RELIABILITY OF NERVE FUNCTION ASSESSMENTS IN PEOPLE WITH PERIPHERAL NEUOPATHY

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INTRODUCTION

Peripheral Neuropathy (PN) is a neurodegenerative disease that damages the peripheral nervous system [1]. People with PN often report tingling / burning sensations starting at their foot sole. PN is usually symmetrical sensory nerve damage starting at the distal part but progresses proximally. People with PN suffer balance problems and are at the high risk of falling [2, 3]. Studies have tried to find effective treatments for balance impairment in this population. However, there is no effective treatment or technique to measure treatment progress. Traditional strength and endurance exercises have not shown direct evidence to improve balance in people with PN [4]. Alternatively, Tai chi training has been reported to improve balance in people with PN and people with reduced sensory conditions [5, 6]. Tai chi has also been shown to revert the degeneration of foot tactile sensation and, in turn, improve balance in people with PN [7]. This observation combined with other studies, indicates that the key to balance impairment for this population is reduced sensory not motor function [8].

Tactile sensitivity and proprioception, along with nerve function properties should be considered for assessments within this population in relation to balance. Central nerve adaptation could be induced by PN [9], which can be assessed using H- reflex and H-Index [10]. Therefore, the purpose of this study was to examine the reliability of measurements from nerve function test such as H-Reflex, H-Index, H- & M-wave ratio, and related latencies. Also, we tested the reliability of foot tactile sensitivity and ankle proprioception. Any reliable measures could be useful in gauging the progress of the disease and effectiveness of intervention studies involving PN.

METHODS

Twelve participants (8 women, 4 men, age =72.5 ± 9.2 years old, height =163 ±12 cm, and body mass = 172 ±46 kg) diagnosed with peripheral neuropathy were recruited and assessed at two occasions with at least 7 days apart. Participants signed the informed consent forms after all of their question were answered satisfactorily at the first visit before any test could be administered. The project was approved by local Institutional Review Board.

The measurements of interest for this study were H-Reflex, H-Index and H- & M-wave ratios for nerve function, five-point monofilament test for plantar pressure sensitivity, and ankle joint reposition for proprioception.

Nerve function was assessed by H- & M-wave and its extracted measures of M_{max}, H_{max}, H_{max}/M_{max}, latency and H-Index. The nerve function tests were performed with the participant lying prone on an examination table with their feet hanging slightly off of the edge. Electrodes were positioned in parallel with the direction of muscle fiber on the lateral gastrocnemius of the right leg.

H- & M-waves were elicited by stimulating the tibial nerve for all participants using a constant voltage stimulator (Biopac, Systems, Inc. Goleta, CA, USA). To determine the proper location of the stimulation, intensity of the stimulation was increased progressively from 0 volts until an involuntary twitch was visible. To obtain the maximal H-wave amplitude (H_{max}), the stimulus intensity was further increased until peak-to-peak H-wave amplitude resulted in no further increases. After determining the H_{max}, the test was repeated consecutively 3 times with 30s break between each trail. Stimulus intensity was further increased until both H- and M-wave could be seen at the same time, 9 more tests were repeated and recorded. H_{max}, M_{max}, and the latencies were measured by built-in tools of Biopac software.

H_{max} was considered as a variable response in participants; thus requiring multiple trials to obtain a stable mean [11, 12]. The average of the three H_{max} recorded were used for further calculations and reliability analysis. M_{max} was calculated in the same fashion. The calculations of interest using were H_{max} to M_{max} ratio, latency between H- and M-wave, and H-Index. The average of 9 latencies recorded was used for reliability analysis and the calculation of H-Index. H-Index was calculated as $[\frac{Height(cm)}{\Delta t_H - \Delta t_M}]^2 * 2$ [13].

Plantar sensitivity was measured by five-point test using a 5.07 gauge Semmes-Weinstein monofilament (North Coast Medical, Inc., Morgan Hill, CA, USA) with participants lying supine on an examination table. Testing sites included the Heel (HL), bases of the first (M1) and fifth (M5) metatarsal, Mid-foot (MF) and hallux (BT) [7]. The sites were tested three times in random order. The correct response was defined as a "yes" and the correct name of the detected sites. A sight was determined as insensitive if it could not be correctly identified for two out of three times. A score of "1" was given for sensitive sites, and "0" for insensitive ones. The assigned scores were then added to produce an overall range from 0 to 5.

Active and passive ankle proprioception (AAP and PAP) were tested at inversion of -15°, 0° and eversion of 10°. AAP and PAP indices were the averaged errors at these positions.

Intraclass correlation coefficients (ICC) (model 1.1) were used for reliability examination [14].

RESULTS AND DISCUSSION

Causes of PN included diabetes (n=2), trauma (n=1), and idiopathic (n=9). Duration of PN was 10 ± 1.70 (Mean ± S.D.) years.

Moderate to high reliability observed for H_{max} (ICC = .71), M_{max} (.84), latency (.78), and H-Index (.85). Low reliability (.09) observed for the ratio of H_{max} to M_{max} although H_{max} and M_{max} were measured highly reliably, ICC = .71 and .84, respectively.

Significant difference was observed in the Active 0° reposition test (P = .04). No other significant differences between testing sessions were observed for either active or passive reposition. Reliability of active ankle reposition for target locations -15° (.61) was moderate and 10° (.45) was below poor. Active ankle reposition for target location 0° exhibited low reliability (.39). Low reliability was observed for all passive ankle reposition target positions. AAP and PAP indices were moderately reliable with ICC = .62 and .60, respectively. Plantar sensitivity measures were highly reliable (0.92).

Measures of plantar sensitivity, AAP and PAP indices, as well as measures of H_{max}, M_{max}, latency and H-Index were reliable for people with PN. These measures will provide the information about the sensations and the nerve function in people with PN for further study.

The means of H_{max} (.55 ± .22) and M_{max} (3.90 ± 1.10) from testing session one, and (.58 ± .34) and (4.30 ± 1.10) from testing session two, were lower than H_{max} (1.49 ± 1.01) and M_{max} (5.28 ± 2.98) reported by Scaglioni, et al. [13] when they looked at nerve conduction properties in healthy older adults. Their H-Index observation (75.19 ± 10.40) is higher than our observed H-Index (61.20 ± 4.50) from testing day one, or (61.00 ± 4.10) from testing day two. The lower scores observed here could possibly be explained by the effects of peripheral neuropathy.

H_{max}/M_{max} ratio has been widely used for a variety of nerve function studies. The low reliability was unexpected in spite of H_{max} and M_{max} were reliable measures. The absent of reliability of H_{max}/M_{max} ratio is most like due to the disease, which may suggests there are neural adaptations to PN. Therefore, H_{max}/M_{max} ratio was not a reliable measure for people with PN. Both latency and H-Index were reliably measured as we expected. In addition, the latency and H_{max} are used as measures of neural system in PN population [15, 16]. The H-reflex is considered as a monosynaptic arc and its amplitude is a measure of excitability of the motoneurons. Latency and H_{max} would provide the information to reflect the function of monosynaptic arc from soleus [17]. The plantar sensitivity measure was reliable to evaluate the tactile sensation of people with PN same as our previous observation [14]. AAP and APP indices are reliable indicator of the active and passive ankle reposition in people with PN. However, the isolated measures of proprioception tests are not as reliable as the indices, except active -15° reposition was measured with moderate reliability. This may be caused by the highly sensitive detection of ankle proprioception at single position.

CONCLUSIONS

The measures of H_{max}, M_{max}, latency and the H-Index, plantar sensitivity, and AAP & PAP indexes of proprioception tests can be measured reliably for people with PN. These measures could be used to better assess progressions of the disease and during different intervention strategies.

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