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Assessment of cervical stiffness in axial rotation among chronic neck pain patients: A trial in the framework of a non-manipulative osteopathic management

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A R T I C L E I N F O

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A B S T R A C T

Background: Cervical stiffness is a clinical feature commonly appraised during the functional examination of cervical spine. Measurements of cervical stiffness in axial rotation have not been reported for patients with neck pain. The purpose of this study was to investigate cervical spine stiffness in axial rotation among neck pain patients and asymptomatic subjects, and to analyze the impact of osteopathic management.
Methods: Thirty-five individuals (17 patients) were enrolled. Measurements were carried out for left-right axial rotation using a torque meter device, prior and after intervention. Passive range of motion, stiffness, and elastic- and neutral zone magnitudes were analyzed. Pain intensity was also collected for patients. The intervention consisted in one single session of non-manipulative osteopathic treatment performed in both groups.
Findings: A significant main effect of intervention was found for total range of motion and neutral zone. Also, treatment by group interaction was demonstrated for neutral-, elastic zone, stiffness in right axial rotation, and for total neutral zone. Significant changes were observed in the clinical group after intervention, indicating elastic zone decrease and neutral zone increase. In contrast, no significant alteration was detected for the control group.
Interpretations: Stiffness characteristics of the cervical spine in axial rotation are prone to be altered in patients with neck pain, but seem to be relieved after a session of non-manipulative manual therapeutic techniques. Further investigations, including randomized clinical trials with various clinical populations and therapeutic modalities, are needed to confirm these preliminary findings.

1. Introduction

Neck pain is a frequent clinical musculoskeletal symptom with a prevalence ranged from 17% to 75% (Fejer et al., 2006) and an annual prevalence ranged from 30% to 50% (Hogg-Johnson et al., 2008). This condition represents one of the most common causes of disability in Western Europe, entailing important expenditures for the health care system (Hoy et al., 2014; Martin et al., 2008; Murray et al., 2012). Besides, spinal stiffness in terms of flexibility impairment is a highly contributing factor related to musculoskeletal disability (Daniels et al., 2015; Ingram et al., 2015; Stanton et al., 2017).

Therapeutic options such as physical and manual approaches (i.e. manipulation, mobilization, exercises) are commonly recommended for treating neck pain with relevant clinical outcomes. Prior to using these modalities, physical examination involves assessment of pain pattern, active range of motion, and motion palpation. The latter represents a manual method for judging cervical stiffness alteration usually characterized as an increase of resistance to movement of a specific vertebral segment including the surrounding soft tissues (Manning et al., 2012). Clinical validity of this application has been demonstrated (Fernandez-de-las-Penas et al., 2005; Humphreys et al., 2004; Rey-Eiriz et al., 2010). Nevertheless clinical prognosis related to these parameters is still questioned.

Innovative methods have been developed for assessing several biomechanical features of the spine in vivo. These techniques aim to quantify the stiffness characteristics (i.e. neutral zone, stiffness coefficient, flexibility) for the lumbar spine (Wong and Kawchuk, 2017) and for the cervical spine (McClure et al., 1998; McGill et al., 1994; Snodgrass et al., 2008). From these investigations, several authors demonstrated measurement feasibility and validity (Snodgrass et al., 2008), influence of spinal positioning (Edmondston et al., 1998; Snodgrass and Rhodes, 2012), and clinical relevance for specific

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populations (Dugailly et al., 2017; Ingram et al., 2015; Wong and Kawchuk, 2017).

In addition, mechanical impact of manual approaches on spinal stiffness has been investigated; however these studies mainly concerned the lumbar spine (Allison et al., 2001; Fritz et al., 2011; Shum et al., 2013; Wong et al., 2015). Significant alteration of cervical stiffness for posteroanterior (PA) movements has been observed following manual intervention (Tuttle et al., 2008), although methodological limitations have to be taken into account such as the location of the applied force, absence of standards for defining limitation of movements, and the non-physiological aspect of PA displacement.

Axial rotation is one of the most usual motions of the neck performed during daily life activities, and thereby represents an essential motion component to assess the cervical function. To our knowledge, the quantification of cervical spine stiffness has not yet been investigated in axial rotation for patients with neck pain. The impact of manual therapeutic techniques on these biomechanical properties is also still unknown.

The objective of the present study is thus (1) to investigate the stiffness of the cervical spine in axial rotation among patients with chronic neck pain compared to asymptomatic subjects and (2) to determine whether a non-manipulative osteopathic management may alter the stiffness parameters.

2. Methods

2.1. Sample

Eighteen healthy, asymptomatic volunteers (12 female and 6 male, 48 years (SD 14 years) and seventeen patients with chronic neck pain (12 female and 5 male, 47 years (SD 13 years) were enrolled. Healthy subjects (AS) had no history of cervical spine pain or injury. Neck pain patients (NP) displayed a history of cervical complaints since at least 3 months, and were recruited from the department of physical medicine and rehabilitation of the academic hospital. Exclusion criteria were neurological and rheumatologic disorders of any kind, infectious disease, cervical vascular deficiency (i.e. vertebral or carotid artery), and history of neck surgery, fracture and trauma. Patients that received a manual treatment within one month before the investigation were also excluded.

All participants gave their informed consent, and ethical approval for the current investigation was obtained from the Academic Hospital Ethics Committee (P2014/094; CCB: B406201420117).

2.2. Instrumentation and procedure

Cervical stiffness measurements were achieved in axial rotation using a customized device for determining simultaneous mono-axial torque (Torque sensor, typ DV-4, 100 Nm, 0.2% accuracy, Metil-Belgium) and angular displacement (Spindle Operated Potentiometers, type M series, MC1, 300°, 1% accuracy, TE-connectivity, Switzerland) as described in Fig. 1 (Dugailly et al., 2017). During experimentation, the subject's head was fully stabilized by a support comprising right and left solid plastic stanchions (diameter: 28 mm) padded by firm foam to ensure comfort and fixation. Stanchions were firmly applied on both sides of the head, and adjusted anteriorly and posteriorly, to avoid motion between the head and the support. Axial displacement of the support was carried out using a lever arm (Fig. 1). Data was collected using Labview software (Labview 2009, Professional Development System - National Instruments) at a sample rate of 20 Hz.

Assessment was carried out before and immediately after (within a delay of 5 min) the treatment session. During assessment, the subject was lying on an adjustable medical table with the head resting in the above-mentioned support; the vertex aligned with the axis of the torsiometer (Fig. 1). Prior to examination, the procedure was explained, and a preconditioning trial was conducted for ensuring motion

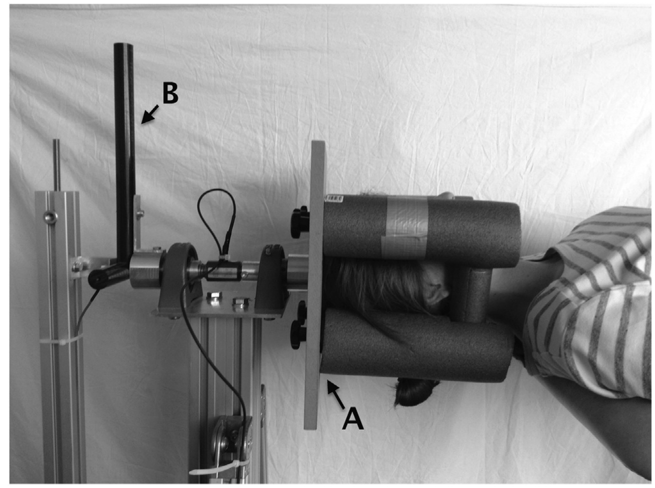

Fig. 1. Experimental set-up for assessing the cervical spine stiffness in axial rotation. The subject's head is secured to the support (A), and the lever arm (B) allows passive displacement (see text for details).

accommodation and subject relaxation. Each measurement session consisted in three repetitive motion cycles (from right to left axial rotation) performed passively by an independent assessor, starting and ending in neutral position. Each cycle lasted 8 s thanks to a metronome. A threshold of applied moment was not imposed and subjects were instructed to indicate the end of motion range, or if discomfort or excessive tension was felt. In order to not trigger the oculo-cervical reflex, subjects were requested to close their eyes during assessment, and shoulder compensation was strictly avoided. The assessor was blinded to which group the subject belonged.

Reliability of measurements was assessed from data obtained during three separate assessment sessions (two on the same day, and one a week later) performed by the assessor on 5 volunteers. Each session consisted of 5 repeated measures. Reliability was determined by calculating the intra-class correlation coefficients ($ICC_{3,1}$) and standard error of measurement (SEM). Results are presented in Table 1.

2.3. Intervention

Osteopathic management (OM) consisted in the application of non-manipulative techniques on the basis of a musculoskeletal examination of the cervical spine and scapular region. Cervical dysfunctions were examined using motion palpation tests (i.e. springing test, lateral gliding test) as previously described (Fernandez-de-las-Penas et al., 2005; Greenman, 2003; Rey-Eiriz et al., 2010). The latter aimed at assessing gliding, end-feel and resistance of zygapophyseal joints for each cervical segment to detect dysfunctional segments. Myofascial restrictions were identified considering cervical soft tissue tenderness, stiffness and pain during manual palpation. Both groups received a similar treatment based on the physical findings (i.e. joint dysfunction, myofascial restriction, trigger point), comprising general osteopathic approach, muscle energy technique, oscillatory mobilization, myofascial release and compressive ischemic technique for the trigger points. The general osteopathic approach consisted in gentle rhythmic

Table 1
Reliability analysis of measurements.

	Within-session		Between-session	
	ICC	SEM	ICC	SEM
PROM (°)	0.924	1.6	0.744	4.7
Torque (Nm)	0.938	0.10	0.764	0.19
Stiffness (Nm/°)	0.828	0.01	0.683	0.01
ZN total (°)	0.928	5.4	0.748	10.0