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Original article

Immediate effects of active cranio-cervical flexion exercise versus passive mobilisation of the upper cervical spine on pain and performance on the cranio-cervical flexion test

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ABSTRACT

This study compared the immediate effects of an assisted plus active cranio-cervical flexion exercise (exercise group) versus a passive mobilisation plus assisted cranio-cervical flexion (mobilisation group) on performance of the cranio-cervical flexion test (CCFT), cervical range of motion (ROM) and pain in patients with chronic neck pain. Eighteen volunteers with chronic idiopathic neck pain participated in the study and were randomised to one of the two intervention groups. Current level of pain, cervical ROM and pain perceived during movement, pressure pain threshold (PPT) and surface electromyography (EMG) during performance of the CCFT were measured before and immediately after the intervention. A significant reduction in resting pain and PPT measured over cervical sites was observed immediately following both interventions, although a greater change was observed for the exercise group. No change in cervical ROM was observed after either intervention. Reduced sternocleidomastoid and anterior scalene EMG amplitude were observed during stages of the CCFT but only for the participants in the active exercise group. Although both active and passive interventions offered pain relief, only the exercise group improved on a task of motor function highlighting the importance of specific active treatment for improved motor control of the cervical spine.

1. Introduction

Neck pain is a long-standing problem (Holmberg and Thelin, 2006; Kjellman et al., 2001) and costly for society (Korthals de Bos et al., 2003). Pain is only a single, non-recurrent event in 6.3% of patients experiencing neck pain (Picavet and Schouten, 2003). Between half and three quarters of people with current neck pain will experience recurrence within 1–5 years (Carroll et al., 2009). A contributing mechanical cause of recurrent neck pain can be disturbances in motor control of the cervical spine which may increase the risk of micro-/macrotrauma of cervical structures (Bogduk and McGuirk, 2006; Pearson et al., 2004). Restoration of muscle function is therefore considered fundamental for the treatment of cervical spine disorders (Jull et al., 2008).

Reduced activation of the deep cervical flexors muscles has been observed directly (Falla et al., 2004) and indirectly (Amiri et al., 2007; Chiu et al., 2005; Jull, 2000; Jull et al., 1999; Jull et al., 2004; Jull et al., 2007) when people with neck pain perform the cranio-cervical flexion test (CCFT). Reduced activation of the deep cervical flexor muscles during performance of this task is concomitant with increased activation of the superficial muscles (e.g. the sternocleidomastoid and anterior scalenes), indicating a reorganization of the motor strategy to perform the task (Falla et al., 2004). Used as an exercise, cranio-cervical flexion succeeds in both immediate (O'Leary et al., 2007) and long term pain relief (Jull et al., 2002; O'Leary et al., 2012) and leads to improved coordination between the deep and superficial cervical flexors (Jull et al., 2009).

Passive joint mobilisation might be a useful technique to promote improved neck muscle activation when painful or

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limited joint mobility makes the movement difficult. However, the efficacy of passive mobilisation and manipulation has been questioned (Gross et al., 2007) and both techniques have shown equal pain relief (Leaver et al., 2010), though only in the short-term (Gross et al., 2010). Their efficacy may be improved when combined with active exercise as recommended by guidelines for the treatment of mechanical neck pain (Childs et al., 2008).

A study which applied a postero-anterior grade III Maitland oscillatory mobilisation to the articular pillars of the C5-6 segment in patients with chronic neck pain, showed decreased activity of the superficial neck flexors post intervention. In this study, ultrasonography was utilised and changes in muscle thickness were calculated to infer muscle recruitment (Jesus-Moraleida et al., 2011). In an earlier study, reduced electromyography (EMG) amplitude of the sternocleidomastoid muscle was observed during the lower stages of the CCFT following passive mobilisation of the cervical spine (Sterling et al., 2001). However, no studies have directly compared the immediate benefit of active versus passive interventions on motor control of the cervical spine.

This study compared the immediate effects of assisted plus active cranio-cervical flexion (exercise group) versus passive mobilisation plus assisted cranio-cervical flexion (mobilisation group) on performance on the CCFT, cervical range of motion and pain in patients with chronic idiopathic neck pain.

2. Methods

The outcome measures for the study were patient reported levels of pain rated on a numerical rating scale (NRS), cervical range of motion (ROM), pressure pain threshold (PPT) and surface electromyography (EMG) of the sternocleidomastoid, anterior scalene and splenius capitis muscles during performance of the CCFT. All measures were conducted before and immediately after an intervention to the cranio-cervical region in patients with chronic idiopathic neck pain.

2.1. Subjects

Eighteen volunteers with chronic idiopathic neck pain were recruited from the Pain Clinic of the University Hospital in Göttingen, Germany. Patients were included if they were aged between 18 and 60 years with a history of neck pain $\geq$3 months during the last year, and a pain intensity of $\geq$3/10 on an NRS.

Subjects were excluded if they had any major circulatory, neurological or respiratory disorders, recent or current pregnancies, or previous spinal surgery. The study was approved by the local Ethics Committee and the procedures were conducted according to the Declaration of Helsinki.

2.2. Cervical range of motion (ROM)

A Multi-Cervical Unit (MCU, BTE technologies) was used to measure active ROM of the neck. The participants were seated with their head rigidly fixed in the device with their back supported, knees and hips in 90° of flexion, their torso placed against the back rest and their hands resting comfortably on their lap. Three measurements of each movement (flexion, extension; left and right lateral flexion and left and right rotation) were performed in a random order and the mean used for further analysis. Moreover, pain intensity rated on an NRS was measured at rest and during each ROM measure both pre and post-intervention.

2.3. Pressure pain threshold

Pressure pain threshold was measured using an analogue algometer (Force Dial, model FDK 20, Wagner Instruments; Greenwich, USA) with a surface area at the round tip of 1 cm^2. PPT was measured posterolaterally, between the lower border of the occiput and the horizontal level of the spinous process of C2 and over the C5/6 zygapophyseal joint. The tip of the algometer was placed at a 45° angle between the frontal and sagittal plane, perpendicular to the skin, and pressure was applied at a rate of 1 kg/cm^2/s.

The PPT was assessed on the most painful side indicated by the patient. In case both sides were equally painful, the right side was selected. After an explanation of the measurement and demonstration on the forearm, four consecutive PPT measures were performed at each location with 30 s of rest between measurements. The first PPT measure was discarded and the mean of the subsequent three PPT measures was used for further analysis (Shiau et al., 2003).

2.4. Surface electromyography and the cranio-cervical flexion test (CCFT)

Subjects were comfortably positioned in supine, crook lying with the head and neck in a neutral position and were instructed to perform cranio-cervical flexion. The task consisted of five incremental movements of increasing cranio-cervical flexion ROM. Performance was guided by visual feedback from a pressure sensor (Stabilizer™, Chattanooga Group Inc. USA), which was placed suboccipitally and inflated to 20 mmHg. During the test, subjects were required to perform gentle nodding motions of cranio-cervical flexion that progressed in range to increase the pressure in five incremental levels, with each increment representing 2 mmHg. Subjects practiced targeting the five test levels (22–30 mmHg; increments of 2 mmHg) in two practice trials before recordings commenced.

Surface EMG signals were recorded from the sternocleidomastoid, anterior scalene and splenius capitis muscles bilaterally using Ag/AgCl electrodes (Ambu Neuroline, Denmark; conductive area: 28 mm^2), following skin preparation and guidelines for electrode placement (Falla et al., 2002; Lindstrøm et al., 2011). A reference electrode was placed on the spinous process of C7.

The bipolar EMG signals were amplified (OT Bioelettronica, Torino, Italy; −3 dB bandwidth 10–500 Hz) by a factor of 2000, sampled at 2048 Hz, and converted to digital form by a 12-bit analogue-to-digital converter. The root mean square (RMS) of the EMG was calculated over a 1 s sliding window and presented as the maximum RMS across the 10-s contraction.

2.5. Interventions

Patients were randomly allocated to an exercise group or a mobilisation group using a computer generated sequence of numbers (Fig. 1).

2.5.1. Active assisted plus active cranio-cervical flexion (exercise group)

Patients were positioned in supine, crook lying with the cervical spine in a neutral position and were instructed to perform repeated movements of cranio-cervical flexion at a rhythm of one repetition per 2 s for three minutes. During the first minute, the therapist assisted the action of cranio-cervical flexion cradling the head of the patient and guiding the correct movement (Fig. 2). For the following two minutes, the patients performed the movement independently.