Manual Therapy xxx (2014) 1–5

Contents lists available at ScienceDirect

Manual Therapy

journal homepage: www.elsevier.com/math

Original article

Side-to-side range of movement variability in variants of the median and radial neurodynamic test sequences in asymptomatic people

Vaidas Stalioraitis [a], Kim Robinson [b], Toby Hall [b,*]

[a] Manual Concepts, Perth, Western Australia, Australia
[b] School of Physiotherapy, Curtin Innovation Health Research Institute, Curtin University of Technology, Hayman Road, Bentley, Perth, Western Australia, Australia

ARTICLE INFO

Article history:
Received 12 September 2013
Received in revised form
3 March 2014
Accepted 5 March 2014

Keywords:
Neurodynamic tests
Reliability
Upper limb

ABSTRACT

Side-to-side discrepancy in range of motion (ROM) during upper limb neurodynamic testing is used in part to identify abnormal peripheral nerve mechanosensitivity and is one of three factors to consider in determining a positive test. Large side-to-side variability is reported for some variants of the upper limb neurodynamic test sequences, however discrepancies for other test variants are unknown. Hence the purpose of this study was to evaluate side-to-side discrepancy in elbow flexion ROM during two variants of upper limb neurodynamic test sequence for the median and radial nerves. 51 asymptomatic subjects (26 females, mean age 29.69 years) were evaluated. A uniaxial electrogoniometer was used to measure elbow flexion ROM at onset of resistance (R1) and onset of discomfort (P1) during the median and radial neurodynamic tests on each side. Reliability was determined by testing 20 subjects twice and was found to be good (ICC greater than 0.88 and SEM less than 4.02°). There was no significant difference in mean ROM between sides. Lower-bound scores indicate that intra-individual, inter-limb differences of more than 15° for the median nerve and 11° for the radial nerve exceeds the range of normal ROM asymmetry on neurodynamic testing at R1 and P1. Correlation of ROM between limbs was significant with R^2 values of 0.62 and 0.85 for the median and radial nerves respectively. These finding provide clinicians with information regarding normal side-to-side variability in ROM during two commonly used variants of neurodynamic tests.

1. Introduction

Upper limb neurodynamic tests are used to evaluate nerve trunk mechanosensitivity of the cervical nerve roots, brachial plexus and its terminal branches (Hall and Elvey, 2011). Range of motion (ROM) and responses (principally sensations and resistance to movement) during such tests are interpreted by comparing with normal responses and with those occurring when testing the asymptomatic side (Butler, 2000). Neurodynamic tests are important in clinical decision-making regarding diagnosis of peripheral nerve disorders (Rubinstein et al., 2007), hence these tests have the potential to direct management.

Clinically, neurodynamic tests are used to determine the presence of neural tissue pain disorders in patients with neck and or arm pain, such as cervical radiculopathy or carpal tunnel syndrome (Wainner and Gill, 2000; Wainner et al., 2005). Such pain disorders may arise from inflammation around peripheral nerves, which become mechanosensitized, and consequently display decreased tolerance to the mechanical stress of neurodynamic tests (Bove et al., 2003; Bove, 2009). Therefore, an indication of mechanosensitized neural tissue may be symptom provocation and ROM deficits, previously reported as important components of the evaluation process during neurodynamic tests (Hall and Elvey, 2011).

According to Elvey (Elvey, 1986), for a neurodynamic test to be positive, the patients symptoms must be reproduced, ROM diminished on the side tested compared to the unaffected side, and sensitizing manoeuvres must alter symptoms. Sensitizing manoeuvres (or structural differentiation) comprise proximal or distal remote joint movements to increase or decrease mechanical provocation on the tested neural tissue. These manoeuvres are important to differentiate between neural and non-neural involvement in upper limb pain disorders (Coppieters et al., 2002).

One of the reported factors for determining a positive neurodynamic test is side to side comparison for ROM (Nee and Butler, 2006). However, it must be recognized that ROM differences for

* Corresponding author. Tel.: +61 8938118363; fax: +61 8 93176022.
E-mail addresses: halltm@netspace.net.au, halltm62@mac.com (T. Hall).

http://dx.doi.org/10.1016/j.math.2014.03.005
1356-689X/

neurodynamic tests exist between the upper limbs even in healthy individuals (Covill and Petersen, 2011; Lohkamp and Small, 2011) not accounted for by hand dominance (Lohkamp and Small, 2011). Despite small mean inter-limb difference of only 4°, large intra-individual discrepancies were reported for variants of the upper limb neurodynamic tests (Covill and Petersen, 2011). Lower-bound scores (upper limit of tolerance interval) were calculated to determine the amount of difference needed to consider asymmetry beyond measurement error. The scores for each neurodynamic test were as follows: median nerve 27°, radial nerve 20°, and ulnar nerve 21°. This is the first time such scores have been reported and indicate a large potential for error when interpreting neurodynamic tests in the absence of symptom reproduction, and when side-to-side differences in ROM are small.

In the study by Covill and Petersen (2011), cervical lateral flexion was not included in the test sequence. This movement is an important component of neurodynamic testing as it significantly influences responses during testing (Coppieters et al., 2001). Omitting this movement may increase variability in nerve strain both between individuals and across sides tested. In addition, the end point for each test was measured only at "firm resistance" determined by the examiner, other upper limb neurodynamic test variants and testing end-points may have a different side-to-side variability. Hence the purpose of this study was to evaluate side-to-side variation in elbow ROM during variants of the median and radial neurodynamic test sequences that included cervical lateral flexion. Two end-points were evaluated: onset of resistance (R1) determined by examiner, and the onset of the discomfort (P1) indicated by the subject.

2. Methods

2.1. Study design

A within subjects comparative measurement design was used to identify differences between sides in elbow ROM during upper limb neurodynamic tests in asymptomatic people. The primary variable of interest was elbow ROM during variants of the median and radial nerve neurodynamic tests.

2.2. Subjects

Fifty-one subjects (26 females and 25 males, mean age 29.69 years, SD 5.85) were included in the study. Volunteers were recruited from advertisements placed on physical and on-line notice-boards at Curtin University and by word of mouth. Subjects were recruited as a sample of convenience and selected on the basis of being asymptomatic and age over 18 years. A power calculation (based on using a two-tailed paired *t*-test with an α level 0.05 and power of 0.8, and a medium effect size of 0.5) indicated that a sample of 34 subjects was required for this study. The inclusion criteria required subjects to have full upper limb joint ROM, be right hand dominant, have no previous upper quadrant pathology or surgery, and no history of diabetes mellitus, rheumatologic diseases or neural disorders. Subjects prior to testing underwent upper quadrant screening examination to ensure they had full pain free ROM of the cervical spine, shoulder, elbow and wrist. In addition this study received approval from the Curtin University Human Research Ethics Committee and participants provided written informed consent before participation.

2.3. Materials and measurements

The independent variable evaluated in this study was side (left or right). The dependent variables were ROM of elbow extension measured by a uniaxial electrogoniometer (Biometrics Ltd, Nine Mile Point Ind Est, Gwent, UK), and nerve tested (median or radial).

The goniometer was fixed to the subjects arm with adhesive tape and calibrated at 0° (full elbow extension) before testing commenced. This electrogoniometer has been shown to have acceptable inter-rater and intra-rater reliability (Oliver and Rushton, 2011). In that study, intra-rater ICC values for reliability during median nerve neurodynamic testing were greater than 0.96, the standard error of measurement 2.6°, and smallest detectable difference 7.2° (Oliver and Rushton, 2011). Additionally, no significant differences were found in elbow ROM when inter-rater measurements were recorded (Goodwin et al., 1992), and acceptable levels of precision with measurement errors up to 3° (Lantz et al., 2003).

2.4. Procedure

Each subject was familiarized with the testing process. Each person was tested in a supine position with legs straight and the untested arm at the side of the body with the hand resting on the abdomen. For each neurodynamic test, the head/neck was passively placed in maximum contralateral lateral flexion and the scapula stabilized in neutral elevation/depression. No brace was used for fixation to mimic the clinical testing process, which has been previously described for each upper extremity nerve (Hall and Elvey, 2011). The electrogoniometer's axis was aligned with the subject's medial epicondyle for the median nerve, and to the lateral epicondyle for the radial nerve. The proximal arm of the goniometer was aligned with the midline of the humerus and the distal arm was aligned with the lateral midline of the ulnar or radius for measurement of the elbow during neurodynamic testing. The voltage was converted in real-time to degrees of elbow movement and manually recorded. Hyperextension was recorded as negative values, while positive values indicated the range short of full extension. Reliability of the measurements was determined by measuring the first 20 subjects twice. Between trial's, subject were given a 5-min rest-break before repeating the measurement procedures.

Neurodynamic tests for the median and radial nerve were examined in random order on both sides by a single physiotherapist with 5 years post-graduate clinical experience using published test protocols (Elvey and Hall, 1997). While these tests are intended to bias the median and radial nerve, they also affect the brachial plexus, cervical nerve roots and other structures. For each test sequence, the participant was given one familiarization trial before a single repetition of each test was carried out. Elbow ROM was recorded by a separate researcher. The goniometer output was not visible to the examiner to avoid bias.

A previous report has shown equal reliability when repeated measurements are used for pain tolerance (Lohkamp and Small, 2011), hence only one measurement was taken for each end-point and for each test. The end-point for each test was R1 and P1, both points have been shown to have a high degree of inter- and intra-rater reliability (Vanti et al., 2010).

2.5. Neurodynamic test sequence biased for the median nerve

The cervical spine was positioned in maximal lateral flexion to the contralateral side. The arm to be tested was positioned in 90° of glenohumeral flexion, followed by 90° horizontal extension, to achieve a position of 90° abduction and 90° external rotation. The elbow was flexed to 90° with forearm maximally supinated, and wrist/fingers maximally extended. The elbow was slowly extended and end-points measured.

2.6. Neurodynamic test sequence biased for the radial nerve

The cervical spine was positioned in maximal lateral flexion to the contralateral side. The arm to be tested was positioned in 90° of