key Indexing Terms: Neck Pain; Range of Motion; Articular; Reproducibility of Results; Whiplash Injuries

Assessments of cervical range of motion (ROM) are useful in the quantification of musculoskeletal impairments and may also be used to provide a basis for assessing the efficacy of therapeutic interventions

in patients with neck pain.¹⁻³ In recent decades, many attempts have been made to obtain an objective method of assessing cervical spine mobility. To successfully distinguish between normal and abnormal motions of the spine, 2 conditions have to be fulfilled: the derivation of age- and sex-based normative data and high reproducibility of the findings.^{4,5} Several noninvasive methods for assessing ROM have been available. However, previous reviews on studies concerning reliability and validity of neck mobility have demonstrated that most of the instruments and procedures used are seriously flawed.⁶⁻⁸

A significant breakthrough in measuring cervical motion has taken place with the introduction of dedicated 3-dimensional motion analysis systems that can record, calculate, and display spatial head position.⁹ These systems have the advantages of monitoring relative changes in curvature of the spine during movement as well as limiting researcher bias because the results are displayed graphically and in tabulated forms on screen.³ One of these systems is the

^a Postdoctoral research fellow, Department of Rehabilitation Sciences and Physiotherapy, Ghent University, Ghent, Belgium.

^b Professor, Department of Rehabilitation Sciences and Physiology, Ghent University, Ghent, Belgium.

^c Physical therapist, Department of Physical Therapy, Centre of Physical Medicine and Rehabilitation, Military Hospital of Base Queen Astrid, Brussels, Belgium.

Submit requests for reprints to: Barbara Cagnie, PT, PhD, Department of Rehabilitation Sciences and Physiotherapy, Ghent University Hospital, De Pintelaan 185, 6K3, B - 9000 Ghent, Belgium (e-mail: barbara.cagnie@ugent.be).

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Table 1. Anthropometric data of the studied sample

	Age group	Weight	Height	BMI
Male	20-34	76.6 (.4)	1.80 (0.1)	23.7 (2.3)
	35-49	80.4 (6.9)	1.85 (0.1)	23.4 (1.9)
	50-64	80.3 (9.3)	1.74 (0.1)	26.3 (2.3)
Female	20-64	79.0 (8.4)	1.79 (0.1)	24.6 (2.5)
	20-34	61.6 (11.3)	1.68 (0.1)	22.1 (3.8)
	35-49	63.2 (8.8)	1.66 (0.1)	22.6 (2.0)
	50-64	67.5 (10.7)	1.66 (0.1)	24.3 (2.9)
	20-64	64.0 (10.4)	1.67 (0.1)	23.0 (3.1)

Mean values are given with SD in parentheses.

Zebris, an ultrasound (US)-based coordinate measuring system that was developed in Aachen, Germany, and appears to be one of the best devices available at the moment to measure cervical ROM.^{3,6}

However, discrepancies exist among similar studies using the Zebris system regarding normative data, which highlights the concerns regarding the comparison between different investigations as well as the published normative data and cutoff points between healthy subjects and patients.^{2,3,9,10} Secondly, high inter- and intrarater reliability estimates have been demonstrated in numerous studies, although a great variety of methodologies makes the comparison between studies almost impossible.^{1,2,6,11} According to Jordan,⁸ reliability of a tool can only be inferred for the protocol used. This emphasizes the need of determination of reliability and normative data before any differentiation can be made between healthy subjects and patients.

The first aim of this study was to determine the reliability of the Zebris testing of cervical ROM. The second aim of the study was to develop a normative database in a healthy sample of 96 volunteers. The third aim of the study was to evaluate, with the Zebris system, the ROM in a sample of patients with chronic neck pain compared to healthy controls to determine if cervical ROM could discriminate between these groups and between subgroups of pain patients (with or without whiplash injury).

METHODS

Sample

Healthy volunteers (n = 96) and 30 patients with chronic neck pain took part in this study. To be included, healthy subjects should not have had neck pain for at least 1 year before testing. The healthy patients were divided into 3 age groups (20-34, 35-49, and 50-64 years), each consisting of 16 men and 16 women. Descriptive characteristics of the subjects are presented in Table 1.

Patients with chronic neck pain were recruited through local advertisement within the university. These patients were divided into idiopathic and those with whiplash. Written informed consent was obtained from all the volunteers, and the study protocol was approved by the local ethics committee.

Idiopathic Neck Pain Group. The primary inclusion criterion for the study was nonspecific, frequent, or continuous neck pain lasting over 6 months. The exclusion criteria were an operation, pregnancy, depression or mental illness, and the presence of specific diseases known to cause chronic neck pain (spinal stenosis, instability or anomaly of the cervical spine, fibromyalgia, inflammatory joint diseases). The patients with chronic neck pain who volunteered to participate in the study were 14 women, in the age group of 20 to 34 years (mean, 28.3 ± 5.4 years).

Whiplash Group. Criteria for inclusion in the study as a patient with whiplash consisted of a period of at least 6 months since the accident, ongoing pain and disability in the neck region, severity of injury classified as Québec Task Force grade 2, and no other injury relating to a previous motor vehicle accident. A total of 16 women in the age group of 20 to 34 years (mean, 27.5 ± 4.8 years) were included.

Study Design

The study design was subdivided into 3 parts.

Intra- and Interrater Reliability Study. In the healthy group, 12 volunteers were recruited to participate in the study of intrarater reliability. A total of 12 other healthy subjects volunteered to take part in the interrater reliability design. The intra- and interrater reliability was assessed on 3 different occasions. One single operator assessed the intrarater reliability, whereas in the interrater study, 3 other investigators were involved. The time interval between the tests was 1 week. Tests were performed at the same time of day to minimize any effect of diurnal variation.

Normative Database. To assess normative data and to determine if cervical ROM is sex- and age-dependent, we carried out a descriptive cross-sectional study in 96 volunteers.

Patient Study. The results obtained from the patients with neck pain were compared with the findings derived from the normative database study to evaluate whether patients with idiopathic or traumatic chronic neck pain had decreased ROM.

Experimental Procedure

Measurements of cervical motion were performed with the Zebris CMS 70P US-based motion analysis system. The

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