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Original article

# Vibration sensibility of the median nerve in a population with chronic whiplash associated disorder: Intra- and inter-rater reliability study

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ABSTRACT

Whiplash Associated Disorders (WAD) grade II are the most prevalent group of whiplash patients seen on a regular basis by musculoskeletal physiotherapists. Impairment of vibration sensibility may be an early indicator of nerve pathology and it has previously been demonstrated in individuals with chronic WAD symptoms utilising vibrameters. A less expensive option, such the tuning fork (TF) may assist with these measures, but research regarding its measurement properties is lacking.

*Objectives:* To investigate the intra- and inter-rater reliability of vibration sensibility of the median nerve in chronic WAD II (CWAD II).

*Methods:* A double blinded, within day intra- and inter-rater reliability study was undertaken. A convenience sample of 26 individuals (8 males, 18 females, age mean 29.9 ± 10.0 years) with CWADII was recruited. Exclusion criteria: WAD I, III & indications of neuropathic pain. Vibration attenuation times were recorded from skin innervated by the median nerve (thenar eminence).

*Results:* Descriptive statistics (mean scores) and reliability statistics [intraclass correlation coefficient ($ICC_{2,1}$) and Bland and Altman limits of agreement] were undertaken with $p = 0.05$. Almost perfect intra-rater reliability (Intraclass Correlation Coefficiency (ICC): 0.972–0.955) and inter-rater reliability (ICC: 0.983) were identified. Confidence Intervals (CI) for inter-rater reliability were 95% CI: −1.461 to −0.056.

*Conclusions:* Almost perfect reliability scores across intra- and inter-rater reliability were found. This provides evidence that, with a standardised testing protocol the TF can be a highly reliable means of vibration sensibility testing. Future studies assessing the validity of the TF in different WAD populations may provide further information about the usefulness of this protocol.



## 1. Introduction

Whiplash Associated Disorders (WAD) are a significant socio-economic problem which is increasing throughout the industrialised world (Rushton et al., 2011). Recent economic data (2010) puts the annual economic cost of WAD, relating to management, lost market and household productivity, at $128 billion in the USA alone (Blincoe et al., 2014).

Clinically, WAD can be classified as grades (0–IV), depending on the severity of presentation, with more severe presentations being higher grades (Spitzer et al., 1995); a system widely adopted in practice (Nederhand et al., 2000; Sterling, 2004). WAD II represent the most common group of patients (93.4%) experiencing neck pain along with stiffness or tenderness, and musculoskeletal signs (Sterling, 2004; Rushton et al., 2011). This group is differentiated from WAD III where patients also present with neurological signs such as decreased or absent reflexes, muscle weakness and sensory deficits (Spitzer et al., 1995).

Individuals with chronic WAD (grade II) may also demonstrate signs of local and/or generalized mechanical and cold hyperalgesia as well as altered sympathetic nervous system activity (Kasch et al. 2001; Sterling et al., 2003; Sterling, 2004).

The studies of Chien et al. (2008 & 2009) were some of the first studies that incorporated Quantitative Sensory Testing (QST) in the assessment of chronic WAD (CWAD) populations and reported coexistence of generalised sensory hypersensitivity and hypoesthetic changes. Such hypoesthetic changes (loss of sensitivity to vibration, electrical and thermal stimuli) indicate a dysfunction of Aβ, Aδ and C nerve fibres and are suggestive of a neuropathic component in the presentation of CWAD (Chien et al., 2008; 2009; Chien and Sterling, 2010). Similar findings have been found in other musculoskeletal conditions (patellofemoral pain and

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chronic diffuse upper limb pain) and may be also associated with central inhibitory processes related to the duration of the nociceptive input (Tucker at al., 2007; Jensen et al., 2008; Chien and Sterling, 2010).

Altered vibration sensibility has also been described as an early indicator of nerve pathology in several conditions (Halonen et al., 1986; Greening et al., 2003) specifically indicating dysfunction of Aβ afferent fibres and the Pacinian corpuscles (Dyck et al., 1987; Reis and Moro, 2012). According to Leak (1998), vibration sensibility testing is rarely used clinically, due to the suggested subjectivity, lack of investigated reliability (e.g. tuning fork) or inconvenience of the available testing instruments (e.g. vibrameter).

Vibration sensibility is assessed through QST, although it is just one of a number of a group of tests representing measures of all relevant features of the somatosensory system (Rolke et al., 2006). The QST enables clinicians to identify the underline mechanism of pain disorders (Edwards et al., 2005). Its validity has been demonstrated by Rolke et al. (2006) who suggested that QST is useful for building the somatosensory profile of patients with suspected neuropathic pain.

Quantitative Sensory Testing can assist the clinician establish the severity of a clinical presentation and lead to more accurate management choices, however the method employs costly equipment, is time consuming and needs further evaluation before it can be efficiently applied in clinical practice (Chien and Sterling, 2010). All current studies that have utilised QST within WAD populations have used a vibrameter (Somedic AB, Sweden) to detect vibration disappearance thresholds (VDT). For clarity, VDT is operationally defined as the time until the perception of vibration disappears. Whilst the vibrameter remains the gold standard for the assessment of VDT (James and Scott, 2012), it is costly and not available in most clinical settings. The tuning fork (TF) offers an inexpensive, convenient and widely available alternative to measure VDT in clinical practice, although little evidence exists for its reliability.

### 1.1. Reliability of the tuning fork (128 Hz)

Only two studies were identified that have examined the reliability of the TF (128 Hz) on asymptomatic populations, and provide conflicting information as to the reliability of the tool. Botez et al. (2009) demonstrated that VDT can be measured with almost perfect (Landis and Koch, 1977) intra- and inter-rater reliability (Intraclass Correlation Coefficiency (ICC) 0.79–0.92 and ICC 0.82–0.95 respectively), while O'Conaire et al. (2011) demonstrated moderate (Landis and Koch, 1977) inter-rater reliability (ICC 0.52). The two studies differed in their designs with Botez et al. (2009) using single blinding and a non-standardised method for production of vibration stimulus and O'Conaire et al., (2011) employing double blinding and a standardised method for producing vibration amplitudes with a novel device adjunctive to the TF. Both studies used an asymptomatic population and failed to control the application pressure of the TF. To date there are no studies that have examined the reliability of the TF (128 Hz) in a symptomatic population.

Clinically, utilisation of tools that are able to provide reliable responses between raters, and within raters are necessary. Considering all the above, there is a need for more inter-and intra-rater reliability studies related to the TF (128 Hz).

### 1.2. Aims

To investigate the intra- and inter-rater reliability of the TF measuring vibration sensation on a median nerve distribution in participants with chronic WAD grade II (CWAD II).

## 2. Materials and methods

### 2.1. Design and sample

A double blinded, cross-sectional, within day intra- and inter-rater reliability study. A convenience sample of twenty six ($n = 26$) participants (university staff and students) with CWAD II symptoms were recruited from the University of Birmingham, based on a power calculation (Walter et al., 1998) designed for studies incorporating three consecutive measurements, with the Intraclass Correlation Coefficiency (ICC) range between 0.6 and 0.8 and the significance level, $\alpha = .05$. According to Walter et al. (1998) a protocol with three measurements ($n = 3$) would be convenient as further measurements could potentially lead to a fatigue effect and an undesirable aversion effect. Using these above specific indices, and with the minimum ICC value set at 0.6 ($\rho 0$) and the maximum set at 0.8 ($\rho 1$), it was estimated that a total of $k = 26$ participants would be required. Based on this power calculation, 26 participants were recruited.

Inclusion criteria: age 18–69 years, a history of a neck injury, and presentation of CWAD II symptoms for at least 6 months. Exclusion criteria: presentation of neck complaint of pain, stiffness, or tenderness only (WAD I), idiopathic neck pain, history of severe neck trauma (fracture, dislocation, WAD IV), indications of neurological deficits (WAD III), and indications of neuropathic pain (S-LANSS score of >12), currently receiving active clinical management. Two raters and an assistant were randomly recruited from a convenient population of four clinical musculoskeletal physiotherapists on a postgraduate programme. The assistant's role was to record the measurements and keep raters and patients blinded from the results. All measurements took place in a laboratory setting to control for external factors and allow similar environmental conditions (Hicks, 2004).

### 2.2. Ethics

The study was approved by the School of Health Sciences of the University of Birmingham (Ethics Reference number: PGT_1314_037).

### 2.3. Equipment

A 128 Hz Tuning Fork (Ragg Gardiner Brown Co, 11 Furnace Hill, Sheffield, S3 7AF, England) was used to measure VDT. Such devices are widely used in clinical practice and research (Fillyaw et al., 1989; Richardson, 2002; O'Neill et al., 2006; Botez et al., 2009; O'Conaire et al., 2011). A pen cap of 14 mm diameter was used to establish standardised vibration amplitudes. A “Fastime Zero 1” stopwatch was used for the recording each subject's VDT.

In order to better characterise the sample, two questionnaires were utilised. The S-LANSS questionnaire was used to identify individuals with lower symptom scores who reflect the common patients attending clinical practice and to possibly avoid those with high scores (>12) that may have neuropathic pain. With specificity ranges from 75% to 80% and sensitivity from 74% to 78% the S-LANSS is considered a valid and reliable self-report outcome measure (Bennett et al., 2005). Neck Disability Index (NDI) was used to evaluate evidence of disability. The NDI has demonstrated a high degree of reliability and internal consistency (Vernon and Mior, 1991; McCarthy et al., 2007; MacDermid et al., 2009) and is used to enable classification of WAD (Sterling, 2004).