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Original article

The long-term course of deficient cervical kinaesthesia following a whiplash injury has a tendency to seek a physiological homeostasis. A prospective study☆

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ABSTRACT

Background: No research exists for the long-term course of deficient cervical kinaesthesia following a whiplash injury. Prior results depicted two divergent courses of deficient cervical kinaesthesia at 1 year.
Objectives: First, to determine the actual course(s) of untreated deficient cervical kinaesthesia from 1 year to 6–8 years post-collision and second, to investigate the association between the test results versus self-reported disability.
Design: A follow-up study was conducted to measure persons who had experienced whiplash from January 2007–September 2009.
Method: The two clinical tests for cervical kinaesthesia, the Head–Neck Relocation (HNR) test and the Fly test are conceptualised to measure two distinct "percepts" of neck proprioception: position sense and movement sense, respectively. In both tests, the mean error of three trials was calculated for each individual and represented the kinaesthetic accuracy. These values were used for analysis.
Results: Forty-one participants out of an initial forty-seven (response rate = 87.2%) were able to participate at the 6–8 years follow-up. The two divergent courses at 12 months had a tendency to seek a physiological homeostasis at the 6–8 years follow-up. Overall, very slight improvements were revealed in disability levels between the 2 assessment points.
Conclusions: Untreated deficient cervical kinaesthesia has a tendency to seek a physiological homeostasis somewhere from 1 year to 6–8 years post-collision. We therefore recommend that cervical kinaesthesia be monitored and treated early, as deficient cervical kinaesthesia may lead to adaptive compensatory patterns secondary to the remaining functional kinaesthetic deficits.

1. Introduction

No research exists for the long-term course of deficient cervical kinaesthesia following a whiplash injury. Our prior 1-year longitudinal study identified, for the first time, two different courses of deficient cervical kinaesthesia in symptomatic people after motor vehicle collisions (MVCs). In this study, significantly diverging results were depicted at 1 month versus at 12 months post-collision in both the Head–Neck Relocation (HNR) test and the Fly test. Those who had poorer results at the start improved their performances significantly during the 1-year course, whereas the opposite was true for those who had better results at the start (Oddsdottir and Kristjansson, 2012). These results cannot be attributed to regression to the mean (RTM) effects, because analysis of covariance – ANCOVA – was used, and the coefficient *b* from the regression analysis is the estimated treatment effect adjusted for RTM (Barnett et al., 2005).

It has been estimated that approximately one half of all people with acute whiplash will recover within 3 months regardless of the interventions, while the other half will experience delayed recovery or chronic problems beyond that time (Kamper et al., 2008; Carroll et al., 2008). There have been a series of systematic reviews (SRs) and data syntheses published for both traumatic and non-traumatic neck pain (Walton et al., 2013a). The most consistent findings amongst these SRs for poor prognosis are initial pain intensity (score > 5.5/10 on Visual Analogue Scale VAS) or high aggregate scores on self-reported disability (score > 14.5/50 on

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Neck Disability Index) (Walton et al., 2013a, 2013b), which individually provide little guidance for intervention decisions (Walton et al., 2013a). Other significant, but moderately confident, predictors of poor outcome following whiplash at inception are report of headache, report of low back pain, a prior history of neck injury, less than postsecondary education, older age, high catastrophizing, post-traumatic stress disorders (PTSD), cold hyperalgesia and female sex (Croft et al., 2001; Walton et al., 2013a, 2013b).

Many potential structures and processes are affected in whiplash-associated disorders (WAD). The deficiency of comprehensive structural and physiologic diagnostic regimens may mean that the sequelae of undocumented impairments on these domains are manifested through higher pain and self-report. Without such diagnostic tools, the physiologic and psychological components of neck disorders can be difficult to disentangle (Walton et al., 2013a). There is a great lack of long-term follow-up studies on diverse physical impairments, which have been demonstrated in WAD, including deficient cervical kinaesthesia.

The primary aim of this study was to determine the actual course(s) of deficient cervical kinaesthesia from 1 year to 6–8 years post-collision in patients diagnosed with WAD. The two clinical tests for cervical kinaesthesia are conceptualised to measure two distinct "percepts" of proprioception: relocation accuracy (position sense) and movement control accuracy (movement sense), respectively (McCloskey, 1973; Proske, 2006). As Sherrington stated "posture follows movement like a shadow". There are therefore two primary elements in the co-ordination of movement, the tonic or postural element and the phasic or movement element (Sherrington, 1906, p. 417). The former test, the Head–Neck Relocation test (HNR test), replicates Revel et al. (1991). The latter test, the Fly test, replicates Kristjansson et al. (2004).

The secondary aim of this study was to investigate the association between the test results of cervical kinaesthesia versus self-reported neck disability and fear of movement.

2. Methods

2.1. Study design

A 6–8 years follow-up study was conducted to measure persons who had experienced MVCs, from January 2007–September 2009. They were originally examined for deficient cervical kinaesthesia at 1, 3, 6, and 12-month post-collision (Oddsdottir and Kristjansson, 2012). The data in the current study was collected from February 18th–April 1st, 2015.

2.2. Participants

The participants, who were originally recruited through the Emergency Department at X were contacted by telephone after receiving a letter and asked if they were willing to participate. Table 1 shows their demographics. They were originally included in the study if they met the criteria of WAD I–III, according to the Québec Task Force (QTF) (Spitzer et al., 1995). WAD IV or multiple traumas, concussion or head injury from MVCs; previous history of whiplash injury; or prior symptoms from the head or neck such as neck pain and/or headache, systemic diseases or psychological disorders of any kind excluded participation. During the first year after injury the participants were instructed to "act as usual" but data was collected regarding received treatment and medication during the whole study period. Sixty-seven percent received physiotherapy, 5.4% had massage and 66.2% used simple analgesic and/or opioid medication in variable combinations or alone. None had received specific treatments to improve their kinaesthetic deficits during the study period. All participants gave informed consent after ethical clearance from the National Bioethics Committee.

2.3. The Head–Neck Relocation test

The HNR test measures the accuracy of relocation of the head (absolute error) to self-assessed natural head position in degrees. The Fastrak device (Fastrak, Polhemus, USA) was used, with one sensor placed on the forehead and the other adhered over C7. The software program that was written for this test transformed the data collected by the Fastrak system directly into angle files and graphs to visualise the real-time process on the screen from the starting position through the excursion of the movement. For more detailed description, see Kristjansson et al. (2003).

2.4. The Fly test

The Fly is a clinical test that measures the accuracy (absolute error) of cervical spine movements in millimetres. Tracking sensors (Fastrak, Polhemus, USA) were fastened on the patient's head. They were asked to use neck movements to track, as accurately as possible, a moving fly (a cursor) on a computer screen. Two cursors were seen on the computer screen; a blue one (derived from the Fastrak system) indicated movements of the head, and a black fly (derived from the Fly software program) traced three generated movement patterns separately (Fig. 1). Since only the cursors are visible on the computer screen but not their trajectories, prediction of movements is difficult. For more detailed description, see Kristjansson et al. (2004).

2.5. Self-assessment

The participants were asked to consider their condition during the previous week and based on that, completed the Neck Disability Index (NDI) (Vernon and Mior, 1991), measuring activity limitations due to neck pain, and the Tampa scale of kinesiophobia (TAMPA), an indicator of fear of movement/re-injury (Crombez et al., 1999; Vlaeyen &, Linton, 2000).

2.6. Procedure

The participants answered the questionnaires before the measurements took place. After receiving explanation on the intention and nature of the tasks and the test procedures, the participants were instructed to assume a comfortable sitting position facing straight forward, with relaxed shoulders and hands resting in their laps. The HNR test was performed first, followed by the Fly test, so the HNR test, which takes 1 min; would not be affected by the Fly test, which takes 9 min.

The starting position in the HNR test was sitting with the head in natural resting posture; the participants were asked, while blindfolded, to remember that position. They were then asked to

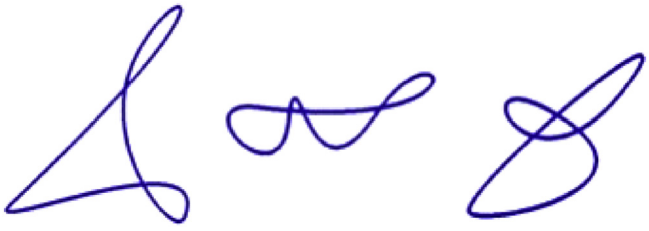

Fig. 1. The movement patterns A, B and C (from left to right) traced by the Fly, the duration of each trial was 30, 20 and 40 s, respectively.