Clinical Biomechanics 42 (2017) 128–133

Contents lists available at ScienceDirect

Clinical Biomechanics

journal homepage: www.elsevier.com/locate/clinbiomech

Lecture

Analysis of the upper cervical spine stiffness during axial rotation: A comparative study among patients with tension-type headache or migraine and asymptomatic subjects

P.-M. Dugailly [a,b,*], A. Decuyper [a], W. Salem [a], A. De Boe [a], G.V. Espí-López [c], Y. Lepers [a]

[a] Department of Osteopathic Sciences, Research Unit in Osteopathy, Faculty of Motor Sciences, Université Libre de Bruxelles (ULB), Brussels, Belgium
[b] Laboratory of Functional Anatomy, Faculty of Motor Sciences, Université Libre de Bruxelles (ULB), Brussels, Belgium
[c] Department of Physiotherapy, University of Valencia, Valencia, Spain

ARTICLE INFO

Article history:
Received 12 May 2016
Accepted 26 January 2017

ABSTRACT

Background: Many studies reported the implication of the cervical musculoskeletal system in patients with tension type headache and migraine. The objective of this study is to investigate the upper cervical spine stiffness features in axial rotation among headache patients in comparison with a healthy population.
Methods: 48 subjects including 30 migraine patients with/without aura and 18 patients with tension-type headache, aged between 18 and 60 years (mean 36, SD 11 years) have been evaluated. Stiffness measurements were carried out for passive axial rotation using a torque meter device. The flexion-rotation test was used to emphasize assessment of the upper cervical spine.
Findings: Neither the stiffness nor the neutral zone varies between different populations studied. Passive range of motion in axial rotation is unilaterally reduced in symptomatic subjects ($p = 0.001$). Considering the elastic zone, right and left motion magnitude was significantly lower for clinical groups compared to the control group.
Interpretation: Stiffness seems not to be altered among tension type headache and migraine patients. However, patients seem prone to display a larger right-left asymmetry of axial rotation and a reduction in the motion range tolerance, emphasizing the likely link between the cervical discomfort and these pathologies. Any difference is observed in the elastic behavior of the upper cervical spine between the two primary headache populations. However, further investigations are needed to confirm these previous results taking various specific clinical characteristics into consideration.

1. Introduction

Headache is one of the most common reasons for medical consultation. Migraine (MI) and tension type headache (TTH), concomitant or not, represent nearly 74% of headache complaints in neurological outpatient clinic. These pathologies may affect all populations, regardless of age, gender or the level of income, and frequently impair the quality of life (Géraud et al., 2009; WHO, 2011). According to the type of primary headache considered, the prevalence may be different from 38.8% for episodic tension type headache to around 2.2% for their chronic form (Fernández-de-Las-Peñas et al., 2006a, 2006b; Robbins and Lipton, 2010). Concerning MI, 10% of the general population may be involved while nearly 0.5–2% for the chronic form (Paemeleire et al., 2015; Robbins and Lipton, 2010; Stovner et al., 2007).

Fully supported by neurology, it's frequent to note MI and/or TTH patients display neck pain, muscles tenderness, sometimes associated with joint dysfunction (Fernández-de-Las-Peñas et al., 2006b, 2007a, 2007b; Calhoun et al., 2010; Sohn et al., 2010). In these cases, physical management is generally prescribed in order to optimize the primary medical treatment (i.e. anti-inflammatory drug or painkiller). Moreover, many studies emphasized the beneficial impact of manual approaches in the treatment of these pathologies (Ajimsha, 2011; Bronfort et al., 2001; Espi-Lopez et al., 2014).

Currently, only primary cervicogenic headache is related with the biomechanics of the cervical spine. However, several clinical features such as neck pain, trigger points, altered pressure pain threshold, forward head posture disorder, are usually presented in MI and TTH (Ashina et al., 2012, 2015; Calhoun et al., 2010; Fernandez-de-las-Penas et al., 2009; Grossi et al., 2011; Landgraf et al., 2015; Sohn et al., 2010). In addition, typical head pain in TTH and migraine without aura may be reproduced when stressing the C0–C1 segments and C2–C3 zygapophysial joints (Watson and Drummond, 2012).

* Corresponding author at: Research Unit in Osteopathy, Faculty of Motor Sciences, Université Libre de Bruxelles (ULB), 808 route de Lennik, CP 640, 1070 Bruxelles, Belgium.
E-mail address: pdugaill@ulb.ac.be (P.-M. Dugailly).

http://dx.doi.org/10.1016/j.clinbiomech.2017.01.019
0268-0033/

In clinical practice, stiffness is usually assessed manually by means of practitioner judgment to determine whether a joint is hypo- or hypermobile (Snodgrass et al., 2012). Few studies have examined this aspect in people suffering from MI and TTH. Tali et al. (2014) found a significantly greater number of subjects with Occiput-C1 and C1–C2 stiffness/hypo mobility in MI patients compared to a control group. In contrast, Zito et al. (2006) found a low incidence of pain associated with joint hypo mobility in control and MI groups versus the cervicogenic headache group. Nevertheless, to our best knowledge, quantification of stiffness magnitude is lacking for the upper cervical spine (UCS) and for these clinical disorders. Therefore the objective of the present study is to investigate the stiffness features of the UCS, in TTH and migraine patients in comparison with a healthy control population.

2. Methods

2.1. Sample

Forty-eight headache sufferers and 80 controls (37 men and 43 women healthy; mean 37, SD 12 years) participated to the study. Nine females and nine males (mean 34, SD 9 years) fulfilled the diagnostic criteria of TTH, and 30 patients with the criteria for migraine with or without aura (21 females and 9 males; mean 36, SD 11 years). Patients with TTH and migraine were recruited form the Department of Neurology of the Academic Hospital. All patients were diagnosed according to the criteria of the International Headache Society by an experienced neurologist. No significant difference was found regarding gender or age between the three groups.

Exclusion criteria included history of spine major trauma (e.g. whiplash), concomitant headache, systemic diseases associated with the musculoskeletal disorders and vascular or inflammatory diseases. The participant was excluded in the case of a drug intake, which can act on cervical muscle tone. Moreover, the patients could not have a history of common neck pain or cervical spinal disease that would have required a medical consultation in a first attempt. Healthy control subjects had to be asymptomatic at the cervical spine for at least six months and could not have a history of cervical spinal pathology.

On request of the Ethics Committee and to minimize the potential vascular impairment that could be associated with axial rotation of the cervical spine, each subject had to successfully pass measuring blood pressure (90/60–140/90 mm Hg) and a test of Wallenberg (E.S.C/E.S.H., 2013; Westaway et al., 2003).

This study protocol was granted for approval by the ethical board of the academic hospital (P2014/247; CCB: B406201421395) and each subject signed an informed consent.

2.2. Instrumentation and procedures

Neck stiffness was measured during passive axial rotation using a customized device for determining simultaneous monoaxial torque (torsionmeter, Ditel Micra-M) and angular displacement (National Instrument NI USB 6210) (Fig. 1). A support was fixed to the device for providing full head stabilization during experimentation. This support comprised right and left solid plastic stanchions (diameter: 28 mm) padded by firm foam to ensure comfort, and was accommodated to the subject's head. In order to secure the head fixation, the stanchions were firmly and equally applied on both sides of the head, anteriorly and posteriorly. This condition was required to minimize motion between the head and the support, and to provide consistency of measurements. A lever arm allowed the operator to carry out axial displacements of the support (Fig. 1). Data was collected using Labview software (Labview 2009, Professional Development System - National Instruments) with an acquisition frequency of 20 Hz.

During evaluation of the upper cervical spine, the subject was seated on a chair with the neck bent forward and the head rested in the above-

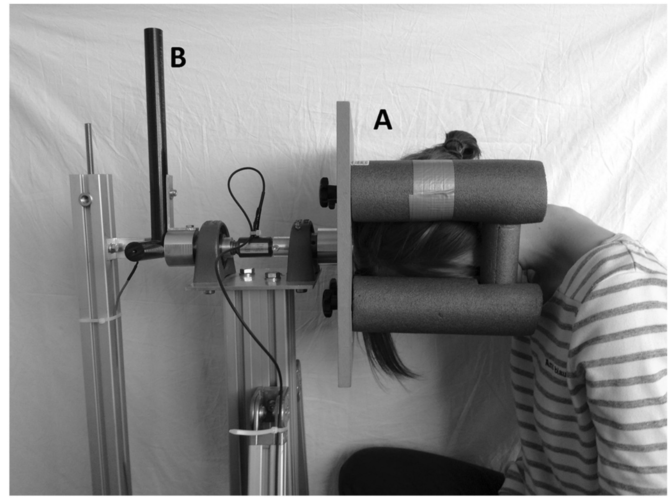

Fig. 1. Experimental set-up for assessing upper cervical spine evaluation using the flexion-rotation test performed in a seated position. The subject's head is stabilized to a securing fixture thanks to right and left padded stanchions pressing the head equally on both sides (A). The head's vertex is aligned with the axis of the test apparatus, and a lever arm (B) allows rotational displacement of the support carried out by the operator (see text for details).

mentioned support (Fig. 1). The amount of cervical flexion was not imposed to meet the physiological conditions of each subject. For the assessment, head's vertex was aligned with the axis of the torsionmeter.

Prior to assessment, each subject performed three active axial rotation trials. Then a pre-trial was achieved passively for ensuring motion accommodation and subject relaxation.

Assessment session consisted in three consecutive continuous motion cycles from right to left performed by the operator passively. Subjects were asked to close their eyes to not trigger the occulocervical reflex during the experiment. The patient had to indicate the end of motion range if discomfort or excessive tension was felt.

Reliability of measurements was assessed following three separate assessment sessions (two on the same day and one a week later) performed by three different operators on 5 volunteers. Each session consisted in 5 measures.

2.3. Data analysis

Data processing allowed data collection regarding biomechanical parameters such as passive range of axial rotation (PRoM), passive torque, range of neutral zone (NZ) and elastic zone (EZ), and EZ stiffness corresponding to the slope of the curve (Fig. 2) (Klein and Sommerfeld, 2008; Panjabi, 1992; Watier, 2006).

The neutral and elastic zones were visually determined on each graph on the basis of previous recommendations (Watier, 2006). The neutral zone (NZ) is defined as the closest range to the neutral position corresponding to the range (°) where no or low resistance (i.e. torque) occurred during joint motion (Panjabi, 1992). The elastic zone is the region from NZ up to the end of the range motion. The point of inflection of the curve indicates the end of the neutral zone and the beginning of the elastic zone (Klein and Sommerfeld, 2008).

The slope of the elastic zone (EZ) enabled us to determine the stiffness or modulus of elasticity by the following formula:

$$\text{Stiffness}\ (\text{Nm}/\ ^\circ) = \frac{\Delta \text{torque}_{EZ}}{\Delta \text{ROM}_{EZ}}$$

The stiffness is estimated by the slope of the elastic zone curve within the last ten degrees. (Klein and Sommerfeld, 2008). The data were average from the three rotations for each subject.