Test-Retest Reliability of Measuring the Vertebral Arterial Blood Flow Velocity in People With Cervicogenic Dizziness

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Abstract

Objectives: The purpose of this study was to determine the within-session and between-sessions reliability of measuring the vertebral artery blood flow velocities in people with cervicogenic dizziness using Doppler ultrasound at both upper and lower cervical levels.

Methods: Outcome measures were taken on 2 occasions 3 weeks apart with no active treatment provided in between the assessments on 12 participants. Pulsed-wave Doppler ultrasound was used to quantify time-averaged mean velocities through the vertebral artery at upper cervical (C0-1) and lower cervical vertebrae (C5-6). The clinical outcome measures were also recorded in people with cervicogenic dizziness. The intraclass correlation coefficient (ICC) was used to determine the within-session and between-session repeatability. Paired *t* test was used to determine the differences in the time-averaged mean velocities of blood flow at the same site of the vertebral artery and the clinical outcome measures in 2 sessions 3 weeks apart.

Results: In people with cervicogenic dizziness, there was no significant change in both clinical outcome measures and the time-averaged mean velocities when the patients were measured 3 weeks apart ($P > .05$). This study identified good within-session (ICC: 0.903-0.967) and between-session (ICC: 0.922-0.984) repeatability in measuring the vertical blood flow velocities in patients with cervicogenic dizziness when the clinical outcome measures were unchanged.

Conclusions: This study supports the use of Doppler ultrasound to identify changes in mean vertebral arterial blood flow velocities before and after intervention in people with cervicogenic dizziness in future studies. (J Manipulative Physiol Ther 2017;40:255-262)

Key Indexing Terms: *Doppler Ultrasound Imaging; Blood Flow Velocity; Vertebral Artery; Dizziness; Reliability*

Introduction

Dizziness is a common problem that can lead to disability and affect quality of life.[1-3] In some cases of dizziness the cause can be attributed to a pathologic condition or dysfunction of upper cervical vertebral segments.[4-7] This form of cervicogenic dizziness is characterized by symptoms of imbalance or spinning associated with neck pain, stiffness, or headache.[7]

It has been hypothesized that mechanical compression or stenosis of the vertebral artery could be one of the causes of cervicogenic dizziness.[8,9] Mechanical compression, tension, dissection, or stenosis of 1 of both vertebral arteries as they pass through the cervical region may reduce blood flow and thus result in symptoms of dizziness. Poor head and neck posture and malalignment of the upper cervical spine are among the causes of the mechanical compromise that could result in decreased vertebrobasilar blood flow velocity and lead to dizziness.[8,9] However, no studies to date have investigated the test-retest reliability in measuring the vertebral artery blood flow velocity in patients with cervicogenic dizziness over time. It can be hypothesized that vertebral artery blood flow velocity would stay the same if the symptoms of cervicogenic dizziness stay the same. The results of this study provide evidence to support the use of Doppler ultrasound in

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investigating the role of vertebral arteries in management of cervicogenic dizziness in future studies.

Color duplex/Doppler ultrasound is considered to provide a valid[10] and reliable noninvasive measurement of vertebral arterial blood flow velcoity.[11-15] There are several studies reporting test-retest reliability of spectral Doppler ultrasound measures of vertebral artery blood flow. Schöning and Scheel[16] reported same-day repeat measure correlation coefficients in excess of 0.9 in measuring the cerebral time-averaged flow velocity and blood flow volume. Johnson et al[17] reported a good same-session test-retest (intraobserver) intraclass correlation coefficient (ICC) in the range of 0.80 to 0.94 for measures taken in left and right vertebral arteries velocities at the upper and lower cervical levels in asymptomatic participants. Previous works[14,17] suggest that it would be feasible to measure the vertebral blood flow characteristics at the lower cervical level (C5-6) and atlantooccipital (C0-1) level when the researchers adhere to protocol by taking account of potential confounding human factors, such as consistency of gain settings, Doppler angle, and stabilization of the ultrasound probe,[18] and possible habituation effects.[16]

There is evidence that Doppler ultrasound measures of vertebral artery blood flow may be sufficiently responsive to detect changes in cervical rotations[13] or after intervention.[19] It has been reported that a decrease in vertebral artery blood flow could be identified by Doppler ultrasound at both upper and lower cervical levels during end-range cervical rotation in asymptomatic participants.[12,20,21] This indicated that Doppler ultrasound would be able to detect changes in the vertebral arterial blood flow velocities decreased when the vertebral arteries are under stress from compression or stretching. Doppler ultrasound has also been used to detect improvement in vertebral arterial blood flow velocities in patients with vertebrobasilar artery insufficiency before and after medical intervention.[19,22] However, no studies have investigated upper and lower vertebral blood flow velocities in people with cervical dizziness. Consequently, it is unknown if there would be significant changes in vertebral artery blood flow velocities at the upper and lower cervical spine if clinical symptoms remain unchanged over a 3-week period in people with cervicogenic dizziness.

The aims of this study were to determine the within-session and between-sessions reliability of measuring the vertebral artery blood flow velocities in people with cervicogenic dizziness using Doppler ultrasound at both upper and lower cervical levels. It is hypothesized that no significant changes would occur in the vertebral artery velocities if there are no significant changes in the clinical symptoms in people with cervicogenic dizziness. The results of this study provide a basis to investigate the role of upper and lower vertebral arterial blood flow velocities and to support the use of Doppler ultrasound in determining the effect of intervention on the blood flow velocities in the management of cervicogenic dizziness in further studies.

Table 1. *Baseline Characteristics of Participants*

Age, y	45.1 ± 9.2
Weight, kg	72.64 ± 10.80
Height, m	1.68 ± 0.07
Onset of symptoms, mo	94.0 ± 65.9
Sex	Male: 5; female: 7

Methods

Participants

The experimental protocol was approved by the Faculty Research Ethics Committee of Faculty of Health, Education and Society at Plymouth University in the United Kingdom, and informed consent for the study was obtained from all participants per the World Medical Association Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects (2008). The sample size was estimated with an effect size of 0.75, a power of 0.80, and a significance level of 0.05.[23] A sample size of 12 was deemed to be appropriate for this matched pair study design. Therefore, 12 participants with symptoms of dizziness and neck pain as their main complaint were recruited with the following inclusion criteria: dizziness described as imbalance or unsteadiness; dizziness related to either movements or positions of the cervical spine, or occurring with a stiff or painful neck; symptoms lasting at least 4 weeks; and 18 to 55 years of age.

Participants were excluded if they had previous history of stroke or any neurologic disorders; had received chiropractic care or physiotherapy within the past 4 weeks; were currently receiving treatment for dizziness or neck pain by other health care providers; had inflammatory joint disease, infection, tumor, or fracture of the spine or cranium, central vascular/neurologic condition suspected of causing neck pain and/or dizziness/vertigo, or other conditions contraindicating high-velocity, small-amplitude spinal manipulative therapy; had evidence of narcotic or other drug abuse; were party to an ongoing personal injury or workers' compensation case related to dizziness/vertigo or neck pain or currently seeking or receiving disability for dizziness/vertigo or neck pain.

The baseline characteristics of the participants are presented in Table 1.

Equipment and Procedures

Outcome measures were taken on 2 occasions 3 weeks apart with no active treatment provided in between the assessments. Both the Doppler ultrasound readings and clinical outcome measures were taken by the same examiner.

Pulsed-wave Doppler ultrasound (Model: MySonoU5, Medison Co., Ltd, Seoul, South Korea) was used to quantify laminar blood flow velocity through the vertebral artery at upper (C0-1) and lower cervical vertebrae (C5-6).[13,15] All blood flow measurements were taken in a quiet, dimmed