Thermal Quantitative Sensory Testing

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Quantitative Sensory Testing

Sensory fibers can be categorized into large mylinated fibers (Aα, Aβ), small myelinated fibers (Aδ) and unmyelinated fibers (C-fiber). Large nerve fibers carry touch and vibration sensations, while the small myelinated and unmylinated fibers mediate temperature and nociception. The diagnosis of small-fiber neuropathy can be challenging because of the inconspicuous clinical signs and normal conventional nerve conduction studies.

Quantitative sensory testing (QST) is a reliable test of large and small fiber sensory modalities. Nowadays, the use of QST has become more widespread, with an increasing focus on somatosensory profiles and pain mechanisms. QST is a psychophysical means of assessing the function of the large and small nerve fibers and their respective pathways. The results of QST are highly dependent on the methodology used and the full cooperation of the subject. A number of different modalities can be assessed using QST, including vibration, pressure pain thresholds, and thermal thresholds. Thermal QST modalities include thermal detection threshold (cold and warm detection), and pain threshold (cold and heat pain). However, the reliability of thermal detection thresholds and thermal pain thresholds in QST has yet to be established [1]. As a psychophysical test, QST is not objective, and the consistency of QST data relies heavily on environmental factors-(such as ambient temperature and noise), methodological factors-(such as test protocol, test application, and test instructions), and the cooperation and attention of the individual being tested [2].

The two main methods employed in the assessment of thermal QST are the method of limits (MLI) and the method of levels (MLE). The MLI is a reaction-time inclusive method, whereby the applied thermal stimulus increases gradually at a preset rate from the baseline temperature. Participants are then asked to depress a response switch when they perceive a change in temperature for thermal detection thresholds or perceive the sensation as painful for pain thresholds [3,4]. The MLE, sometimes referred to as the forced-choice method, is a reaction-time exclusive method. A set temperature is applied, and the participant is asked to respond "yes" or "no" to whether the stimulus is felt or not. If the participant answers yes, then the temperature is reduced; if he or she answers no, the temperature is increased. This procedure is repeated until the threshold is identified. The staircase method is a variation of the MLI [5].

The use of QST and the body of work in relation to reliability of thermal QST has grown substantially since Chong and Cros' 2004 review [6]. However, the reliability of thermal QST has yet to be established. Moloney et al, systematically searched the literature (from January 1990 to May 2010) using key medical databases and evaluated reliability data using the Quality Appraisal for Reliability Studies checklist. They included 21 studies

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in the review and deemed only 5 to have high methodological quality. Overall, the reliability of cold and warm detection thresholds ranged from poor to excellent, while heat and cold pain thresholds ranged from fair to excellent. The methodological quality of thermal QST warrants improvement, particularly in terms of appropriate blinding. The results from this review showed considerable variability in the reliability of each thermal QST parameter[7].

Most of the previous research investigating the reliability of thermal QST focuses on intra-tester reliability, inter-tester reliability and test-retest reliability. However, there is no concrete data about the impact of inter-trial intervals (ITI) in QST. A study indicated that the latency of warm perception was delayed and pain perception intensity was reduced after a conditioning stimulus at ITI below 60 seconds. Based on these results the authors suggested that the ITI for QST should be greater than 60 seconds[8]. However, it is important to note that the procedures of this experiment were different from the ones commonly implemented in clinical practice. The main goal of the article "The Influences of Inter-Trial Interval on the Thermal and Thermal Pain Thresholds in Quantitative Sensory Testing" by Huang et al. was to investigate the effects of ITI on QST results under procedural conditions that are commonly implemented in clinical practice. They concluded that while ITI and the modality order did not have significant effects on the test results, the trial order did have effects on the results of all modalities. The results implied that the test results by the limit method are independent of ITI in the range of 10 to 60 seconds, but the results may not be the true thresholds. In view of methodology and reliability quality of Huang's study, some needed greater attention including lack of the descriptions of the raters and their training, blinding, and randomization (they used pseudo-randomization) and future studies of patient populations, particularly those with painful conditions, representative of those who would typically be undergoing QST in clinical or research settings.

There were some reports about the application of QST in Taiwan. In 2004, Shun et al. conducted and analyzed the correlations of intra-epidermal nerve fiber (IENF) densities in skin in diabetes with glycemic status and functional parameters of small fibers (warm and cold thresholds) and large fibers (vibratory threshold and parameters of nerve conduction studies). They concluded that small-fiber sensory neuropathy presenting with reduced IENF densities and correlated elevation of warm thresholds is a major manifestation of type-2 diabetics. In addition, the extent of skin denervation increases with diabetic duration[9]. The Influences of aging on the thermal thresholds of QST can't be emphasized more. In the studies of Lin et al. (2005) and Huang (2010) et al., they suggest that age is the most significant factor in determining sensory thresholds compared with the other factors of gender and anthropometric parameters, and age has an effect on all modalities[10,11].

QST is a psychological method and thus is not truly objective, as are nerve conduction studies and skin biopsy. Patients may be unwell to perform and score "abnormal" when they are in fact normal. Patients may also score "abnormal" for reasons not related to real abnormalities, due to inattention during the test or inability to understand the test protocol. In addition, we cannot stress enough the importance of normative data in the clinical application of QST, including the effects of age and gender. The use of QST in research and clinical practice should be limited to instruments and their corresponding methodologies that have been shown to be reproducible. Literature data do not allow conclusions regarding the relative merits of individual QST instruments and test algorithms.

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