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Original article

Use of neck torsion as a specific test of neck related postural instability

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Background: Disturbed postural stability in neck pain (NP) is likely due to abnormal cervical afferent function. Several potential causes requires specific diagnostic tests. The neck torsion (head still body rotated) manoeuvre stimulates cervical but not vestibular receptors and identified abnormal cervical afferent input as the cause in patients with NP compared to healthy controls. Comparison between vestibular and NP subjects is now needed.
Aims: To compare individuals with unilateral vestibular loss (UVL), persistent NP and asymptomatic controls. It was hypothesized that neck torsion will increase postural stability in NP compared to both the asymptomatic and UVL groups.
Methods: Twenty UVL, 20 persistent NP and 20 asymptomatic control subjects underwent measurement of postural stability on a computerised force plate with eyes closed in comfortable stance under 5 conditions: neutral head, head rotated 45° (left and right) and neck torsion (left and right). Root mean square (rms) amplitude of sway was measured in the anterior posterior (AP) and medial lateral (ML) directions. Average torsion and torsion difference (average torsion − neutral neck) were calculated.
Results: NP subjects had significantly greater ($p < 0.05$) AP sway with average torsion and torsion difference compared to both control and UVL. There were no significant differences between control and UVL and no between group differences for neutral neck, rotation or rotation difference.
Conclusion: The results of the study suggest that the torsion manouever may identify cervical afferent causes of disturbed postural stability. This is important for guiding assessment and management of balance disturbances in patients.

1. Introduction

Sensorimotor control disturbances such as altered head and eye movement control and postural stability have been demonstrated in those with neck pain (NP) of various causes but are generally more prevalent in traumatic NP (Treleaven, 2008, 2011). The cause of these disturbances are most likely due to damage or functional impairment of the abundant and important cervical proprioceptors. Cervical afferents, along with the vestibular and visual systems, provide information to the sensorimotor control system. Specifically, with regard to postural stability, impairments in both static and dynamic balance have been demonstrated. (Schieppati et al., 2003; Sjöström et al., 2003; Field et al., 2008). Relationships to altered cervical proprioception and impaired postural stability have also been demonstrated experimentally in asymptomatic individuals and support the role of cervical afferent dysfunction as a cause of postural stability deficits in those with NP (McPartland et al., 1997; Schieppati et al., 2003; Vuillerme et al., 2005). Nevertheless other possible causes of these disturbances need to be considered, especially in those with traumatic NP. Potential damage to the peripheral or central vestibular system can occur in conjunction with a whiplash injury, and associated elevated anxiety or medication intake may also alter postural stability (Sturzenegger et al., 1995; Ernst, 2005). Whilst there is evidence that anxiety and medication intake do not influence mean group outcomes with respect to postural stability in those with persistent whiplash (Treleaven et al., 2005b) and postural stability deficits due to vestibular disorders are less likely and or present differently to those with whiplash (Treleaven et al., 2008), there is a need for specific diagnostic tests for differential diagnosis.

The neck torsion (head still body rotated) manoeuvre stimulates the cervical but not the vestibular receptors and has shown potential to identify abnormal cervical afferent input, as an underlying cause of sensorimotor control disturbances in NP (Tjell and Rosenhall, 1998; Treleaven et al., 2005a; Yu et al., 2011). It was

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first described in a test of eye movement control – the smooth pursuit neck torsion test (SPNT) (Tjell and Rosenhall, 1998). Essentially, it compares a person's performance on a test when the head is in a neutral compared to a torsioned position. If performance in torsion is worse compared to neutral it suggests a cervical afferent influence. Previous research has shown SPNT difference occurs in those with NP but not in those with peripheral or central vestibular disorders or asymptomatic individuals and thus justifies its use as a specific test (Tjell and Rosenhall, 1998; Treleaven et al., 2005c).

The premise of the SPNT test was modified and tested on postural stability in a group of subjects with persistent whiplash compared to healthy asymptomatic controls (Yu et al., 2011). This showed that those with NP have worsening postural stability in torsion when compared to the neutral position. In order to determine its use as a specific test to assist the differential diagnosis of the cause of the postural stability disturbances in those with NP, it now needs to be tested in those with postural instability of another cause ie vestibular pathology (VP).

The aim of this study is to compare postural stability of individuals with VP, persistent NP and asymptomatic controls in various positions including neck torsion to determine whether the neck torsion position adversely affects balance responses. We hypothesized that postural stability will be adversely affected in the neck torsion compared to a neutral position in subjects with NP and there will be no differences in VP and healthy controls.

2. Methods

2.1. Design overview

This cross-sectional, observational study, sought asymptomatic control subjects, subjects with VP and subjects with persistent NP of similar age and gender.

2.2. Setting and participants

The study was conducted at the Neck pain and Whiplash Research Unit at the XXXXX. Recruitment was through general advertising in the greater XXX area, through vestibular pathology support groups and through University and private practice treatment clinics.

Asymptomatic control subjects were excluded if they had any existing vestibular or cervical pathology, cervical fracture/dislocation, history of traumatic head injury, lower limb disorders, Neck Disability Index (NDI) of greater than 10%, systemic diseases, neurological/respiratory/cardiovascular disorders affecting physical performance or postural stability.

Inclusion/exclusion criteria were ascertained via telephone interview. Inclusion criteria for subjects with NP included NP for greater than three months, and a NDI score greater than 10% (Vernon and Mior, 1991). Exclusion criteria were as listed above.

Inclusion criteria for subjects with VP included those with a medically diagnosed unilateral vestibular loss (ie acoustic neuroma or Meniere's disease) and active VP deficits confirmed by a clinical physical examination including tandem gait, clinical dynamic visual acuity and visual vertical. Exclusion criteria for this group also included other vestibular disorders such as Benign Paroxysmal Positional Vertigo, an NDI of greater than 10%, and any other health conditions listed above that could impair postural stability.

Any subject was also excluded if they lacked at least 45° head rotation to each side.

Ethical clearance for the study was obtained from the Human Medical Research Ethics Committee of XXX. All subjects gave their written informed consent to undertake the study.

2.3. Measures

Demographic data such as age, gender, height and weight as well as cause of VP and NP was collected. *The Neck disability index* (NDI) was used to quantify self-perceived disability associated with neck pain. The NDI is both valid and reliable with higher percentage scores indicating greater disability (Cleland et al., 2006; Vernon, 2008). *The Dizziness Handicap Inventory short form (DHIsf)* (Tesio et al., 1999) was used as it has been shown to be a reliable and valid measure of perceived handicap associated with symptoms of dizziness or unsteadiness. Lower scores indicate greater handicap.

2.4. Computerised posturography

Postural stability in comfortable stance was measured for 30 s with eyes closed on a computerised force plate (Kistler 9286A, Switzerland). Centre of pressure force changes in the medio-lateral (ML) and anterior-posterior (AP) directions were measured by four corner strain gauges mounted within the floor. The signal was converted to electrical signals by force transducers and charge amplifiers. An analogue low pass filter was used to restrict the frequency content on the signals to within 0–5 Hz. The force signals were AD converted at a sampling rate of 15 Hz and recorded using a LabView (2000 National Instruments) programme.

The subject was positioned on the force platform with the following 5 conditions: 1) neutral – feet in the straight ahead position and the neck neutral, 2 and 3) neck rotation right and left – feet in the straight ahead position with the neck positioned 45° to the right and left measured with a goniometer, 4 and 5) neck torsion right and left – head, body and feet in the 45° position to start, then the head held still in the 45° position and turning the body and feet to the straight ahead position (Fig. 1). The torsion manoeuvre was done as above to maintain a consistent foot position on the force plates throughout all tests. One researcher helped

Fig. 1. Neck torsion-participant starts with feet positioned 45° to the left or right. Participants head is held in this position while the feet are assisted to be placed in the neutral facing position.