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An exploratory study examining factors underpinning postural instability in older adults with idiopathic neck pain

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ABSTRACT

There is limited understanding of potential mechanisms underpinning postural control deficits in people with neck pain. This study examined several characteristics that might explain impaired postural stability in a group of older adults with neck pain, and compared the results in this cohort with that of asymptomatic controls. In this cross-sectional study we compared physical activity, lower limb motor and sensory function, vestibular and visual function, falls efficacy and dizziness handicap in 84 older adults with ($n = 35$, age 69.6 ± 6.3) and without ($n = 49$, age 69.4 ± 4.7) idiopathic neck-pain. Additionally, dynamic balance was assessed using the dynamic gait index (DGI) and standard and wavelet analysis of static balance was computed after data capture. Physical activity levels, lower limb motor and sensory function, vestibular function and visual contrast sensitivity were not different between groups ($p > 0.05$). The neck-pain group demonstrated higher falls efficacy ($p = 0.01$), greater levels of dizziness handicap ($p < 0.01$), and higher CoP velocity measures in the moderate (1.56–6.25 Hz) and low (0.39–1.56Hz) frequency bandwidths. Our results suggest that neck-pain induced postural control deficits in older adults may not be associated with the physical activity levels, lower limb motor and sensory function, or vestibular and visual function. Inferring from wavelet analysis results, we speculated that sensory re-weighting may have occurred to compensate for the deficits in neck proprioception. Further research is warranted to determine neck specific mechanisms underpinning postural control dysfunction in neck pain.

1. Introduction

The cervical spine plays a critical role in sensorimotor function. Abundant cervical mechanoreceptors are important in integrating multisensory afferent input from the vestibular, visual, proprioceptive and central nervous systems (CNS). Individuals with NP have demonstrated sensorimotor disturbances, amongst which is the negative impact of NP on postural stability [1]. Of greater relevance is that older adults with NP have demonstrated poor dynamic postural stability placing them at a higher risk of falls [2]. The potential serious consequences of falls and the burden it imposes on public health [3] highlights the need for a comprehensive assessment to inform intervention for this population. Unfortunately, there is limited understanding of the fundamental mechanisms underlying NP related postural control deficits.

Because of the multi-sensory complex nature of postural control, it is important to explore whether other factors that might negatively impact on postural stability such as physical activity levels, lower limb sensory and motor function, and vestibular and visual function are different in older adults with and without NP. First, level of physical-activity has been negatively associated with onset of NP [4]. Lower levels of physical activity may be associated with poorer lower limb function such as reduced strength and flexibility [5] and consequently contribute to a decrease in postural stability in older adults with NP. In particular, big toe flexor strength [6], range-of-motion [7], light touch sensation [8] and ankle vibration sense [9] have been closely associated with postural stability in older adults. Second, a disruption in the dynamics between the intimately blended systems involved in sensorimotor control could be expected in older adults with neck pain (NP) [1]. This is not only due to diminished cervical proprioception but also a progressive decline in vestibular, visual and CNS function with ageing. Moreover, vestibular dysfunction and specific to vision, deficits in visual contrast sensitivity, have been associated with increased falls risk [10,11], hence supporting the need to explore vestibular and visual function in older adults with NP.

As a preliminary step towards understanding mechanisms contributing to the development of postural control deficits in older adults with NP, in addition to clinically relevant balance measures and

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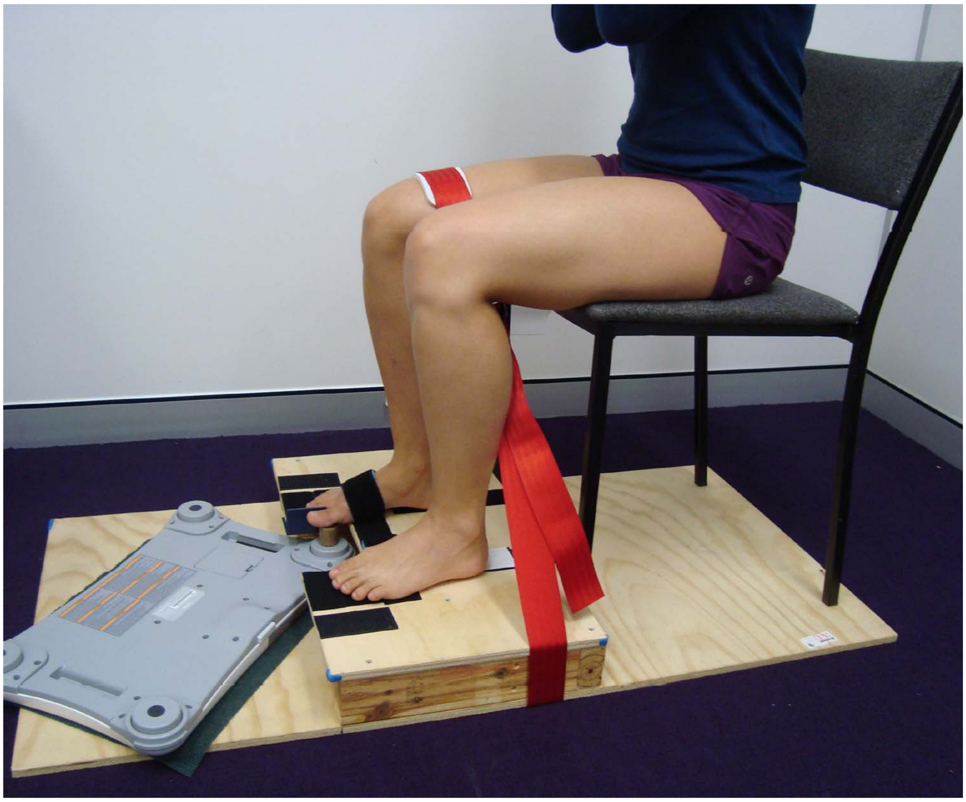

Fig. 1. Experimental set-up with the NWBB placed upside down on the wooden platform and the foot was secured using Velcro straps. Sticky Velcro was applied under the heel to prevent the heel from lifting off. The foot was positioned in such a way that the proximal metatarsophalangeal joint was at the edge of the platform and the sensor was placed under the interphalangeal joint of the big toe. Test trials where compensatory strategies were observed, such as toe curling and excessive trunk movements, were deemed invalid and repeated.

standard centre-of-pressure (CoP) measures, we will use analytical techniques of wavelet analysis. This technique decomposes the postural sway data into multiple independent frequency distinct bandwidths each hypothesised to identify with physiological significance of postural movements associated with muscular proprioception (1.56–6.25 Hz) [12], cerebellar (0.39–1.56 Hz) [12], vestibular (0.10–0.39 Hz) [13] and visual (< 0.10 Hz) [14] systems.

Given the aforementioned background, this cross-sectional, exploratory study sought to understand the mechanisms underlying postural control deficits in older adults with and without NP by (i) comparing several features that might relate to impaired postural stability but not directly related to the cervical spine to determine their influence, including level of physical-activity, lower limb, vestibular and visual function, as well as (ii) employing the use of wavelet analysis of standing balance. We hypothesized differences between groups in the level of physical-activity, lower limb, vestibular and visual function and that wavelet analysis will demonstrate changes in frequency measures in the NP group.

2. Materials and methods

2.1. Participants

This cross-sectional study involved 84 older adults with (n = 35, mean age 69.63 ± 6.3 years) and without (n = 49, mean age 69.5 ± 4.9) idiopathic NP. Participants aged 60 years and older were recruited using convenience sampling. Participants were given an option of location of testing; either at the research laboratory or at their residence. Participants were included in the NP group if they reported chronic NP for ≥3 months, neck disability index (NDI) of ≥10% (worst) and neck-related pain intensity of ≥2/10 measured on the visual analogue scale (VAS). Subjects were excluded if they had visual impairment not corrected by prescriptive lenses, trauma-induced NP such as whiplash injury, orthopaedic surgery of the lower limb within the past one year, diabetes, uncontrolled cardiorespiratory problems, known ongoing neurological or vestibular pathology, arthritis that requires active management and any acute musculoskeletal injuries. All participants provided informed consent as outlined by the Medical Ethics Committee of the University of Queensland and all procedures were conducted according to the Declaration of Helsinki. All procedures were supervised by the same physiotherapist (JQ) who has post-graduate qualifications and 15 years of clinical experience.

2.2. Questionnaires

Age, gender, co-morbidities (including musculoskeletal, heart, kidney and liver conditions and any psychological conditions such as depression), body mass index (BMI) and medication intake were included in demographic data. Activities-Specific Balance (ABC) scale was used to assess falls-related self-efficacy [15] and the level of physical activity of a typical week in the past 12 months was documented using a self-reported questionnaire [16]. Self-reported neck disability was measured using the NDI [17] and the intensity of NP was measured on a 11-point VAS [18]. Self-perceived handicap associated with dizziness was evaluated using the Dizziness Handicap Inventory (DHI) [19]. Given that previous research found a significantly higher fear of falls in subjects experiencing a fall in the prior three months [20], and a high fear of fall has been associated with reduced postural control [21], falls history was obtained in those sustaining a fall within 3 months prior.

2.3. Lower limb function

Ankle range-of-motion was determined using a standard goniometer. Sensory testing included both light touch and vibration sense at the lateral malleolus of the participant's dominant foot using the Semmes-Weinstein Monofilaments (Aesthesio, San Jose, CA, USA) and a tuning fork (128 Hz) respectively. Light touch was assessed in a descending order of the monofilaments and the final detectable monofilament was confirmed by applying the monofilaments in an ascending