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Original article

Neck motion, motor control, pain and disability: A longitudinal study of associations in neck pain patients in physiotherapy treatment

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ABSTRACT

Background: Neck pain is associated with several alterations in neck motion and motor control, but most of the findings are based on cross-sectional studies.
Objective: The aim of this study was to investigate associations between changes in neck motion and motor control, and changes in neck pain and disability in physiotherapy patients during a course of treatment.
Design: Prospective cohort study.
Method: Subjects with non-specific neck pain ($n = 71$) participated in this study. Neck flexibility, joint position error (JPE), head steadiness, trajectory movement control and postural sway were recorded before commencement of physiotherapy (baseline), at 2 weeks, and at 2 months. Numerical Rating Scale and Neck Disability Index were used to measure neck pain and disability at the day of testing. To analyze within subjects effects in neck motion and motor control, neck pain, and disability over time we used fixed effects linear regression analysis.
Results: Changes in neck motion and motor control occurred primarily within 2 weeks. Reduction in neck pain was associated with increased cervical range of motion in flexion-/extension and increased postural sway when standing with eyes open. Decreased neck disability was associated with some variables for neck flexibility and trajectory movement control. Cervical range of motion in flexion-/extension was the only variable associated with changes in both neck pain and neck disability.
Conclusions: This study shows that few of the variables for neck motion and motor control were associated with changes neck pain and disability over a course of 2 months with physiotherapy treatment.

1. Introduction

Treatment offered to neck pain patients often includes a combination of different physiotherapy modalities and exercise. However, the treatment effect on non-specific neck pain and disability is similar across a wide range of reported interventions (Hurwitz et al., 2008). The effect sizes reported in interventional studies is comparable to the natural course of neck pain, suggesting that effective treatment for neck pain should be based on underlying mechanisms or modifiable factors that will induce a treatment effect larger than the natural course of neck pain (Vasseljen et al., 2013). Identification of patients who respond to a particular treatment or patients with a good or poor prognosis has become increasingly interesting in the research on neck pain and low back pain. Subgrouping of patients based on differences in underlying mechanisms, effect modifiers or prognostic factors may potentially improve the treatment efficacy in neck pain patients as shown in low back pain patients (Hill et al., 2011). It has however been reported that subgrouping of neck patients based on a clinical prediction rule to a specific treatment did not improve treatment efficacy in the short term (1–4 weeks) or long term (6 months) (Cleland et al., 2010).

An increasing number of studies have found that neck pain patients may have several alterations in motor control and neck motion compared to healthy controls (Falla and Farina, 2007; Meisingset et al., 2015; Roijezon et al., 2015). Most studies are however case–control studies and causal relationships are unclear. Changes in motor control and function may simply be a consequence of adjustments due to neck pain symptoms. Motor

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control appears often in the literature without a clear definition. In the present study, we rely on the definition by Shumway-Cook & Wollacott; "motor control is the ability to regulate or direct the mechanisms essential to movement (Shumway-Cook and Wollacott, 2001), and the term thus covers a wide range of aspects related to control of movement. There are few interventional studies on motor control in neck pain. O'Leary et al. found that changes in neck motor control are dependent on the training mode applied, but the different training modes had similar effect on neck pain and disability (O'Leary et al., 2012). Another study found similar treatment effects on postural control, a measure of motor control in neck pain patients, using three different interventions (Rudolfsson et al., 2014). The inconsistency points to a need for further longitudinal studies to investigate if changes in motor control are associated with changes in neck pain. Evidence suggests that changes in neck pain occur early in the treatment and follow up period with minimal changes in the long term (Cleland et al., 2010; Leaver et al., 2013). In contrast, the time course of changes in motor control and neck motion is unknown.

The aim of the study was therefore to investigate associations between changes in motor control and neck motion, and changes in self-reported neck pain and disability during a clinical course in physiotherapy patients.

2. Methods

We conducted a prospective cohort study among neck pain patients seeking health care in the period January 2013 to August 2014. A case–control study by Meisingset et al. using the same set of tests compared neck motor control in healthy controls and neck pain patients (Meisingset et al., 2015). The current study was a follow-up and measured clinical characteristics, neck motion, and motor control before, 2 weeks and 2 months after start of physiotherapy treatment. The study was approved by the Regional Ethics committee (ref. number 2011/2522/REC Central). All subjects gave written and informed consent and the study was conducted in accordance to the Helsinki Declaration.

2.1. Participants and treatment

Men and women (aged 18–67 years), with non-specific neck pain ≥3 on numerical rating scale (NRS: 0–10) at the day of testing, were recruited consecutively from 12 invited physiotherapy clinics in primary health care (n = 60) and from a specialized neck and back pain clinic at the university hospital (n = 21), totally 81 subjects. The patients were recruited to the study by a telephone interview by the first author. Exclusion criteria were markedly reduced or uncorrected vision, history of neck trauma, diagnosed with neurological or orthopaedic conditions that could affect motor control, positive Spurlings's test for neurological radiating arm pain, and pregnancy.

Patients in the private clinics received usual care physiotherapy and duration and number of treatments were at the discretion of the physiotherapists. The treatment consisted of a wide range of physiotherapy modalities (percentage of patients who received the specific modality in parentheses): individually supervised exercises (52%), massage (43%), mobilization/manipulation (45%), advice and information (27%), dry needling (23%), cognitive therapy (14%), and other modalities reported by less than 10% of the physiotherapists (exercises in group, prescribed home exercises, electrotherapy and shock wave therapy). Manual therapists treated 50% of the patients, while general physiotherapists and psychomotoric physiotherapists treated 30% and 20% of the patients, respectively.

The patients in the specialized neck and back pain clinic received a three week multimodal treatment from a group of several professions (physicians, physiotherapists, psychologists and social workers). The first and third week of the multimodal treatment consisted of four full days including patient education, physical exercise and cognitive therapy aimed at reducing fear avoidance/catastrophizing and to increase function, coping and self-management. The week in between was dedicated to individually prescribed home exercises.

2.2. Outcome measures

The primary outcome for the longitudinal analysis was current neck pain at the day of testing measured by NRS before, 2 weeks and 2 months after start of physiotherapy treatment. Secondary outcome was neck disability measured by Neck Disability Index (NDI; 0–100) at the same occasions.

2.3. Tests of motor control and neck motion

A comprehensive set of tests to evaluate motor control and neck motion, included variables sorted in 5 different constructs: 1. neck flexibility, consisting of tests of range of motion (ROM), conjunct motion (CM), defined as movement in associated planes outside primary motion plane, and peak velocity in the three cardinal planes. 2. proprioception, consisting of a test of joint position error (JPE) following cervical rotation. 3. head steadiness, consisting of isometric neck flexion laying in supine (0°) and in 60° recumbent position. 4. trajectory movement control, consisting of three tests of tracing a figure-of-eight (FOE), adapted from Woodhouse et al. and four versions of the Fly test, adapted from Kristjansson et al. (Kristjansson and Oddsdottir, 2010; Woodhouse et al., 2010). 5. postural sway, consisting of standing balance with eyes open (EO), eyes closed (EC) and eyes open standing on a balance pad (EOB). Category 1 was taken to reflect neck motion and categories 2–5 different aspects of neck motor control. Detailed description of the motor control variables and data analysis is given elsewhere (Meisingset et al., 2015).

2.4. Data collection

At baseline, all eligible patients completed a questionnaire (demographic and clinical characteristics) before the motion data was acquired (Table 1). The same assessor (the first author) performed the data collection at all occasions.

Motion data were acquired with 3 body worn sensors using the Liberty electromagnetic motion tracker system (Polhemus, Inc, Colchester, Vermont, USA) with a sampling rate of 240 Hz. Sensor 1 was placed on the subject's forehead 1 cm above arcus superciliaris, the second sensor was placed on the spinous process of Th2, and a third sensor was placed in the area of the spinous processes of L4–L5. Tight elastic bands were used to hold the sensors in position. A software tool based on Matlab (The MathWorks, Inc., Natick, MA, USA) was developed (SINTEF ICT, Applied Cybernetics and Dept. of Engineering Cybernetics, NTNU, Norway) to record and analyze the motion data. The coordinate system defined by the electromagnetic transmitter was used for calculating all variables except cervical range of motion (ROM). For this variable, a new coordinate system was calibrated for each subject to adjust the coordinate axes to the individually preferred axes of cervical motion (see Meisingset et al., 2015 for details).

The same test set up was used at 2 weeks and 2 months. The test-session, including questionnaires, lasted for approximately 1 h. Standardized instructions were used for all tests.