Quantitative Sensory Testing and Pressure Pain Threshold

Subjects: Orthopedics
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Several published articles have shown that quantitative sensory testing (QST) and pressure pain threshold (PPT) are useful in the analysis of neck/shoulder and low back pain. A valid reference for normal PPT values might be helpful for the clinical diagnosis of abnormal tenderness or muscle pain. However, there have been no reliable references for PPT values of neck/shoulder and back pain because the data vary depending on the devices used, the measurement units, and the area examined.

quantitative sensory testing | pressure pain threshold | musculoskeletal pain | reference value | low back pain | neck/shoulder pain

1. Introduction

Musculoskeletal disease is a worldwide problem for which healthcare assistance is frequently sought. Low back pain (LBP) and neck/shoulder pain are the most common musculoskeletal conditions that evolve into chronic problems [1][2]. Musculoskeletal pathology may initiate chronic pain, but the pain is often also modulated by sensory inputs from the peripheral and central nervous systems [3]. Central sensitization is involved in the chronification of pain, which manifests as hypersensitivity to pain and is spread beyond the areas immediately affected by musculoskeletal pathology [4]. It continues to be challenging to detect and measure hypersensitivity in clinical practice, and no consensus has been reached on which tools are best for assessing musculoskeletal pain [2].

Quantitative sensory testing (QST) combines simple tools that can assess the ability to perceive touch, vibration, proprioception, and sensitivity to pinpricks or blunt pressure and to cold or heat stimuli [2]. QST and the assessment of the pressure pain threshold (PPT) have become commonplace in clinical neurophysiology units [5][6][7][8]. QST/PPT uses psychophysical tests defined as stimuli with predetermined physical properties based on specific measurement protocols for the analysis of somatosensory aberrations. QST/PPT measures sensory stimuli and can be used to assess somatosensory system functions, the measurement of altered peripheral and/or central pain sensitivity, and descending pain modulation [8].

PPT is the QST parameter most frequently used to investigate local and widespread hyperalgesia. PPT reflects sensitivity to pain and can be measured by either electronic or mechanical pressure algometry. In this test, subjects report when gradually applied pressure changes from a feeling of pressure to that of pressure combined with pain

[8]. The advantages of PPT include its simplicity and rapid measurement time compared to other QST protocols in which measurement time is longer and requires more effort [5][9][10].

Several articles published over recent years have shown the usefulness of PPT in analyzing neck/shoulder and back pain [11][12][13][14][15][16][17]. Evidence from these studies indicates that PPT would appear to be a useful tool for analyzing the pathogenesis, classification, differential diagnosis, and prognosis of neck/shoulder and back pain [11]. However, the assessment of neck/shoulder and back pain with PPT has one main problem. Standardized normative values for neck/shoulder and back pain conditions are lacking and need to be developed. Although valid reference values indicative of a normal PPT would aid in the clinical diagnosis of muscle pain or abnormal tenderness, no such reliable values currently exist for neck/shoulder and back pain [17].

2. Quantitative Sensory Testing

QST collectively refers to a group of procedures that assess the perceptual response to systematically applied and quantitative sensory stimuli to characterize somatosensory function or dysfunction [8][18]. QST involves procedures that test perception, pain threshold, and pain tolerance thresholds for different stimuli based on the application of standardized pressure, vibration, thermal, or electrical impulses. QST measures the response to sensory stimuli and can be used to assess somatosensory system function, the measurement of altered peripheral and/or central pain sensitivity, and descending pain modulation [8][19].

By selecting various QST modalities, different fibers can be tested. The function of Aδ fibers is represented by the cold detection threshold, that of C fibers by the heat detection threshold, that of nociceptive C fibers mainly by the heat pain threshold, and that of Aβ fibers by mechanical detection and vibration [11][18][20]. The thermal, mechanical, and electrical tests commonly applied in QST are listed in **Table 1** [20][21][22].

Table 1. Type of assessment of stimulus modalities by quantitative sensory testing (QST).

QST Type	Sensation/Modulation	Stimulus Modalities
Thermal	Warm	Warm detection threshold (WDT)
	Cold	Cold detection threshold (CDT)
	Pain	Heat pain threshold (HPT)
		Cold pain threshold (CPT)
		Suprathreshold heat pain intensity (STHPI)
Mechanical	Vibration	Vibration detection threshold (VDT)
	Pain	Pressure pain threshold (PPT)
		Suprathreshold pressure pain intensity (STPPI)

QST Type	Sensation/Modulation	Stimulus Modalities
		Pressure pain tolerance (PPTol)
Electrical	Pain	Electrical pain threshold (EPT)
		Electrical pain tolerance (EPTol)
Dynamic	Wind-up	Temporal summation (TS)
	Excitability of spinal cord neurons	
	Diffuse noxious inhibitory controls (DNIC)	Conditioned pain modulation (CPM)

3. Pressure Pain Threshold

Among the QST parameters, PPT is the most frequently assessed. PPT is determined by applying a mechanical stimulus to determine the moment that the stimulus-induced sensation of pressure first changes to that of pain [23]. This allows the quantification of the PPTs of skin and muscle. An algometer is often used to apply pressure to sites both close and far from the location of the subject's pain. Factors such as sex, the investigator, and the apparatus used may affect the measurement of PPT by pressure algometry. The reliability of PPT based on raters or measurement frequencies is reported to be relatively high [23][24].

3.1. Perceptions of Peripheral and Central Sensitization Can Be Quantified by PPT

PPT can be used to evaluate peripheral and central sensitization. Tenderness experienced with blunt pressure may be caused by the peripheral sensitization of primary afferents or central sensitization [25]. Because PPT preferentially activates deep afferents, it is a good clinical device for measuring peripheral sensitization. Hyperalgesia of the affected area to blunt mechanical stimuli is thought to reflect the peripheral sensitization of Aδ and C fibers. Unlike cutaneous nociceptors, which are particularly sensitive to thermal stimuli, nociceptors in deep somatic tissue, such as joints and muscles, exhibit a pronounced sensitivity to mechanical stimuli [25][26].

PPT can also assess central sensitization, which can cause mechanical receptive fields to expand. Although this might account for some local spreading of tenderness, the alteration of pathways descending from the brainstem is more likely to result in widespread or generalized tenderness. A widespread lowering of PPT may reflect the dysfunction of the endogenous pain inhibitory mechanism [25][26][27].

3.2. PPT Analysis in Neck/Shoulder and Low Back Pain

PPT is also effective in disorders involving musculoskeletal pain. Pressure stimuli generated by an algometer can target muscles or fascia, thus indicating that the application of such stimuli would be suitable for patients with muscle or joint pain [28]. The reliability of algometer use in patients with musculoskeletal pain has been established. In addition, in a reliability study using several PPTs, algometers were reported to have the least variability and highest reliability in assessing musculoskeletal pain [26][28]. Distinguishing between alterations in peripheral and central pain processing in patients with musculoskeletal pain is important, as central sensitization is considered a

potential influence in the development and maintenance of chronic pain. There are many reports on the use of PPT in patients with neck/shoulder, low back, and other musculoskeletal pain [28]. Furthermore, PPT might be valuable in predicting postoperative pain after surgery on musculoskeletal structures [2][6][9]. PPT can be used to evaluate the pathophysiology of peripheral and central sensitization in patients with neck/shoulder and LBP and is useful when analyzing the pathogenesis of chronic pain as well as its classification, differential diagnosis, and prediction [12].

They are meaningful evaluation techniques for patients with chronic pain because it is generally very difficult to objectively score how much pain the patients feel in the neck/shoulder and back area, including central sensitizations. PPT examination is one of the solutions to examining patients with chronic pain for digitalization [12]. However, no reviews of previous articles on PPT analysis for chronic neck/shoulder and LBP have been published, nor have standardized methods of assessing PPT for musculoskeletal pain been reported. Moreover, the results are different in the articles showing standardized, normative, and abnormal PPT values of neck/shoulder and LBP in volunteers/patients with and without chronic pain [12].

For these reasons, PPT is not a popular tool in the evaluation of patients with chronic pain even now in general clinics [11]. It is necessary to review all articles on PPT related to neck/shoulder and LBP in volunteers/patients with and without chronic pain in order to achieve the wide and general use of PPT examination.

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