Manual Therapy 18 (2013) 403–409

Contents lists available at SciVerse ScienceDirect

Manual Therapy

journal homepage: www.elsevier.com/math

Original article

Using the cervical range of motion (CROM) device to assess head repositioning accuracy in individuals with cervical radiculopathy in comparison to neck- healthy individuals

Johanna Wibault [a,*], Jacques Vaillant [b,c], Nicolas Vuillerme [c], Åsa Dedering [d], Anneli Peolsson [a]

[a] Department of Medical and Health Sciences, Division of Physiotherapy, Faculty of Health Sciences, Linköping University, Linköping, Sweden
[b] Ecole de kinésithérapie du centre Hospitalier Universitaire de Grenoble, France
[c] AGIM (AGeing Imaging Modeling) Laboratory, FRE 3405, CNRS-UJF-UPMF-EPHE, Faculty of Medicine, La Tronche, France
[d] Division of Physiotherapy, Department of Neurobiology, Care sciences and Society, Department of physical therapy, Karolinska University Hospital, Stockholm, Sweden

ARTICLE INFO

Article history:
Received 25 March 2012
Received in revised form
2 February 2013
Accepted 7 February 2013

Keywords:
Neck pain
Radiculopathy
Head repositioning accuracy
Measurement

ABSTRACT

This study had two purposes: to compare head repositioning accuracy (HRA) using the cervical range of motion (CROM) device between individuals with cervical radiculopathy caused by disc disease (CDD; $n = 71$) and neck- healthy individuals ($n = 173$); and to evaluate the test–retest reliability of the CROM device in individuals with CDD, and criterion validity between the CROM device and a laser in neck-healthy individuals, with quantification of measurement errors. Parameters of reliability and validity were expressed with intra- class- correlation coefficients (ICCs), and measurement errors with standard error of measurement (SEM) and Bland Altman limits of agreement. HRA (Mdn, IQR) differed significantly between individuals with CDD and neck- healthy individuals after rotation right 2.7° (6.0), 1.7° (2.7); and rotation left 2.7° (3.3), 1.3° (2.7) ($p <= 0.021$); 31% of individuals with CDD were classified as having impairment in HRA. The test–retest reliability of the CROM device in individuals with CDD showed ICCs of 0.79- 0.85, and SEMs of 1.4°- 2°. The criterion validity between the CROM device and the laser in neck-healthy individuals showed ICCs of 0.43- 0.91 and SEMs of 0.8°- 1.3°. The results support the use of the CROM device for quantifying HRA impairment in individuals with CDD in clinical practice; however, criterion validity between the CROM device and a laser in neck-healthy individuals was questionable. HRA impairment in individuals with CDD may be important to consider during rehabilitation and evaluated with the criterion established with the CROM device in neck-healthy individuals.

1. Introduction

Sensorimotor function relates to the control of posture and movements (Treleaven, 2008). The contribution of cervical muscles to sensorimotor function has been emphasized with regards to the density of muscle spindles that reflect a well-developed proprioceptive system (Dutia, 1991; Boyd-Clark et al., 2002), and cervical muscles play a major role in motor control of the head and neck (Dutia, 1991; Peterson, 2004; Armstrong et al., 2008), eye movements (Karlberg et al., 1991), and bipedal posture during quiet standing (Vuillerme et al., 2005).

The ability to reposition the head in a neutral position after active head movements has been used to indirectly assess impairment in sensorimotor function originating from the neck (Revel et al., 1991; Loudon et al., 1997; Heikkila and Wenngren, 1998; Kristjansson et al., 2003; Treleaven et al., 2003). Larger than typical errors in head repositioning accuracy (HRA) have been reported in individuals with neck disorders (Revel et al., 1991; Loudon et al., 1997; Kristjansson et al., 2003; Treleaven et al., 2003); although the results are controversial (Rix and Bagust, 2001; Hill et al., 2009); without a consensus on the best method (Strimpakos, 2011). The original test used a laser to assess HRA (Revel et al., 1991), a method that has since been widely used (Heikkila and Wenngren, 1998; Vuillerme et al., 2008; Pinsault and Vuillerme, 2010) and that exhibits good reliability (Pinsault et al., 2008a) and validity (Pinsault et al., 2008b; Roren et al., 2009). As an alternative method for assessment of HRA, the Cervical Range of Motion (CROM) device has been used in several

* Corresponding author. Department of Medical and Health Sciences, Division of Physiotherapy, Faculty of Health Sciences, Linköping University, SE-58183 Linköping, Sweden. Tel.: +46 10 103 17 65; fax: +46 10 103 17 06.
E-mail address: Johanna.Wibault@liu.se (J. Wibault).

1356-689X/$ – see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.math.2013.02.004

studies with reported good reliability (Loudon et al., 1997; Dumas et al., 2001; Uremovic et al., 2007).

Individuals with cervical radiculopathy caused by disc disease (CDD) display reduced physical functioning and overall health (Peolsson et al., 2002; Daffner et al., 2003; Ylinen et al., 2003; Peolsson and Kjellman, 2007). Assessment of HRA is recommended in individuals with neck pain (Humphreys, 2008; Treleaven, 2008; Kristjansson and Treleaven, 2009), but to our knowledge, studies reporting this assessment have not previously been carried out in individuals with CDD.

The CROM device possesses several advantages for clinical practice because it can be managed by one rater and requires no advanced time-consuming calculations, but the test–retest reliability and measurement error of the CROM device for assessment of HRA in individuals with CDD are unknown (Mokkink et al., 2010). Knowledge about assessment of HRA with the CROM device in neck-healthy individuals is also limited (Loudon et al., 1997), and the device has not been compared to a laser which might be considered the gold standard for clinical practice (Roren et al., 2009).

The present study had two specific purposes. The first was to compare assessment of HRA with the CROM device between individuals with CDD and neck-healthy individuals. The second was to evaluate the test–retest reliability of the CROM device in individuals with CDD, and criterion validity between the CROM device and a laser in neck- healthy individuals, with quantification of measurement errors.

2. Methods

2.1. Participants

The present experimental study included one sample of individuals with CDD, and two samples of neck- healthy individuals. Participation was voluntary, and participants provided written informed consent. The regional ethical review board approved the study.

2.1.1. Individuals with cervical radiculopathy

Individuals with CDD were referred to neck surgery and consecutively recruited from a neurosurgery department at a University Hospital in Sweden. Inclusion criteria were age 18–65 years and an association between clinical findings and verified CDD on MRI. Individuals with previous surgery, earlier fracture or luxation of the cervical spine, malignity or spinal tumor, myelopathy, systematic disease, diagnosis of fibromyalgia or generalized myofascial pain, persistent or recurring severe back pain, diagnosed psychiatric disorders, alcohol or drug addiction, or lack of familiarity with the Swedish language were excluded. Seventy-one individuals with CDD participated in the study (38 men; 33 women; mean age 50 years, standard deviation (SD) 10.0 years) (Table 1). Twenty-four individuals (14 men; 10 women; mean age 51 years, (SD) 8.4 years) (Table 1) also contributed to the evaluation of the test–retest reliability and measurement error of the CROM device in individuals with CDD.

2.1.2. Neck- healthy individuals

Individuals permanently employed at a hospital were stratified according to sex and age and randomly selected (computerized random list developed by a statistician) to be asked to volunteer in the comparative study of HRA assessment using the CROM device between individuals with CDD and neck-healthy individuals (640 individuals; 340 men; 300 women). A total of 149 individuals (75 men; 74 women) met the inclusion criteria of no self-reported current neck disorders (score on the Neck Disability Index (NDI) $< 20\%$) (Fairbank et al., 1980), pain on the visual analog scale (VAS) ≤ 10 mm (Croft et al., 1998), and no recurrent neck or low back pain, inflammatory joint disease, or other systemic disease during the last three years; 10 of the recruited men were unable to attend the testing. The sample was filled with 34 individuals (employees and students from a university) to include at least 80 men and 80 women (20 individuals in each of the following age intervals: 25–34, 35–44, 45–54 and 55–64 years) (Peolsson et al., 2007). The final sample included 173 individuals (86 women; 87 men; mean age 44 years, SD 12.0) (Table 1). A convenient sample of 12 neck-healthy individuals (10 women; 2 men; mean age 42 years, (SD) 8.5 years) (Table 1) was recruited from employees at a university for participation in the criterion validity study between the CROM device and laser. The neck- healthy individuals differed significantly from individuals with CDD in age, body mass index (BMI) and level of physical activity ($p < 0.001$).

Table 1
Background information for individuals with cervical radiculopathy caused by disc disease (CDD) and neck-healthy individuals.

	Individuals with CDD		Neck-healthy individuals			Criterion validity study
	Total	Test–retest	Total	Women	Men	
Participants (*n*)	71	24	173	86	87	12
Age (mean, SD)	50(10.0)	51(8.4)	44(12.0)	45(12.3)	44(11.8)	42(8.5)
Female *n* (%)	33(47)	10(42)	86(50)			10(83)
Height cm (mean, SD)	175(8.9)	176(9.0)	173(8.4)	167(5.7)	179(5.4)	172(8.8)
Weight kg (mean, SD)	84(15.7)	83(12.0)	74(11.6)	67(8.5)	81(9.6)	66(8.0)
BMI (mean, SD)	27(4.4)	27(3.7)	24(3.0)	24(3.0)	25(2.9)	23(3.0)
Right-handed *n* (%)	67(94)	22(92)	160 (92.5)	77(89.0)	83(95.4)	11(92)
Physical activity *n* (%)						
Inactivity	9(13)	4(17)	4(2)	1(1)	3(4)	0
Low activity	32(45)	7(29)	26(15)	11(13)	15(17)	1(8)
Moderate activity	20(28)	7(29)	72(42)	39(45)	33(38)	3(25)
High activity	8(11)	3(13)	70(41)	35(41)	35(41)	8(67)
Neck pain VAS (mean, SD)	48 (23.0)	43 (26.1)	0.12	0.03 (0.15)	0.2 (1.0)	0
Disability % NDI (mean, SD)	43.4 (14.4)	42 (15.0)	2.2	3.2 (3.5)	1.2 (2.4)	1.2 (1.3)

[a]BMI: Body Mass Index; [b]VAS: Visual Analog Scale for rating pain intensity; [c]NDI: Neck Disability Index.

2.2. Measurements

2.2.1. Background data

Individuals completed the NDI (Vernon and Mior, 1991), reported pain intensity on the VAS (Harms-Ringdahl et al., 1986), and estimated their daily physical activity and their weekly practice of exercise, sport, and open-air activities during the preceding12 months. Answers to the two questions were interpreted on the basis of a four-point scale (1 = inactivity, 2 = low activity, 3 = moderate activity, 4 = high activity) in accordance with a previous study (Peolsson et al., 2007). A self-reporting measure for assessment of physical activity has been evaluated accurate and reliable when compared to objective quantification (Babor et al., 2004).

2.2.2. Assessment of head repositioning accuracy with the CROM device

Assessment of HRA with the CROM device was performed according to a previous protocol (Loudon et al., 1997). Individuals