

Streszczenie w języku angielskim

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Title: Small-Fiber Damage in Carpal Tunnel Syndrome

Introduction: Peripheral nerves are functionally heterogeneous structures, and a pathological process does not necessarily affect all fiber populations to the same extent. In carpal tunnel syndrome (CTS), the function of large myelinated fibers is assessed primarily by electrophysiological studies, whereas the involvement of small fibers remains less well characterized. Different diagnostic methods provide distinct and complementary information. Quantitative sensory testing (QST) enables a parametric, functional assessment of thermal perception associated with A δ - and C-fiber function. The aim of this study was to expand current knowledge on the role of small-fiber damage in CTS using thermal QST.

Material: A single-center, observational, cross-sectional study with a control group was conducted. The analyses included 34 patients with clinically and electrophysiologically confirmed CTS and 59 healthy volunteers. In the primary analysis, one limb from each patient with CTS ($n = 34$) and one limb from age- and sex-frequency-matched healthy participants ($n = 43$) were evaluated. Additional analyses included data from all limbs with confirmed CTS and from the full healthy population.

Methods: Participants underwent a structured medical history and neurological examination. CTS was confirmed by nerve conduction studies (NCS), while symptom severity and functional impairment were assessed using the Boston Carpal Tunnel Questionnaire (BCTQ). Thermal QST was performed using the Medoc Q-Sense device, with warm detection threshold (WDT) and cold detection threshold (CDT) assessed using the Method of Levels and the Method of Limits, yielding a total of four protocols.

Results: Values obtained with all four QST protocols were significantly higher in the CTS group than in the control group, including after adjustment for age, sex, and side. The Method of Levels WDT showed the highest ability to discriminate CTS from controls, whereas combining all four protocols did not improve discriminatory performance compared with this single parameter. The findings of the primary analysis were confirmed when all CTS-affected limbs were included.

Symptom severity according to the BCTQ Symptom Severity Scale (BCTQ-SSS) correlated with all four QST protocols, whereas associations with the BCTQ Functional Status Scale (BCTQ-FSS)

were observed mainly in within-patient comparisons between limbs. No simple relationship was found between QST results and the overall electrophysiological severity of CTS. Markedly greater thermal detection abnormalities were observed in the pain phenotype. In patients with unilateral CTS, the affected limb showed greater abnormalities than the contralateral limb for most of the analyzed parameters. In the healthy population, age was the strongest and most consistent factor associated with thermal detection thresholds.

Discussion: The main findings are consistent with the predominant trend in previous studies, which have demonstrated elevated warm and cold detection thresholds in patients with CTS. The association between QST abnormalities and the pain phenotype, together with the absence of a simple gradient according to electrophysiological severity, supports a multidimensional view of CTS, in which clinical, electrophysiological, and sensory assessments describe partially distinct aspects of nerve dysfunction. At the same time, the available literature indicates that QST results are substantially influenced by measurement site, the protocol used, and the clinical characteristics of the study population.

Conclusions: The findings support the hypothesis of a functional small-fiber component in CTS, but they do not constitute direct evidence of morphological damage to A δ and C fibers. Thermal QST may provide information complementary to clinical assessment and NCS. The Method of Levels WDT emerged as the most promising single parameter. At present, QST should not replace standard diagnostic methods, and its potential clinical application requires external validation, further standardization, and confirmation of its added value in independent populations.