

UPDATE
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ABSTRACT BOOKLET

Incorporating Frequently Asked Questions



NEUROMETER® CPT
Neuroselective Sensory Nerve
Conduction Threshold (sNCT)
Electrodiagnostic Current Perception
Threshold (CPT) Devices.

Selected abstracts from publications
referencing Neurometer® CPT
electrodiagnostic neuroselective
sensory nerve evaluations are enclosed.
A bibliography of selected publications
grouped by topic and specialty is
also included along with answers
to frequently asked questions.

Neurotron, Incorporated, Medical Electronics

Neurometer® CPT® and NervScan Neuroselective Electrodiagnostic Sensory Nerve Testing Equipment

Neuroselective Sensory Nerve Conduction Threshold (sNCT®),
Current Perception Threshold (CPT®) and Pain Tolerance
Threshold (PTT) Publications and FAQ

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March 2007

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Neurotron Incorporated was founded in Baltimore, MD USA in 1981. FDA permission to market the Neurometer® electrodiagnostic technology was granted in 1986. Initial clinical studies, approved by the Johns Hopkins Medical School Investigational Review Board, were conducted at various affiliated Hopkins health facilities as well as at the University of Maryland in Baltimore. Initially the Neurometer® device was used only by Neurologists. This easy to perform procedure soon came to be used by orthopedic surgeons, endocrinologists, pain clinicians and many other specialities including toxicology, urology, dermatology and laboratory animal research. Presently there are more than 500 peer-reviewed scientific publications demonstrating the utility of Neurometer® technology. This Abstract Booklet includes selected abstracts grouped according to 8 major topics as well as 13 bibliographies of selected publications also grouped by topic.

Today Neurometer® devices are in routine clinical use around the world. Additionally, there are non-clinical applications including field-testing for environmental and industrial applications, pharmaceutical, cosmetic, epidemiological and laboratory animal applications. Neurotron, Inc. is constantly upgrading and expanding the applications of its technology. We invite you to visit our website www.neurotron.com for updates and take advantage of our “*Documents & Download*” extensive reference library.

Frequently Asked Questions (FAQs)

What are Neurometer® electrodiagnostic devices?

Neurometer® devices measure sensory nerve thresholds for detecting an electrical stimulus. The electrical stimulus is neuro-selective and it is applied to measure the selective sensory detection threshold for each of the three major sub-populations of sensory nerve fibers innervating the test site. Just as the hearing test determines the auditory detection threshold for different sub-populations of auditory nerve fibers with different frequencies of painless auditory stimuli. The Current Perception Threshold (CPT) test determines the sensory detection threshold for different sub-populations of sensory nerve fibers with different frequencies of painless electrical stimulus. CPTs are determined using an automated double-blind testing methodology. The Neurometer® device stimulus is microprocessor controlled. The neuroselective electrical stimuli quickly and painlessly quantify the conduction and functional integrity of the large and small myelinated and small unmyelinated sensory nerve fibers at any cutaneous site, mucosal or tooth test site. CPT measures have the unique capability to map the distribution of impairments ranging from neuritis (hyperesthesia) to neuropathy (hypoesthesia). Additionally, the Neurometer® device may provide atraumatic Pain Tolerance Threshold's (PTT's) and laboratory Animal Response Threshold (ART) measures.

What are the characteristics of the Neurometer® electrical stimulus?

Neurometer® devices generate three different constant alternating current sinusoid waveform stimuli at 2000 Hz, 250 Hz and 5 Hz. Stimulus output intensities range from 0.001 to 9.99 mAmperes (mA). A constant current output maintained by impedance feedback circuitry. This assures highly

reproducible measures which are unaffected by variables such as trophic skin changes, thickness or temperature variations or edema. The device's microprocessor is capable of performing both single-blind and fully automated double-blind examinations as well as permitting external computer control.. Other device functions include an automated system integrity check and a continuous monitoring of stimulus output parameters and battery charge levels with appropriate warning alarms and messages. The external computer control enhances its utility for clinical, laboratory, fMRI imaging and other applications. Both the printer and the Neurometer® unit are powered by the device's internal rechargeable battery.

Neurometer® devices are currently being employed for routine clinical purposes at thousands of locations around the world, as well as in research and industrial settings. Use of the neuroselective sNCT evaluation has been taught in AMA accredited and international continuing medical education courses starting with the American Academy of Neurology in 1985. To date, more than 1 million Neurometer® CPT examinations have been performed.

What types of procedures can Neurometer® CPT devices perform?

The Neurometer® CPT/C device has two automated double blind painless Current Perception Threshold determination modes of operation: automated forced choice CPT ($p < 0.006$), ranged R-CPT ($p < 0.05$) as well as a single-blind manual CPT determination mode. The Pain Tolerance Threshold (PTT) mode allows a reproducible, non-invasive and atraumatic method for measuring Pain Tolerance Threshold (PTT) levels in small and large fibers (if present) for evaluation of analgesic interventions or the patient with pain. The Windows® based CPT/C Computer Control Package allows the output of the CPT/C unit to be controlled through a PC. It allows the setting of repetitive stimuli at specific durations and intensity profiles. The Computer Control Package is also ideal for fMRI testing and laboratory animal investigations.

How is the CPT procedure conducted?

Neurometer® electrodiagnostic examinations use a standardized, automated procedure to generate objective, quantitative measures of the conduction and functional integrity of sensory nerve fibers. The unit emits non-aversive transcutaneous electrical stimuli through a pair of gold plated electrodes to evoke sensation for CPT determination. The procedure includes testing the patient at one or more body sites with three different sinusoidal frequencies of electrical stimulus. Each frequency, 2000 Hz, 250 Hz, and 5 Hz, evokes a response from a different subpopulation of sensory nerve fibers: large myelinated, small myelinated and small unmyelinated fibers, respectively. Normative CPT values have been established and published for multiple body sites and they are used to analyze patient measures. Windows® based software included with each device can be used to analyze the data and print a report summarizing the results. The following is a brief description of the standard CPT examination.

The technician turns the unit on and conducts a Pre-Exam Cable Test by following directions displayed on the unit's Liquid Crystal Display (LCD) screen. Successful completion of this test confirms the proper functioning of the CPT unit, electrodes and cables.

The patient is placed in a comfortable position - sitting or reclining - and

preferably in a location with minimal distractions. The examination procedure is explained to the patient. The prescribed skin sites to be evaluated are examined to confirm that the skin is intact. The skin may be cleaned and prepared for testing using a skin prep-paste. A pair of 1 cm. diameter disposable gold electrodes are coated with a thin layer of conductive gel and then taped to the test site. Specialized electrodes and catheter electrodes are available for animal, mucosal and other evaluations.

The patient performs an automated Intensity Alignment procedure which quickly narrows down the threshold level to a range of $\pm 50 \mu\text{Amperes}$ out of a total range of 0 to 9.99 mAmperes. Next, the patient begins the Auto Test Mode which is a fully automatic, double-blind, forced choice procedure to determine the actual Current Perception Threshold measures ($p < 0.006$). The patient is presented with randomly generated pairs of real and placebo stimuli which they are then asked to identify verbally or by pressing a button on a remote unit. Based upon the patient's response, the CPT device adjusts the output level of the stimulus and randomly generates a new testing order for the next pair of tests in the series. The automated design of the CPT testing procedure assures that neither the patient nor the operator can influence the test outcome based upon subjective impressions. When a sufficient number of tests have been performed, the device determines and displays the CPT value for the test series and optionally prints out the results. The Auto Test Mode follows a testing paradigm similar to that used in standard auditory tests and determines the patient's CPT measures to within $\pm 20 \mu\text{Amperes}$. Compliance Guard® technology monitors patient responses for consistency and accuracy. This testing sequence is repeated for each of the three frequencies of stimulus before moving on to the next body site.

How long does it take to perform the CPT evaluation?

The CPT evaluation of the 3 sub-populations of nerve fibers measure requires approximately 8 minutes whereas the "Ranged-CPT" or "R-CPT" evaluation requires approximately 2 minutes at each test site. A typical clinical evaluation may involve testing 2 to 6 sites (1 to 3 sites bilaterally)

What specific information does the CPT evaluation provide?

CPT measures provide objective, quantitative determinations of sensory nerve conduction and functional integrity from any cutaneous/mucosal site. Each CPT measure represents the minimum amount of a painless, neuroselective, transcutaneous electrical stimulus required to reproducibly evoke a sensation approximately 50% of the times it's presented. Three independent CPT measures are obtained from each test site by using three different sinusoidal frequencies of electrical stimuli: 2000 Hz, 250 Hz and 5 Hz. These measures selectively quantify the functioning of the three major sub-populations of sensory nerve fibers providing innervation to the test site: the large myelinated, small myelinated and small unmyelinated fibers. Abnormally low CPT measures indicate a hyper-sensitive nerve function (commonly associated with inflammation or neuritis) reflecting a hyperesthetic condition. Abnormally elevated CPT measures indicate a loss of nerve function reflecting a hypoesthetic condition or neuropathy.

CPTs are measured in units equivalent to 0.01 mAmperes (mA) of output intensity. At output intensities below 0.10 mA, CPT measures are resolved

in increments of 0.1 CPT units (1 μ Ampere). For example, a CPT measure of 100 indicates a stimulus output intensity of 1.0 mA; a CPT of 9.5 indicates an output intensity of 0.095 mA. The stimulus output range of the CPT device is 0.001 mA (CPT=0.1) to 9.99 mA (CPT=999).

Ranged R-CPTs are from 1 through 25. They are determined using previously established site and stimulus frequency specific normative values indicating hyperesthetic (1-5), normal (6-13) and hypoesthetic (14-25). R-CPT of 25 =9.99mA.

How does the CPT evaluation assist in clinical evaluations?

Differential Diagnosis: The CPT evaluation is used to objectively quantify sensory nerve function when the history (sensory symptoms) and physical examination (abnormalities detected with tuning fork, pinwheel, radiating pain reproduced with provocative orthopedic maneuvers etc.) merit further investigation of sensory function. The CPT evaluation is not indicated for routine use with every patient.

The differential diagnosis of sensory neuropathy can include: radiculopathy (disc injury), compressive lesion (e.g., carpal or tarsal tunnel syndrome), as well as axonal versus demyelinating vs distal axonal polyneuropathy (e.g. Guillian-Barré Syndrome, diabetic, uremic, alcoholic, toxic), spinal impairment or other types of central nervous system dysfunction (e.g. syringomyelia). Different sensory nerve pathologies typically exhibit distinctly different distributions of sensory impairment and may selectively effect the functioning of specific sub-populations of nerve fiber function (e.g. demyelinating neuropathies or large versus small fiber dysfunction). For instance, the impairment resulting from radiculopathy will be confined to a dermatomal distribution whereas the impairment from polyneuropathy secondary to axonopathy is most often confined to a distal distribution, involving primarily the toes, fingers and multiple nerves/dermatomes. CPTs can be mapped from any cutaneous location in order to assist in identification and diagnosis. Patients may also have a combination of sensory neuropathies such as an alcoholic with “Saturday Night Palsy”, a diabetic with radiculopathy or a uremic with carpal tunnel syndrome superimposed on polyneuropathy.

The objective nature of the CPT exam can also help in determining if a patient has sensory neuropathy consistent with their reported symptoms or if instead they might be suffering possible non-neurological impairments or seeking secondary gain. Conditions such as vascular or soft tissue lesions or arthritis, a ligamentous sprain or muscular sprain which can include symptoms of radiating pain, may mimic neuropathic conditions. For these reasons, it is sometimes necessary to conduct the automated CPT evaluation in patients with complaints of pain to confirm the differential diagnosis in order to prescribe appropriate treatment.

Determining Clinical Severity: The neuro-selective CPT evaluation objectively documents the clinical severity of neurogenic abnormalities. The evaluation measures whether the impairment is in the sub-clinical or early clinical stages (hyperesthesia) versus late stage neuropathy, hypoesthesia (loss of function) or anesthesia (complete loss of sensation). Serial mapping of the distribution of impairment permits the assessment of the progression of disease. This information guides the clinician's decision for the most

appropriate treatment and/or medical/surgical referral. Generally, the earlier the therapeutic intervention the better the prognosis.

The Neurometer® CPT evaluation enables physicians to evaluate those sensory fibers which mediate both pain and non-pain sensation. Both types of fibers should be evaluated because disease conditions may selectively impair large fiber function (position and vibratory sense) and/or smaller fiber function (pain and temperature). The evaluation of small fiber function is also critical for assessing protective sensation and can provide an indirect index of autonomic function.

Monitoring Therapeutic Intervention: The CPT evaluation is also used to monitor the efficacy and gauge the outcome of therapeutic intervention by providing objective serial measurements of the neuropathy, disability and neuro-regenerative processes. The painless nature of the test ensures high patient compliance for follow-up examinations.

How does the CPT exam compare to other neurodiagnostic exam procedures (sNCV, SSEP, EMG, MRI)?

There are numerous publications comparing CPT studies to traditional nerve conduction velocity studies, and they generally demonstrate a strong correlation between both their findings and levels of reliability. Several studies comparing CPT to MRI and intraoperative neurophysiological evaluations have demonstrated similar levels of correlation. While the CPT evaluation does have much in common with other neurodiagnostic procedures, many publications have also pointed out specific areas in which its capabilities surpass those of the other procedures. It is a painless measurement and patient compliance with serial testing is extremely high. It is also relatively insensitive to changes in skin temperature, thickness, scar tissue or edema which can distort or block the measures from other types of exams. The test is neuroselective for large myelinated, small myelinated and unmyelinated sensory fibers. It is a functional evaluation that can be performed at early stage neuritis or late stage neuropathy, and healthy control CPT values are available for measures of the shortest afferents on the face to the longest afferents on the toe. The Neurometer® CPT device is extremely safe, battery powered, and easy to use. (Comparison chart available at: <http://www.neurotron.com/compare.html>)

The sNCV and SSEP tests evaluate the large diameter myelinated sensory nerve fibers, which typically comprise less than 10% of a peripheral nerve. Conditions which selectively effect the smaller nerve fibers are undetectable by these tests. The CPT evaluation measures the conduction and functional integrity of all three major sub-populations of sensory nerves fibers, including the large myelinated, small myelinated and unmyelinated fibers. Together, these make up more than 90% of the sensory fibers in a typical nerve. Many conditions, particularly in the early stages, selectively effect a specific sub-population of fibers while leaving the other fibers untouched. The sNCT/CPT test is indicated for neuropathologies effecting large and/or small sensory fiber pathology.

The sNCV and SSEP tests are limited to measuring reductions in amplitude or conduction velocity resulting from a significant loss of nerve function. The sNCT/CPT evaluation is not limited to evaluating only those conditions which result in a significant loss of nerve function since it detects and quantifies hyperesthesia as well as hypoesthesia. Hyperesthetic conditions

reflect inflamed or irritated sensory nerve fibers with elevated resting membrane potentials and resultant lower electrical thresholds that have not yet lost their functioning (i.e. become hypoesthetic). Hyperesthesia commonly precedes hypoesthesia or anesthesia in progressive peripheral nerve damage. Detection of hyperesthesia allows for earlier therapeutic intervention in a disease condition with the potential of limiting more severe damage. The ability to quantify the functioning of the smallest unmyelinated afferents also makes CPT exam capable of detecting patients at risk for autonomic dysfunction as well as a loss of protective sensation.

The needle EMG test and motor nerve conduction velocity (mNCV) tests only provide information about muscle function and motor nerve innervation. These tests provide no information about sensory nerve function. The automated CPT evaluation only provides information about the sensory nerves. Sensory nerves are usually effected at an earlier stage than motor nerves in most common types of progressive neuropathology.

The Neurometer® CPT evaluation is also capable of monitoring recovery of sensory nerve functional integrity following carpal tunnel release, nerve repair or treatments such as plasmapheresis or immunoglobulin therapy. All of these therapeutic interventions result in scar formation which causes an artifact that impairs physiological measures such as the sNCV or the SSEP.

The CPT evaluation is indicated in the early stages of suspected radiculopathy, instead of a needle EMG, to perform an objective evaluation of the patient's condition and ascertain the efficacy of therapeutic intervention. In the case of a compressive radiculopathy from, for example from a bulging disc, Wallerian degeneration is required before a needle EMG will show any abnormal findings. This degeneration typically requires three to six weeks to occur before the needle EMG can document this impairment which can result in a delay in the application of effective therapeutic intervention. The CPT evaluation has been shown to be capable of documenting immediate changes in spinal nerve function. Various publications have demonstrated the effects of spinal lidocaine and narcotics on CPT and/or PTT measures concurrent with loss and recovery of sensory function.

The sensory nerve conduction velocity (sNCV) evaluation tests only a small segment of a peripheral nerve, typically less than 50 cm on an arm or a leg. With most radiculopathies, sensory nerve function is impaired by an injury of the spinal nerve roots but these lesions are not detectable by peripheral sNCV measures (e.g. from the arms and legs). The automated sNCT CPT or PTT evaluation is sensitive to an impairment of sensory nerve function occurring anywhere between the nerve test site and the cortex. Studies have documented the ability of the sNCT CPT and/or PTT measures to evaluate the sensory abnormalities resulting from a radiculopathy as well as the loss of sensory nerve function resulting from spinal pathology, spinal anesthesia and analgesia.

The CPT evaluation may also be a test to be considered instead of the MRI for certain patients, not only because of the financial savings, but primarily to help improve the quality of patient care. According to the 1994 publication by Jensen, et al from the *New England Journal of Medicine*, (331:69-73) titled "Magnetic resonance imaging of the lumbar spine in people without back pain" and in more recent publications, the MRI evaluation has a high number of false positive findings yielding erroneous diagnostic

interpretations (disc herniations without symptoms). The MRI is a structural and not a functional test - and as such is insensitive to inflammatory conditions such as disc irritation or nerve root irritation which may result in sensory dysfunction within a dermatomal distribution but not effect MRI imaging findings (i.e. an unremarkable or normal MRI). CPT measures have also been identified as superior to intraoperative neurophysiological measures of spinal cord sensory function.

What are the indications for conducting the CPT examination?

The CPT test is indicated in any patient with a presumptive diagnosis of sensory nerve dysfunction. Peripheral sensory nerve impairments have four major categories: poly-neuropathy, radiculopathy, compressive neuropathy and focal nerve lesions. The CPT test is used to identify and localize areas of abnormal function, to determine the severity of the abnormality and to aid in diagnosis, prognosis, guiding and evaluating treatment. The following is a partial list of those conditions associated with neuropathology that maybe evaluated by the CPT evaluation:

Metabolic: Uremic, hepatic, thyroid, diabetic and other endocrine disorders.

Compressive or Traumatic: Carpal and tarsal tunnel syndrome, thoracic outlet syndrome, brachial plexopathy, radiculopathy, vibration neuropathy and focal nerve lesions.

Toxic: Ethanol, heavy metals (such as lead), arsenic, acrylamide, organophosphate (pesticides), PCBs, trichloroethane, organic solvents and antineoplastic chemotherapeutic agents.

Acquired: HIV, Lyme disease, Hansen's disease (leprosy), post herpetic neuralgia.

Hereditary and Others: Charcot Marie Tooth, Laurence Moon Bidal, Freidricks Ataxia, Multiple Sclerosis, Vitamin B12 deficiency, reflex sympathetic dystrophy (RSD) or Complex Regional Pain Syndrome (CRPS), neuroma, regeneration, ruling-out psychogenic (hysterical sensory loss), neuropathy of cancer, COPD associated neuropathy, high altitude neuropathy, syringomyelia, cerebral vascular accident related sensory loss, and immune mediated sensory dysfunction (e.g. neuropathy associated with Anti-Myelin-Associated Glycoprotein Antibodies).

How much training is required to be able to properly perform the procedure?

Technicians can be trained in a few hours by a qualified sales representative for both clinical and laboratory animal applications. Manufacturer's technical certification courses are also available. A manual detailing the examination procedure is included with each device.

What type of training is required to interpret the procedure?

Any licensed physician can interpret the results of the sNCT/CPT test procedure by using the data generated by the NEUVAL® CPT data analysis software in conjunction with other clinical data and impressions of the patient. The location and distribution of the sNCT/CPT or PTT abnormalities on the patient (if present) can help the physician corroborate a diagnosis made based on history and physical examination findings. A manufacturer's clinical certification course is offered to physicians and provides training by a certified physician on the clinical use of the sNCT/CPT test and the

interpretation of the results of the test.

How are the examination results interpreted?

The NEUVAL® CPT evaluation and database software, included with each CPT device, evaluates and stores a patient's CPT values and generates a report detailing the condition of the nerves tested. These evaluations are based upon comparisons with standardized ranges of healthy CPT values and ratios included in the software. Both the CPT values and their ratios are considered when determining the degree of sensory nerve impairment and both contribute to the overall neurological diagnosis. The data analysis may include a determination of hyperesthetic and/or hypoesthetic conditions. Normative data is provided for more than thirty different test sites. All normative CPT values employed are either published in peer reviewed journals or available for review. They are not confidential.

Most importantly, as with any neuro-diagnostic test, a clinician's interpretation including a clinical correlation is essential and necessary for diagnostic purposes.

Is the CPT test an objective or subjective procedure?

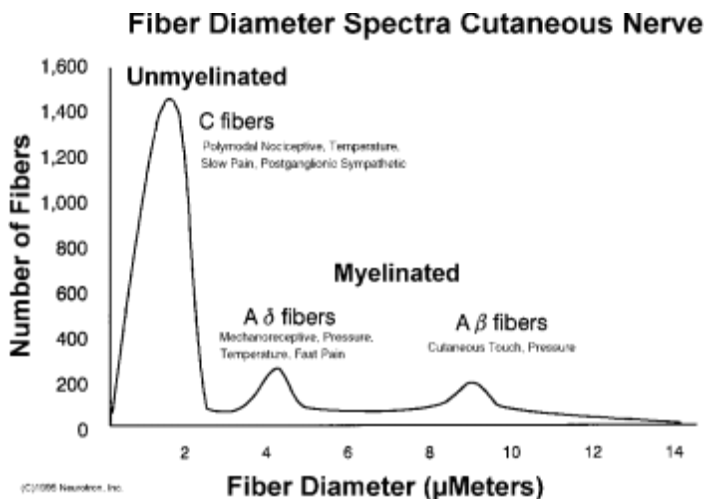
The Neurometer® CPT examination is an objective test for quantifying the functional integrity of sensory nerve fibers. The automated double-blinded CPT procedure is based on the same objective paradigm used for evaluating hearing and vision. These methodologies are widely used, well characterized, and legally recognized.

Where is additional information?

Extensive information and reference material is available from www.neurotron.com the following is a partial list: Utilization Guidelines, Comprehensive Bibliography, Governmental, Insurance and Legal Citations, Evaluation of sNCT Measures, Differential Diagnosis and Mapping of Sensory Neuropathy, Neurometer® sNCT/CPT Electrodiagnostic Evaluation Neuroselectivity and Hyperesthesia, Unmyelinated C-fiber Polyneuropathy in Endocrinology, Animal Research Using Neurometer® Neurodiagnostic Neuroselective Sensory Nerve Evaluation as well as generic Investigational Review Board applications.

Neurometer® CPT® Multi Modal Evaluation of the Peripheral Nerve

Neurometer® CPT® electrodiagnostic sensory nerve tests selectively evaluate the functioning of all major subpopulations of sensory nerve fibers comprising more than 90% of the typical peripheral sensory nerve. Traditional electrodiagnostic tests (sNCV, SSEP) evaluate less than 10% of the fibers i.e. A_B only.



CPT/sNCT Sensitivity Comparison
to Traditional (sNCV) Procedure

Condition (study #)	(n=)	Test Sensitivity		p Value
		sNCV	CPT	
Small Fiber Neuropathy ^(326, 392)	16	0%	50%	<0.001
Nerve Regeneration ⁽⁴²⁾	22	0%	100%	<0.001
Metabolic Polyneuropathy ⁽¹⁵⁰⁾	29	79%	92%	ns
<u>Vibration Neuropathy</u> ⁽²⁰⁷⁾				
Stage 3	33	100%	92%	ns
Stage 2	13	0%	77%	<0.001
Stage 1	13	0%	0%	ns
		Correlation Significance		
<u>Diabetic Neuropathy</u> ⁽³¹⁹⁾ *	71			
“Normal” vs “Abnormal”		ns	p<0.01	
“Abnormal” vs. “Very Abnormal”		ns	p<0.01	

* Discrimination of severity based on Symptom & Physical Scores examinations

Evaluation and prediction of efficacy of radiofrequency combined with platelet-rich plasma in the treatment of trigeminal nerve ophthalmic branch herpes zoster by current threshold measurement.

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Abstract

Herpes zoster (HZ) is a viral infection caused by the reactivation of the varicella-zoster virus (VZV) latent in the ganglia due to immunosuppression resulting from advanced age, immunosuppressive diseases, or malignancies [1]. Herpes zoster-associated pain is a critical clinical feature of HZ, which may persist for months or even years. The incidence of trigeminal neuralgia (TN) and postherpetic neuralgia (PHN) is higher in HZ patients, and early intervention is essential for effective prevention [2]. Pulsed radiofrequency (PRF) is a classical therapy for TN in pain management [3], while platelet-rich plasma (PRP) is widely used in nerve repair [4]. Our department has achieved favorable outcomes with the combined application of these two therapies for TN in HZ, although some patients still exhibit suboptimal responses. Risk factors for poor HZ response include age, gender, severity of prodromal pain, herpes lesion location, and the presence of immune system malignancies or other complications [5]. Current perception threshold (CPT) is used to assess functional impairment of cutaneous sensory nerve fibers and has been employed for the early diagnosis of diabetic peripheral neuropathy [6]. In recent years, it has also been utilized by researchers to evaluate the prognosis of herpes zoster (HZ) patients, as well as to assess and prevent the efficacy of epidural block and electrical stimulation [7]. To investigate whether CPT, as an objective diagnostic indicator, can evaluate and predict the therapeutic efficacy of radiofrequency (RF) combined with platelet-rich plasma (PRP) therapy for HZ, this study retrospectively analyzed the CPT data of our department's RF combined with PRP treatment for HZ of the ophthalmic branch of the trigeminal nerve. The ROC curve revealed that the preoperative CPT values at various frequencies had an AUC greater than 0.7, indicating predictive value for the therapeutic efficacy of RF combined with PRP in treating HZ of the ophthalmic branch of the trigeminal nerve

Effect of ultra laser irradiation combined with suspension exercise on pain and surface electromyography of neck in patients with cervical spondylotic radiculopathy

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Objective

To investigate the effect of ultra laser irradiation combined with suspension exercise on pain and surface electromyography (EMG) of the neck in patients with cervical spondylotic radiculopathy.

Method

A total of 70 patients with cervical radiculopathy admitted to Henan Provincial People's Hospital from January 2022 to December 2023 were selected and divided into a rehabilitation group and a comprehensive group by coin toss, with 35 cases in each group. The rehabilitation group received suspension exercise rehabilitation, while the comprehensive group received additional ultra-laser irradiation therapy. The differences in cervical surface electromyographic signals, current sensory threshold, visual analog scale (VAS) scores, Tanaka Yasuhisa Cervical Spondylosis Symptom Scale 20-point (CSR20) scores, cervical dysfunction index (NDI), self-rating depression scale (SDS) scores, self-rating anxiety scale (SAS) scores, and serum-related factors such as substance P (SP), prostaglandin E2 (PGE2), neuropeptide Y (NPY), cyclooxygenase-2 (COX-2), as well as cervical range of motion were compared between the two groups.

Results

No statistically significant differences were observed between the two groups in the aforementioned indicators before treatment ($P > 0.05$). After treatment, the mean electromyographic values (AEMG), current sensory threshold, VAS score, NDI, and serum levels of SP, PGE2, NPY, and COX-2 in the erector spinae and sternocleidomastoid muscles were all lower than pre-treatment levels, with the comprehensive group showing significantly lower values than the rehabilitation group ($P < 0.05$). Post-treatment, the median frequency (MF) and CSR20 scores of the erector spinae and sternocleidomastoid muscles, as well as the range of motion for cervical flexion, extension, lateral rotation, and lateral flexion, were all higher than pre-treatment levels, with the comprehensive group demonstrating significantly greater values than the rehabilitation group ($P < 0.05$).

Conclusion

Compared with the single suspension exercise rehabilitation, combined with the ultralaser irradiation therapy can better improve the surface electromyographic signal and nerve conduction function of the cervical surface of patients with cervical spondylotic radiculopathy, reduce pain and increase the cervical mobility.

Curative effect of Feijing Zouqi acupuncture at five points of lumbar process combined with Duhuo Jisheng Decoction in lumbar disc herniation

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Objective

To explore the curative effect of Feijing Zouqi acupuncture at five points of lumbar process combined with Duhuo Jisheng Decoction in lumbar disc herniation (LDH).

Methods

A total of 200 patients with LDH were enrolled as the research objects between May 2023 and February 2024. According to random number table method, they were divided into Qinglong Baiwei group (treated with "Qinglong Baiwei" technique combined with Duhuo Jisheng decoction, 40 cases), Baihu Yaotou group (treated with "Baihu Yaotou" technique combined with Duhuo Jisheng decoction, 40 cases), Canggui tanxue group (treated with "Canggui tanxue" acupuncture combined with Duhuo Jisheng Decoction, 40 cases), and Chifeng Yingyuan group (treated with "Chifeng Yingyuan" acupuncture combined with Duhuo Jisheng Decoction, 40 cases), and conventional millineedles group (treated with conventional millineedles deep acupuncture combined with Duhuo Jisheng Decoction, 40 cases). The clinical curative effect, scores of visual analogue scale (VAS) and Japanese Orthopaedic Association (JOA), pain matching threshold (PMT), current perception threshold (CPT), cellular inflammatory factors (IL-1 β , IL-10, IL-17, TNF- α) and immune function indexes (CD4 $^{+}$, CD8 $^{+}$, CD4 $^{+}$ /CD8 $^{+}$) were compared between the five groups.

Results

The total response rate of Qinglong baiwei group, Baihu Yaotou group, Canggui tanxue group, and Chifeng Yingyuan group was higher than that of conventional millineedles group ($P<0.05$). After treatment, VAS score and PMT in Qinglong baiwei group, Baihu Yaotou group, Canggui tanxue group, and Chifeng Yingyuan group were lower than those in conventional millineedles, while JOA score was higher than that in conventional millineedles group ($P<0.05$). After treatment, CPT values of L4, L5 and S1 nerve roots in Qinglong baiwei group, Baihu Yaotou group, Canggui tanxue group, and Chifeng Yingyuan group were lower than those in conventional millineedles group ($P<0.05$). After treatment, levels of serum IL-1 β , IL-17 and TNF- α in Qinglong baiwei group, Baihu Yaotou group, Canggui tanxue group, and Chifeng Yingyuan group were lower than those in conventional millineedles group, while IL-10 level was higher than that in conventional millineedles group ($P<0.05$). After treatment, CD4 $^{+}$ and CD4 $^{+}$ /CD8 $^{+}$ in Qinglong baiwei group, Baihu Yaotou group, Canggui tanxue group, and Chifeng Yingyuan group were higher than those in conventional millineedles group ($P<0.05$).

Conclusion

Curative effect of Feijing Zouqi acupuncture at five points of lumbar process combined with Duhuo Jisheng Decoction is significant in LDH patients, which can effectively relieve lumbago, reduce inflammatory response, improve immune function and function injury of peripheral nerves, and thus improve lumbar function.

Effect of Shaoyang Meridian Acupuncture Combined with Tao Wu Tong Prescription on Painful Diabetic Peripheral Neuropathy and Its Influence on Neural Conduction Function.

Shi Guirong prunus salicina Ting Jay Chou

Objective

To investigate the efficacy of Shaoyang meridian acupuncture combined with Tao Wu Tong prescription in the treatment of painful diabetic peripheral neuropathy (PDPN) and its effect on nerve conduction function.

Method

A total of 80 patients with postoperative diabetic neuropathy (PDPN) were randomly divided into two groups, with 40 cases in each group. The control group (n=38, with 2 cases dropped) received conventional treatment. The treatment group (n=38, with 2 cases dropped) received conventional treatment plus Shaoyang meridian acupuncture combined with Taowutong prescription. The clinical efficacy after 4 weeks of treatment was compared between the two groups. Pain intensity was assessed using the Numerical Rating Scale (NRS). Peripheral neuropathic symptoms were evaluated using the Toronto Clinical Score (TCSS). Motor and sensory nerve conduction velocities of the posterior tibial nerve and median nerve, as well as sensory nerve action potentials, were measured. Current perception thresholds (CPT) of the posterior tibial nerve, ulnar nerve, and median nerve were determined using a sensory nerve quantification device (NEUROMETER CPT, USA). Serum levels of prostaglandin E2 (PGE2), interleukin-1 β (IL-1 β), and tumor necrosis factor- α (TNF- α) were measured.

Results

After 4 weeks of treatment, the total response rate in the treatment group was higher than that in the control group ($P<0.05$). After 4 weeks of treatment, the NRS scores in both groups were lower than before treatment ($P<0.05$); the NRS score in the treatment group was lower than that in the control group ($P<0.05$). After 4 weeks of treatment, all TCSS scores in both groups improved compared to before treatment ($P<0.05$); the improvement in TCSS scores in the treatment group was more significant than that in the control group, with a statistically significant difference between groups ($P<0.05$). After 4 weeks of treatment, the motor and sensory nerve conduction velocities and sensory nerve action potentials of the posterior tibial nerve, ulnar nerve, and median nerve in both groups were higher than before treatment ($P<0.05$); the motor and sensory nerve conduction velocities and sensory nerve action potentials of the posterior tibial nerve, ulnar nerve, and median nerve in the treatment group were higher than those in the control group ($P<0.05$). After 4 weeks of treatment, the CPT scores of the posterior tibial nerve, ulnar nerve, and median nerve in both groups were lower than before treatment ($P<0.05$); the CPT scores of the posterior tibial nerve, ulnar nerve, and median nerve in the treatment group were lower than those in the control group ($P<0.05$). After 4 weeks of treatment, the levels of PGE2, IL-1 β , and TNF- α in both groups were lower than before treatment

($P<0.05$); the levels of PGE2, IL-1 β , and TNF- α in the treatment group were lower than those in the control group ($P<0.05$).

Conclusion

The combination of Shaoyang meridian acupuncture and Tao Wu Tong prescription can enhance the therapeutic effect of PDPN, further reduce neuropathic pain symptoms and pain intensity, improve nerve conduction velocity, and alleviate inflammatory responses.

Prediction and evaluation of current perception threshold for epidural block in patients with herpes zoster neuralgia.

Zhu Chunyan, Ni Huadong, He Qiuli, Xie Keyue, Fei Yong, Zhou Xiyan, Huang Bing, Yao Ming.

Objective

To explore the prediction and evaluation of current perception threshold for epidural block in patients with herpes zoster neuralgia.

Methods

Totally 50 cases of epidural block for herpes zoster radiculopathy in chest or back were enrolled. All patients were divided into effective group (n=44) and ineffective group (n=6) based on the classification criteria of the Barrow neurological institute. The general data including sex, age, course of disease and complication were compared between the two groups respectively, and the CPT values before and after surgery were compared.

Results

The course of disease of the effective group was shorter than that of the ineffective group ($t=2.31$, $P<0.05$). One day before surgery, the CPT values under 2000 Hz, 250 Hz and 5 Hz in the effective group were significantly lower than those of the ineffective group ($t=5.57$, 4.26 , 4.93 , $P<0.05$). One day and one week after operation, the CPT values under 2000 Hz, 250 Hz and 5 Hz in the effective group were higher than one day before surgery ($t=11.28$, 8.46 , 11.51 , 11.85 , 9.66 , 11.48 , $P<0.05$). One week after operation, the CPT values under 2000 Hz, 250 Hz and 5 Hz in the effective group were higher than one day after operation, and the differences were statistically significant ($t=3.15$, 3.90 , 6.89 , $P<0.05$). In the ineffective group, there was no significant difference in CPT values under 2000 Hz, 250 Hz and 5 Hz between once day before and after surgery ($t=2.20$, 1.42 , 0.46 , $P>0.05$).

Conclusion

CPT has a significance in evaluating the degree of lesions of the herpes zoster. It can be evaluated before surgery, it also can predict and evaluate the clinical effect of CT-guided epidural block in patients with herpetic neuralgia.

The study of the evaluation of sensory nerves for the treatment of cervical headache from milli fire needle under the guidance of ingjin theory.

Liang Shufen
Guangxi University of Chinese Medicine

Objective:

In this study, the sensory nerve quantitative detector was used to measure the cervical 2 and cervical 3 current sensory threshold (CPT), and the score grade was used to further quantify the clinical efficacy of the needle intervention in cervical headache under the guidance of the thejinging theory. In order to provide more objective clinical data support for the treatment of cervical headache with the guidance of the theory of sinews and tendons, and to further improve its clinical efficacy evaluation system.

Methods:

60 patients diagnosed with cervical source sex have a headache, and the research into the standard degree of headache patients (VAS) score, cervical vertebra of motion (ROM) score, and USES the quantitative sensory nerve detector feeling about the current neck 2, 3 after measure threshold (CPT) were randomly divided into treatment group and control group, 30 cases in each group. In the treatment group, the needle was used under the guidance of the tendon theory, and the treatment was performed once every other day for a total of 7 times. The control group took flunarizine hydrochloride capsules orally (xi 'an yangsen pharmaceutical co., LTD., national drug approval: H10930003), 10mg daily, and took them after dinner for a total of 2 weeks. Two groups of patients after the treatment, treatment after 1 month of headache (VAS) score, cervical vertebra of motion (ROM) score, as well as by the neck, neck 2-3 current sensory thresholds (CPT) measure the income of the lateral (pain than what side) rating for clinical effect assessment, finally USES the SPSS25.0 statistical software will be treated as the obtained data were statistically analyzed.

Results:

Among the 60 patients with cervicogenic headache, 1 case fell off in the treatment group and 2 cases fell off in the control group, and 57 cases were actually collected. (1) Before treatment, there was no statistically significant difference in the age, gender and course of disease in the general data of the two groups ($P>0.05$). The general data of the two groups were clinically. (2) before treatment, the headache intensity (VAS) score, cervical range of motion (ROM) score, and the score grade obtained by quantitative measurement of CPT were compared between the two groups. The difference was not statistically significant ($P>0.05$), and clinical comparison could be conducted. (3) VAS score and efficacy evaluation after treatment: compared with before treatment, VAS score of both the treatment group and the control group decreased ($P<0.05$), with statistically significant difference. Comparison of VAS scores between the two groups after treatment and 1 months after treatment showed that the scores in the treatment group decreased significantly compared with the control group ($P<0.05$), and the

difference was statistically significant. (4) ROM score of cervical range of motion after treatment: compared with that before treatment, ROM scores of both the treatment group and the control group were reduced ($P<0.05$), with statistically significant differences. After the end of treatment and 1 month after the end of treatment, the score of the treatment group decreased significantly compared with the control group ($P<0.05$), and the difference was statistically significant. (5) At the end of treatment and follow-up 1 month after the end of treatment, the scores obtained by quantitative measurement of cervical 2 and cervical 3 current sensory threshold (CPT) in the two groups were significantly lower than those before treatment, and the difference was statistically significant ($P<0.05$). In addition, compared with the control group, the scores obtained by quantitative measurement of CPT in the treatment group and CPT in the treatment group decreased significantly, and the difference was statistically significant ($P<0.05$). (6) after the end of treatment, the overall efficacy of the two groups was compared, and the efficacy of the treatment group was better than that of the control group, and the difference was statistically significant ($P<0.05$).

Conclusion:

1. Under the guidance of the jingjin theory, needle acupuncture at the point of tendon fixation has achieved good clinical efficacy in the treatment of cervical headache. The score grade obtained by quantitative detection of CPT in neck 2 and neck 3 decreased significantly after the use of milli fire needle intervention, and the symptoms of head and neck pain were relieved. It was preliminarily proved that cervical headache was related to the nerve dysfunction of neck, and milli fire needle could effectively improve the symptoms of nerve dysfunction.
2. The quantitative detection of sensory nerves is of quantitative, objective and accurate significance for the diagnosis of the degree and location of cervical nerve injury and the evaluation of clinical efficacy in patients with cervical headache. It can be used as a new method for the diagnosis and efficacy evaluation of cervical nerve injury in patients with cervical headache and is expected to be further studied.

Application Of Current Perception Threshold In Ct-Guided Trigeminal Radiofrequency Coagulation Surgery

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Objective:

To summarize the application of current perception threshold (CPT), CPT before and after radiofrequency coagulation for treating, and quantitatively evaluating the clinical effect of radiofrequency thermocoagulation on trigeminal neuralgia.

Methods:

We collected and analyzed 30 trigeminal neuralgia patients undergoing trigeminal radiofrequency coagulation with CT (computed tomography)-guidance from February 2017 to August 2017 in Jiaying First Hospital. The preoperative and postoperative changes in CPT values were compared, and patients were followed up after surgery.

Results:

Thirty patients were treated with ipsilateral CPT test 1 day before and after surgery. According to the classification criteria of the Barrow Neurological Institute, all patients were divided into two groups: if the patients were graded as excellent or good after surgery, they were included in the effective group, and the others were included in the ineffective group. Totally, 23 patients were included in the effective group and 7 patients were included in the ineffective group. Paired t-tests were performed on the CPT values of the two groups for data processing. Preoperative CPT values between two groups were calculated as independent sample t-tests. In the effective group, the CPT value of the ipsilateral side increased significantly ($P < 0.05$), but in the ineffective group, some patients had elevated CPT after surgery, but the differences within the group were not statistically significant. The difference of pre-operative CPT between the two groups was statistically significant ($P < 0.05$).

Conclusion:

CPT is effective in evaluating the patient's sensory function. In the application of trigeminal radiofrequency thermocoagulation, the degree of lesions of the trigeminal nerve can be evaluated before surgery that has clinical reference value for predicting the effect of surgery and quantitatively evaluating the effect of surgery.

Quantitative and fiber-selective evaluation of pain and sensory dysfunction in patients with Parkinson's disease.

Yi Chen , Cheng-Jie Mao , Si-Jiao Li , Fen Wang , Jing Chen , Hui-Jun Zhang , Ling Li , Sha-Sha Guo , Ya-Ping Yang , Chun-Feng Liu

Introduction

Pain and sensory disturbances affect many patients with Parkinson's disease (PD). The present study aimed to evaluate the pain and sensory sensitivity of each class of afferent fibers in PD patients and determine the effects of dopaminergic therapy on pain and sensory sensitivity.

Methods

Current perception threshold (CPT) and pain tolerance thresholds (PTT) at three frequencies, 2000 Hz, 250 Hz, and 5 Hz, to stimulate Ab fibers, Ad fibers, and small C-polymodal fibers, respectively, were measured in 72 PD patients and 35 healthy controls.

Results

CPT was higher at all three frequencies and PTT was lower at 2000 Hz and 250 Hz in PD patients with pain versus healthy controls ($P < 0.05$). CPT was higher at 2000 Hz and 250 Hz and PTT was lower at 2000 Hz and 250 Hz in PD patients without pain versus healthy controls ($P < 0.05$). PD patients with pain exhibited higher CPT at 5 Hz and 250 Hz than PD patients without pain ($P < 0.05$). Dopaminergic therapy did not affect CPT or PPT in PD patients ($P > 0.05$).

Conclusions

Abnormal Ad fiber- and Ab fiber-dependent sensory inputs may exist in PD. Abnormal sensory inputs via C fibers and Ad fibers might be associated with the presence of pain in PD. Because dopaminergic therapy failed to mitigate these sensory and pain dysfunctions, mechanisms not involving the dopaminergic pathway are likely to be implicated.

The Current Perception Threshold Test Differentiates Categories of Mechanical Neck Disorder

Zakir Uddin, MScPT, Joy C MacDermid, PhD, Victoria Galea, PhD, Anita R Gross, MSc, Michael R Pierrynowski, PhD,

Study Design

Cross-sectional discriminative analysis.

Objective

To determine whether current perception threshold (CPT) can differentiate between categories of patients with mechanical neck disorders (MNDs).

Background

Neck pain is the third most common musculoskeletal disorder, affecting a third of all adults each year. It can present as neck pain without musculoskeletal signs; neck pain with musculoskeletal signs but no neurological signs; neck pain with neurological signs. CPT testing can assess altered sensory perception that may reflect neurological changes.

Methods

Patients with MNDs (n=106) were classified into 3 groups based on a standardized musculoskeletal examination process performed by an experienced physiotherapist blinded to CPT scores. The 3 groups were defined as: MND-I, neck pain without musculoskeletal signs (n=60); MND-II, neck pain with musculoskeletal signs (n=29); MND-III, neck pain with neurological signs (n=17). A rapid protocol of CPT testing was performed at 3 frequencies (5, 250, 2000 Hz), using 3 dermatomal locations on the hand. A 1-way ANOVA with post hoc comparison and effect sizes were calculated to compare the mean CPT score between the groups. A binary logistic regression model was used to predict probability of higher CPT in MND-III and used to create a receiver operating characteristic (ROC) curve.

Results

Mean CPT differed significantly across the 3 MND groups (MND-I, 9.7; MND-II, 10.6; and MND-III, 11.8; $P < .001$, $\eta^2 = .6$). Post hoc comparisons indicated differences between MND-I and MND-II ($P = .05$) and between MND-II and MND-III ($P = .01$), that were large effect sizes (MND I versus II, $d = 1$ and MND II versus III, $d = 2.2$). CPT testing was able to distinguish between MND II and III when a threshold value of greater than 11 was used to indicate MND-III. The predicted probability of abnormal CPT in MND-III had an 2 Journal of Orthopaedic & Sports Physical Therapy® estimated 73% sensitivity and 81% specificity; the odds ratio was 11.5 ($P = .001$) for the differentiation capacity of CPT between MND-II and III with a cut-off of 11. The area under the ROC curve (AUC) was .84 (95% CI = .72 to .96, $P < .001$).

Conclusions

CPT testing has moderate discriminatory accuracy, specificity, and sensitivity for classification of MND categories into neck pain with or without neurological signs.

Involvement of LPA1 receptor signaling in cerebral ischemia-induced neuropathic pain.

Halder SK, Yano R, Chun J, Ueda H.

Abstract

We demonstrated previously that the lysophosphatidic acid-1 (LPA1) receptor plays a crucial role in the initiation of peripheral nerve injury-induced neuropathic pain through the alternation of pain-related genes/proteins expression and demyelination. The present study revealed that mild cerebral ischemia by left transient middle cerebral artery occlusion (tMCAO) for 15 min causes the hypersensitive responses (paw withdrawal) to the nociception by electrical stimuli to the paw by the use of Neurometer Current Perception Threshold/C (CPT/C). The hypersensitivity or neuropathic pain was only observed by the stimulation with 250 and 2000, but not 5 Hz, which are the characterized sinewave frequencies of Ad-, Ab- or C-fibers, respectively. The significant neuropathic pain was observed from day 2 through week 2 on the right paw after tMCAO, while there was slight but significant pain sensitivity on the left paw at day 7. The neuropathic pain on the contralateral side at week 2 after tMCAO was completely abolished in LPA1^{-/-} mice. These results suggest that LPA1 receptor signaling plays key roles in the development of central neuropathic pain following cerebral ischemia as well as the peripheral neuropathic pain following partial sciatic nerve injury. 2013 IBRO. Published by Elsevier Ltd. All rights reserved.

The relationship between neck pain and physical activity

Cheung J, Kajaks T, Janice Cheung¹, Tara Kajaks² and Joy C. MacDermid,

Abstract:

Neck pain is a significant societal burden due to its high prevalence and healthcare costs. While physical activity can help to manage other forms of chronic musculoskeletal pain, little data exists on the relationship between physical activity and neck pain. The purpose of this study was to compare physical activity levels between individuals with neck pain and healthy controls, and then to relate disability, fear of movement, and pain sensitivity measures to physical activity levels in each of the two participant groups. 21 participants were recruited for each of the two participant groups (n = 42). Data collection included the use of the Neck Disability Index, the Tampa Scale for Kinesiophobia, electrocutaneous (Neurometer® CPT) and pressure stimulation (JTech algometer) for quantitative sensory testing, and 5 days of subjective (Rapid Assessment of Physical Activity) and objective (BioTrainer II) measurements of physical activity. Analysis of Variance and Pearson's Correlation were used to determine if differences and relationships exist between dependent variables both within and between groups. The results show that individuals with mild neck pain and healthy controls do not differ in subjectively and objectively measured physical activity. While participants with neck pain reported higher neck disability and fear of movement, these factors did not significantly relate to physical activity levels. Perceived activity level was related to pain threshold and tolerance at local neck muscles sites (C2 paraspinal muscle and upper trapezius muscle), whereas measured activity was related to generalized pain sensitivity, as measured at the tibialis anterior muscle site.

Effect of acupuncture on perception threshold: a randomised controlled trial

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Objective

Determine the current sensory thresholds (CPTs) in the arm and infraorbital regions to quantitatively assess the efficacy of acupuncture therapy.

Methods

A total of 98 volunteers were recruited as subjects and randomly divided into three groups: Acupuncture Treatment Group (34 subjects), Simulated Acupuncture Treatment Group (32 subjects), and Waiting Control Group (32 subjects). Acupuncture was administered at the Hegu (LI4) point on the left hand, and the current sensory thresholds (CPTs) in the arm and mentomotor area were measured before and after acupuncture. The sensory thresholds in the ipsilateral arm and mentomotor area were quantitatively assessed using a sensory nerve quantifier. For further investigation, a subgroup of 13 subjects from the Acupuncture Treatment Group was randomly selected to have their ipsilateral and contralateral mentomotor area sensory thresholds measured before and after acupuncture treatment.

Results

In the acupuncture treatment group, acupuncture stimulation at the Hegu (LI4) acupoint significantly increased the sensory threshold in the left mental foramen region ($p < 0.01$). The increase in sensory threshold in the left mental foramen region in the acupuncture treatment group was significantly higher than that observed in the control group at all stimulation frequencies, and also significantly higher than the increases in the simulated acupuncture treatment group at 250Hz and 5Hz stimulation frequencies. In the subgroup of the acupuncture treatment group, the sensory threshold in the contralateral mental foramen region showed a significant increase only at the 5Hz stimulation frequency.

Conclusions

Acupuncture stimulation at the Hegu (LI4) point increases the sensory threshold in the maxillary region without elevating the sensory threshold in the arm. This finding is likely associated with the analgesic effect of acupuncture therapy

Assessment and follow-up of intercostal nerve damage after video-assisted thoracic surgery

宮崎拓郎、境徹也、土谷智史、山崎直哉、田川努、三根真理子、柴田義貞、永安武

Abstract

Postoperative pain syndrome after thoracotomy is defined as persistent perioperative pain lasting more than 2 months postoperatively. It is estimated that approximately 50% of cases experience this condition, characterized by chronic pain that is difficult to resolve. Although various measures have been developed to alleviate postoperative pain syndrome after thoracotomy, such as anesthesia techniques and surgical approaches, a definitive preventive method remains elusive. The primary etiology of this condition is attributed to intercostal nerve injury. Previous postoperative pain assessments predominantly relied on subjective methods, such as patient questionnaires, and no objective reports have been published to date regarding the evaluation of intercostal nerve injury. This study employed the CPT/C® neurometric device to measure the Current Perception Threshold (CPT) of intercostal nerves—widely recognized as a major trigger of postoperative pain—to assess the differential impact of current mainstream thoracotomy techniques on the incidence of postoperative pain.

Increased pain sensitivity in alcohol withdrawal syndrome

Thomas Jochum , Michael K. Boettger , Christin Burkhardt , Georg Juckel, Karl-Jürgen Bär

Abstract

Withdrawal from analgesic and addictive substances such as opioids or ethanol is associated with increased sensitivity to sensory stimulation in animal models. Here, we investigated perception of innocuous and noxious thermal or electric stimuli applied to the left hand or sternum in 30 male patients undergoing withdrawal from alcohol, 30 male abstained alcoholics and matched controls. The alcohol withdrawal scale and the Banger score were obtained to estimate the severity of withdrawal. In addition, the Beck depression inventory was used to estimate the influence of depressive symptoms on pain perception. The data presented provide substantial evidence that subjects undergoing alcohol withdrawal show increased heat pain sensitivity. Interestingly, this effect was observed both on the left hand and sternum. Pain thresholds and tolerances of electric stimuli did not differ between groups. However, in a subgroup analysis, a higher sensitivity for electrical pain thresholds and tolerances was observed in those patients that were identified to require pharmacological treatment for withdrawal according to disease severity. Furthermore, the perceived painful thermal and electrical sensation was substantially influenced by the affective state of patients. No differences were found between patients of the abstained group and control subjects for any pain parameter. In conclusion, we demonstrate withdrawal-induced hyperalgesia upon thermal stimulation in patients. Since the influence of affective symptoms on pain perception during withdrawal is remarkable, we assume that peripheral and central mechanisms might account for this finding, which should be assessed in detail in future studies.

Sensory hypoaesthesia is a feature of chronic whiplash but not chronic idiopathic neck pain

Andy Chien a,b , Michele Sterling

Abstract

Both sensory hypersensitivity and hypoaesthesia are features of chronic whiplash associated disorders (WAD). Sensory hypersensitivity is not a consistent feature of chronic idiopathic (non-traumatic) neck pain but the presence of hypoaesthesia has not been investigated. This study compared the somato sensory phenotype of whiplash and idiopathic neck pain. Comprehensive Quantitative Sensory Testing (QST) including both detection and pain thresholds as well as psychological distress were measured in 50 participants with chronic WAD, 28 participants with chronic idiopathic neck pain and 31 healthy controls. The whiplash group demonstrated lowered pressure pain thresholds (PPTs) at all sites compared to the controls ($p < 0.01$) but there was no difference between the two neck pain groups ($p > 0.05$) except at the tibialis anterior site ($p = 0.02$). The whiplash group demonstrated lowered cold pain thresholds compared to idiopathic and control groups ($p < 0.03$). For detection thresholds, the whiplash group showed elevated vibration ($p < 0.04$), heat ($p < 0.02$) and electrical ($p < 0.04$) thresholds at all upper limb sites compared to the idiopathic neck pain group and the controls ($p < 0.04$). Sensory hypoesthesia whilst present in chronic whiplash is not a feature of chronic idiopathic neck pain. These findings indicate that different pain processing mechanisms underlie these two neck pain conditions and may have implications for their management.

Comparative Analgesic and Mental Effects of Increasing Plasma Concentrations of Dexmedetomidine and Alfentanil in Humans

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BACKGROUND

In animals, systemic and intrathecal administration of the α_2 -adrenergic receptor agonist dexmedetomidine results in robust antinociceptive effects in models of heat pain. In humans, systemically administered dexmedetomidine is approved for sedating patients in the intensive care unit. However, whether systemic administration of dexmedetomidine in humans produces significant analgesia at doses causing sedation but not unconsciousness remains controversial.

METHODS

This study in human volunteers used a placebo controlled, double-blind, and randomized design to examine whether dexmedetomidine at doses causing mild to severe sedation produces analgesia in experimental models of heat and electrical pain. Results were compared to the effects of the μ -opioid receptor agonist alfentanil. A computer-controlled infusion provided four median step-up plasma concentrations of dexmedetomidine (0.09, 0.24, 0.54, and 1.23 ng/ml) and alfentanil (13.4, 33.8, 67.8, and 126.1 ng/ml).

RESULTS

Sedative and cognitive effects of dexmedetomidine were dose-dependent, resulting in a median sedation score of 95 of 100 and slowing of cognitive speed (reaction time, trailmaking test) by a factor of about two at the highest plasma concentration. Dexmedetomidine did not attenuate heat or electrical pain. Alfentanil caused severe sedation (median sedation score 88 of 100) and slowed cognitive speed by a factor of approximately 1.4 at the highest plasma concentration. Alfentanil attenuated heat and electrical pain dose dependently.

CONCLUSION

This study documents that systemic dexmedetomidine lacks analgesic efficacy for heat and electrical pain at doses causing mild to severe sedation. These results provide further evidence suggesting that systemic administration of dexmedetomidine lacks broad analgesic activity in models of acute pain at doses not rendering humans unconscious."

Influence of Topical Capsaicin on Facial Sensitivity in Response to Experimental Pain

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Department of Oral Medicine and Oral Diagnosis
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Seoul National University, Seoul Korea

ABSTRACT

“Capsaicin, the pungent component of the red pepper, has been used as an analgesic in a variety of pain conditions, but sensory impairment after long-term treatment has been concerned. This study investigated the influence of topical capsaicin on various types of sensations including pain in the facial areas innervated by the mental nerve, and also evaluated whether the measurement of cutaneous current perception threshold (CPT) is reliable for the quantification of sensory change following capsaicin application. Twenty healthy subjects were given topical capsaicin cream (0.075%), which was applied to the mental area unilaterally, four times daily for 2 weeks. Burning sensation after capsaicin application gradually decreased with repeated applications. Repeated topical capsaicin resulted in reduced sensation to mechanical, heat and cold pain without changing non-painful tactile sensation. It also resulted in increased CPTs at 5 Hz and 250 Hz stimuli but no change in the CPTs at 2000 Hz from the first evaluation after capsaicin treatment and throughout the treatment period. This study demonstrated that topical capsaicin treatment for the management of chronic localized pain can be safely applied to the face without affecting non-painful normal sensations, and that CPT testing is a clinically useful tool for the quantification of sensory changes following capsaicin application.”

Neuroselective Sensory Electrodiagnostic Evaluation of 4% Liposomal Topical Lidocaine

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Kantilal M. Patel, Ph.D.⁺

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Children's National Medical Center. and George Washington University,
Washington, D.C.

Abstract

“We used a neuroselective transcutaneous electrical stimulus to determine the onset time of cutaneous anesthesia with 4% Liposomal Lidocaine under occluded and non occluded conditions. The pain tolerance threshold (PTT) was used to atraumatically evaluate nociception. Twenty adult volunteers had liposomal lidocaine applied to the volar surface of each forearm for durations ranging from 0 through 30 min(at 5 min intervals) under occluded and nonoccluded conditions. The PTT was determined using three different frequencies (2000Hz, 250Hz, 5Hz) stimulating the A beta, A delta, and C fibers respectively. The time to reach the Maximum PUT achieved defined the anesthetic onset time for each frequency. A differential onset of cutaneous anesthesia among the three frequencies was clearly demonstrated, however there was no significant difference in onset time between occluded and non occluded conditions. Blockade of C fiber transmission occurred significantly earlier than that of A delta ($P=0.029$), which occurred earlier than that of A beta ($P = 0.001$ as determined using the Wilcoxon's signed rank test. We conclude that a me onset time of approximately 4 ± 2 min for blockade of C fiber transmission and 6 ± 4 min for A delta transmissions suggests the painful stimuli such as venipuncture may be attenuated as early as 7 min.”

The Pharmacodynamics of Orally Administered Sustained Release Hydromorphone in Humans

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Wada, D.R., Stanski, D.R.

Stanford University Medical Center, Stanford, CA, U.S.A.

Background

"The disposition kinetics of hydromorphone generally mandates 4-hourly oral administration of the conventional immediate release tablet to provide sustained pain relief. However, multiple daily dosing may result in decreased compliance and more pronounced pain. This trial examined time course and magnitude of analgesia to experimental pain after administration of sustained release hydromorphone as compared with that following immediate release hydromorphone or placebo."

Methods

"Using a 4x4 Latin square double-blind design 12 subjects were randomized to receive a single dose of 8, 16, and 32 mg sustained release hydromorphone and placebo. The same subjects had received 8 mg immediate release hydromorphone prior to this study. Using an electrical experimental pain paradigm analgesic effects were assessed for up to 30 hours after administration and venous hydromorphone plasma concentrations were measured at corresponding times."

Results

"The hydromorphone plasma concentration peaked significantly later (12.0 h [12.0-18.0] versus 0.8 h [0.8-1.0]; median and inter-quartile range) but was maintained significantly longer at greater than 50% of peak concentration (22.7 ± 8.2 h versus 1.1 ± 0.7 h; mean $\pm$ SD) after sustained than after immediate release hydromorphone. Similarly, sustained release hydromorphone produced analgesic effects that peaked significantly later (9.0 h [9.0-12.0] versus 1.5 h [1.0-2.0]) but were maintained significantly longer at greater than 50% of peak analgesic effect (13.3 ± 6.3 h vs 3.6 ± 1.7 h). A significant relationship between the hydromorphone plasma concentration and the analgesic effect on supra-threshold nociceptive stimuli existed."

Conclusion

"A single oral dose of a new sustained release formulation of hydromorphone provided analgesia to experimental pain beyond 24 hours of its administration."

* Electrodiagnostic sensory test device: Neurometer® CPT/C

Painless Electrodiagnostic Current Perception Threshold and Pain Tolerance Threshold Values in CRPS Subjects and Healthy Controls: A Multi-Center Study

P. Prithvi Raj, M.D., et al

Dept. of Anesthesia, Texas Tech Health Sciences Center, Lubbock TX
and Eighteen Other Medical Centers

Introduction

“The purpose of this study is to evaluate both painless and painful sensory transmission in patients with Complex Regional Pain Syndrome (CRPS) using the automated electrodiagnostic sensory Nerve Conduction Threshold (sNCT) test. This test generates reliable, painless Current Perception Threshold (CPT) and automatic Pain Tolerance Threshold (PTT) measures.”

Methods

“Standardized CPT and PTT measures using constant alternating current sinusoid waveform stimulus at three different frequencies 5 Hz, 250 Hz and 2 kHz (Neurometer® CPT/C Neurotron, Inc. Baltimore, MD) were obtained from CRPS subjects at a distal phalange of the effected extremity and at an ipsilateral asymptomatic control site. Matched sites were tested on healthy subjects. Detection sensitivities for an abnormal PTT and CPT test was calculated based on specificity of 90% as determined from data obtained from healthy controls. A Spearman rank correlation was used to test for a significant association between presence of allodynia and an abnormal PTT or CPT at any frequency tested.”

Results

“Thirty-six CRPS subjects and fifty-seven healthy controls were tested. The highest detection sensitivity of the PTT test from symptomatic test sites was 63% for the finger and 71% for the toe. PTT abnormalities were also detected, to a lesser degree, at the asymptomatic control site (41% finger control site, 16% toe control site). The highest CPT detection sensitivity at the symptomatic site was 37% for the finger site and 53% for the toe site. CPT abnormalities were also detected at the asymptomatic control site (29% finger control site, 37% toe control site). Eighty-six percent of the CRPS subjects had either a PTT or CPT abnormality at any frequency at the symptomatic site. There was a significant correlation between presence of allodynia and presence of an abnormal CPT and PTT, respectively ($p < 0.01$). The correlation coefficient was lower for CPT than for PTT, i.e. 0.34 versus 0.6 for the finger and 0.48 versus 0.67 for the toe, respectively.”

Discussion

“CRPS patients displayed a greater number of abnormal PTT measures than abnormal CPT measures. Assessing PTT may become a useful electrodiagnostic quantitative sensory test for diagnosing and following the course of neuropathic pain conditions.”

Comparison of different quantitative sensory testing methods during remifentanyl infusion in volunteers

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Background

“The aim of this study was to compare thermal and current sensory testing stimuli with respect to opioid responsiveness.”

Methods

“Eighteen healthy volunteers were randomized in a placebo-controlled, double-blind crossover study to receive an infusion of remifentanyl 0.08 µg kg⁻¹ min⁻¹ or saline for 40 min. Test procedures included determination of pain perception thresholds (PPT) and pain tolerance thresholds (PTT) to heat, cold, and current at 5, 250 and 2000 Hz, at baseline and at the end of the infusion.”

Results

“Both current at 5 Hz (PPT 3.69 (SD 2.48) mA vs 2.01 (1.52) mA; PTT 6.42 (2.79) mA vs 3.63 (2.31) mA; P<0.001) and 250 Hz (PPT 4.31 (2.42) mA vs 2.89 (1.57) mA; PTT 7.08 (2.68) mA vs 4.81 (2.42) mA; P<0.001) and heat (PPT 47.4 (2.7)°C vs 45.2 (3)°C; PTT 51.1 (1.8)°C vs 49.7 (1.8)°C; P<0.05) detected a significant analgesic effect of remifentanyl compared with placebo. No analgesic effect was shown on cold or current at 2000 Hz. The magnitude of responsiveness of current stimuli at 5 Hz and 250 Hz was superior to heat stimuli.”

Conclusion

“Both current (5 and 250 Hz) and heat sensory testing detected a significant analgesic effect of a remifentanyl infusion compared with saline. There was more response to current testing.”

Quantitative Assessment of Differential Sensory Nerve Block After Lidocaine Spinal Anesthesia

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Virginia Mason Medical Center, Seattle, WA

Background

"Recent technology allows for quantitative and selective measurement of A beta (A β), A delta (A δ), and C fiber nerve transmission. To gain further insight into the physiology of differential block after lidocaine spinal anesthesia, we quantitatively measured function of these different fibers over time and correlated these measurements with regression of anesthesia to pinprick, touch, cold, and tolerance of tetanic electrical current (equivalent to surgical incision)."

Methods

"Six volunteers received lidocaine spinal anesthesia with 50 mg of lidocaine (5% in dextrose). Cutaneous current perception thresholds (CPT) at 2000 Hz, 250 Hz, and 5 Hz which stimulate A β , A δ , and C fibers, respectively, were determined at L2-L3 (medial aspect above knee) prior to and then every 10 minutes after spinal anesthesia. Dermatomal levels to pinprick, touch, and cold were assessed every 5 minutes after spinal anesthesia. Tolerance to tetanic electrical stimulus, equivalent to surgical incision, was assessed at L2-L3 every 10 minutes after spinal anesthesia."

Results

"Differential block was demonstrated by the sequential return of sensation to touch, pinprick, and cold at L2-L3. Recovery of function of A β , A δ , and C fibers correlated with return of sensation to touch ($R^2=0.7$, $p=0.03$), pinprick ($R^2=0.75$, $p=0.02$), and cold ($R^2=0.67$, $p=.04$) respectively. Loss of tolerance of surgical anesthesia corresponded to return of A β CPTs to baseline, whereas CPTs for A δ and C fibers were still elevated above baseline ($p=0.025$)."

Conclusions

"Differential sensory block during spinal anesthesia is due to different recovery profiles of A β , A δ and C fibers. Return of A β CPTs to baseline correlated with duration of surgical anesthesia as assessed with an electrical stimulation model."

Effects of electrical stimulation at different frequencies on perception and pain in human volunteers: Epidural versus intravenous administration of fentanyl

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Abstract

"This study was performed to determine whether epidural fentanyl produced segmental sensory changes to electrical stimulation at different frequencies. Eight healthy volunteers received fentanyl 1 µg/kg both intravenously and epidurally in a randomized, double-blind, cross-over fashion. Perception thresholds and amount of current required to elicit moderate pain (pain stimulation) at 5, 250, and 2000 Hz stimulation were measured at ipsilateral dermatomes C2 and L2 at 0, 5, 15, 30, 45, and 60 minutes after injection. Perceptions to 5, 250, and 2000 Hz stimulation were unaffected by either intravenous or epidural fentanyl ($p > 0.08$). Intravenous fentanyl increased pain stimulation at both 5 and 250 Hz at both dermatomes ($p < 0.004$) and thus did not produce segmental analgesia. In contrast, epidural fentanyl increased pain stimulation only at the L2 dermatome and only at 5 Hz ($p = 0.005$). We conclude that an epidural bolus of fentanyl results in segmental spinal analgesia to transcutaneous electrical stimulation only at specific frequencies. Furthermore, pain produced by stimulation at 5 Hz may have a different pharmacology than pain produced by 250 Hz stimulation."

Computer Controlled Lidocaine Infusion for the Evaluation of Neuropathic Pain after Peripheral Nerve Injury

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Background

"Systemic lidocaine has been reported to be effective in treating several neuropathic pain syndromes. Few reports relate plasma lidocaine concentration to analgesia and the available studies have been complicated by labile plasma lidocaine concentrations. We utilized a computer controlled infusion pump (CCIP) to target and maintain stable plasma lidocaine concentrations and study the effect of intravenous lidocaine on 1) pain sources, 2) current perception thresholds, 3) side effects, and 4) pain distribution in patients suffering from peripheral nerve injury pain."

Methods

"This study utilized a randomized double-blind placebo controlled design. Eleven patients suffering from neuropathic pain after a peripheral nerve injury received both a lidocaine and saline infusion in separate study sessions. The order of the study sessions was randomized and separated from each other by one week. The CCIP was programmed to target plasma lidocaine concentration of 0.5, 1, 1.5, 2, and 2.5 µg/ml, each held for 10 minutes. Pain scores and pain distribution was assessed in the painful area, and electrical current perception thresholds (CPT) of the ring finger were measured using a cutaneous perception threshold Neurometer (Neurometer CPT, Neurotron, Inc., Baltimore, MD). Plasma lidocaine concentrations were measured at 4 and 9 minutes after each step increase in infusion and correlated with the observed effects."

Results

"Saline infusion had no effect. However, with lidocaine there was a significant plasma concentration dependent decrease in pain scores starting at 1.5 µg/ml. This effect typically corresponded with a decrease in the size of the receptive field to which the pain was referred. For the electrical stimulus, there was no significant effect on cutaneous perception at 2000 Hz stimulation at the highest concentration examined, however, there was a significant increase in thresholds at 250 Hz (starting at 1.5 µg/ml) and 5 Hz (starting at 1.0 µg/ml) stimulation. There were no serious side effects."

Discussion

"The computer controlled delivery of intravenous lidocaine results in relatively stable plasma concentrations which allows a more thorough evaluation of the relationship between plasma concentration and patient response."

Quantitative Assessment of Differential Sensory Blockade After Lumbar Epidural Lidocaine

Wallace, M.S.,¹ Tay, B.,² Irving, G.³

¹ Assistant Clinical Professor, ² Pain Fellow, ³ Associate Clinical Professor
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Introduction

"Differential epidural blockade is frequently used in the evaluation of chronic pain syndromes, however, it has been met with much controversy.¹ With the crude sensory measurements used in the human studies, it is difficult to determine which fibers are blocked. Recent technological advances allow for the quantitative measurement of the functional integrity of both large and small diameter sensory fibers using a Current Perception Threshold (CPT) quantitative sensory testing device.^{2,3} We used this device to evaluate the existence of a differential blockade after the administration of epidural lidocaine."

Methods

"8 patients suffering from lower abdominal (1 subject) or lower extremity pain (7 subjects) received both lumbar epidural saline (control) and lidocaine...Serial CPTs and sensation to touch, pinprick, and cold at the following sites on the right side were measured at the: 1) mastoid process, 2) umbilicus, 3) anterior knee, 4) great toe; cephalad anesthetic level to touch, pinprick, and cold; and pain scores using a visual analog scale."

Results

"The administration of saline epidurally had no effect on any measures. The administration of 10 milliliters of 2% plain lidocaine epidurally caused an increase in all CPTs at the umbilicus and the knee reaching a statistical significance at 5 Hz for the umbilicus only. There was no effect on CPTs or sensory measures seen at the mastoid process. There was a significant decrease in touch, pinprick, and cold sensation at the umbilicus and knee."

Conclusion

"After epidural lidocaine, it appears possible to demonstrate a differential neural blockade utilizing a Current Perception Threshold device whereas it is not possible with crude sensory measurements. Further studies may allow for better utilization of the CPT device in the management of the pain patient."

Cardiovascular autonomic and peripheral sensory neuropathy in women with obesity

Keller N, Zádori J, Lippai B, Szöllősi D, Márton V, Wellinger K, Lada S, Szűcs M, Menyhárt A, Kempler P, Baczkó I, Várkonyi T, Lengyel C, Vágvölgyi A

Introduction:

A higher incidence of neural dysfunction in people with obesity has been described. We determined the prevalence of neuropathic lesions in obese women and evaluated their potential association with anthropometric and laboratory parameters.

Patients and methods:

In our cross-sectional study, we enrolled female patients with obesity and without diabetes before obesity treatment. Voluntary female subjects were controls with a normal body mass index (BMI). Autonomic function was assessed by Ewing's cardiovascular reflex tests, while comprehensive peripheral neuropathic assessments were conducted utilizing the Neurometer®, Tiptherm®, Monofilament®, and Rydel-Seiffer tuning fork tests. Sudomotor function was assessed by the Neuropad®-test. Body composition was examined using the InBody 770.

Results:

71 patients (mean $\pm$ SD; age: 36.1 ± 8.3 years; BMI: 40.2 ± 8.5 kg/m²) and 36 controls (age: 36.4 ± 13.3 years; BMI: 21.6 ± 2.1 kg/m²) were enrolled. Patients had significantly higher systolic (patients vs. controls; 137.5 ± 16.9 vs. 114.6 ± 14.8 mmHg, $p < 0.001$) and diastolic (83.0 ± 11.7 vs. 69.8 ± 11.2 mmHg, $p < 0.001$) blood pressure compared to controls. Among autonomic tests, only the heart rate response to Valsalva maneuver (Valsalva-ratio) revealed significant impairment in patients (1.4 ± 0.2 vs. 1.7 ± 0.4 , $p < 0.001$). Neurometer® at the median nerve revealed increased current perception threshold (CPT) values at all stimulating frequencies in patients (CPT at 2000 Hz: 204.6 ± 70.9 vs. 168.1 ± 66.9 , $p = 0.013$; 250 Hz: 84.4 ± 38.9 vs. 56.5 ± 34.8 , $p < 0.001$; CPT at 5 Hz: 58.5 ± 31.2 vs. 36.9 ± 29.1 , $p < 0.001$). The Rydel-Seiffer tuning fork test has revealed a significant impairment of vibrational sensing on the lower limb in patients (right hallux: 6.8 ± 0.9 vs. 7.4 ± 0.8 , $p = 0.030$; left hallux: 6.9 ± 0.8 vs. 7.3 ± 0.9 , $p = 0.029$). The Neuropad® testing showed a significant impairment of sudomotor function in women with obesity. A negative correlation was found in patients between BMI and the 25-hydroxy-D3/D2-vitamin levels ($r = -0.41$, $p = 0.00126$) and a positive correlation between the BMI and resting systolic blood pressure ($r = 0.26$, $p = 0.0325$).

Conclusion:

Peripheral sensory neuronal and sudomotor function impairments were detected in female patients with obesity compared to the controls with normal BMI. Cardiovascular autonomic dysfunction was also revealed by the Valsalva-ratio in these patients, suggesting the presence of parasympathetic dysfunction. The negative correlation between BMI and the 25-hydroxy-D3/D2-vitamin highlights the potential deficiency of vitamin D in the population affected by obesity.

Association of Cardiovascular Autonomic Neuropathy and Distal Symmetric Polyneuropathy with All-Cause Mortality: A Retrospective Cohort Study.

Orsolya E Vági, Márk M Svébis, Beatrix A Domján, Anna E Körei, Ildikó Istenes, Zsuzsanna Putz, Szilvia Mészáros, Noémi Hajdú, Magdolna Békeffy, Solomon Tesfaye, Péter Kempler, Viktor J Horváth, Adam G Tabák.

Background.

People with diabetic cardiovascular autonomic neuropathy (CAN) have increased cardiovascular mortality. However, the association between distal symmetric polyneuropathy (DSPN) or CAN with all-cause mortality is much less investigated. Thus, we set out to examine the effect of CAN and DSPN on all-cause mortality in a well-phenotyped cohort.

Methods

All diabetes cases ($n = 1,347$) from the catchment area of a secondary diabetes care centre who had medical examination including neuropathy assessment between 1997 and 2016 were followed up for all-cause mortality in the NHS Hungary reimbursement database until 2018. We investigated the association of CAN (Ewing tests) and DSPN (Neurometer) with all-cause mortality using Cox models stratified by diabetes type.

Results

Altogether, $n = 131/1,011$ persons with type 1/type 2 diabetes were included. Of the participants, 53%/43% were male, mean age was $46 \pm 12/64 \pm 10$ years, diabetes duration was $13 \pm 10/7 \pm 8$ years, 42%/29% had CAN, and 39%/37% had DSPN. During the $9 \pm 5/8 \pm 5$ -year follow-up, $n = 28/494$ participants died. In fully adjusted models, participants with type 1 diabetes patients with versus without DSPN had an increased mortality (HR 2.99, 95% CI 1.4-8.63), while no association with CAN was observed. In type 2 diabetes, both DSPN and CAN independently increased mortality (HR 1.32, 95% CI: 1.07-1.64, and HR 1.44, 95% CI: 1.17-1.76).

Conclusions

Our results are compatible with an increased risk of mortality in people with type 1 diabetes and DSPN. Furthermore, we report a similarly strong association between DSPN and CAN and all-cause mortality in type 2 diabetes mellitus.

Autonomic and peripheral neuropathy in primary biliary cirrhosis: evidence of small sensory fibre damage and prolongation of the QT interval

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Excerpt

"Hendrickse et. al. found abnormalities of autonomic and peripheral nerve function in primary biliary cirrhosis (PBC). We confirm their findings and report on small sensory fibre damage and prolongation of QT interval in PBC. Thirteen patients were examined (mean age, 60.3; range, 41-73 years; all females) with clinical, biochemical and histological evidence of PBC. Controls (C) were 14 healthy women (mean age, 55.9; range, 41-68 years). The five standard tests of cardiovascular autonomic function - heart rate response to deep breath (HRDB), standing (30/15 ratio) and Valsalva manoeuvre as well as blood pressure responses to standing and sustained handgrip - were evaluated. Corrected QT interval (QT_c) were determined with Bazett's formula. Sensory neuropathy was assessed by the Neurometer® CPT (Neurotron, Incorporated, Baltimore, USA). This method provides a simple, non-invasive and quantitative measure of peripheral sensory nerve function. Detection thresholds for constant current electric sine wave stimulation were measured at three different frequencies (2 kHz, 250 Hz, 5 Hz). Digital median and peroneal nerves were studied."

"Significant decrease of autonomic function was found in four reflex tests compared to controls ($p < 0.01$ for HRDB, 30/15 ratio and sustained handgrip, $p < 0.01$ for Valsalva ratio). Autonomic dysfunction (with one or more abnormal tests) was found in 77% (10/13) patients, similarly to our previous findings. Two patients had one, 5 had two and 3 had three abnormal tests. Current perception threshold (CPT) was significantly higher in PBC at 2 kHz at both sites ($p < 0.01$ for median and $p < 0.05$ for peroneal nerves) and at 5 Hz for peroneal nerve ($p < 0.05$). 9/13 patients (69%) had abnormal CPT values. Five patients had one abnormal parameter while 2, 3, 4 and 5 abnormal parameters were observed equally in one patient. Two kHz CPT values correlate significantly with tests of large fibre function and 5 Hz detection thresholds correlate significantly with tests of small fiber function. Thus, our data confirm the findings of Hendrickse et. al. in respect of large fibre damage and provides further evidence of small sensory fibre dysfunction in PBC. Evaluation of current perception threshold by the Neurometer® CPT maybe a simple and comprehensive way of assessing even early abnormalities of peripheral sensory nerve function in patients with PBC."

Baroreflex Sensitivity and Heart-rate Variability in Insulin-dependent Diabetics with Polyneuropathy

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Introduction

“The ATRAMI investigators (February 14, P 478) show that measurement of baroreceptor reflex sensitivity (BRS) is an appropriate way to identify patients after myocardial infarction who were at a high risk of cardiac death or a non-fatal cardiac arrest because of documented ventricular fibrillation. Autonomic imbalance, however, maybe associated with an increased risk of sudden death, even without myocardial infarction.”

Methods

“We analyzed the BRS and heart-rate variability (SDNN: standard deviation of normal-to-normal beats) in the resting supine position and after standing up in patients with long-standing insulin-dependent diabetes mellitus (IDDM) with autonomic and sensory neuropathy.”

“We enrolled 12 patients (six women, six men, mean age 47.8 [SD 15.9] years, duration of IDDM 26.8 [13.4] years...Peripheral sensory nerve function was characterized by current perception thresholds measured by a neuro-selective diagnostic stimulator on the peroneal and median nerves, which permits transcutaneous testing at three sinusoidal frequencies (2000, 250, and 5 Hz) of electrical stimulus.”

Results/Conclusion

Neuropathy Indices (1.0 = 1.00 mAmpere)			
Peripheral Sensory Function CPT (Hz)	IDDM Patients	Controls	P
Median Nerve	Mean (SD)	Mean (SD)	
2000 Hz	4.1 (2.1)	2.7 (0.6)	0.010
250 Hz	3.3 (3.5)	1.0 (0.4)	0.040
5 Hz	2.3 (3.3)	0.5 (0.2)	0.030
Peroneal Nerve	Mean (SD)	Mean (SD)	
2000 Hz	6.6 (3.1)	3.5 (0.7)	0.019
250 Hz	5.0 (3.8)	1.6 (0.5)	0.007
5 Hz	3.0 (3.3)	0.7 (0.2)	0.002

“...the IDDM patients with polyneuropathy displayed a severely impaired cardiovascular adaptation mechanism. The decreases in heart-rate variability and BRS probably contribute to the poor prognosis of acute myocardial infarction in diabetic patients.”

Correlation between peripheral neuropathic hyperesthesia and body fat composition and thyroid function in patients with type 2 diabetes mellitus

Zhang Bilin, Han Pingping, Zhang Yu, Xiang Shiqiang, Xiang Guangda

Objective

To investigate the effect of body fat composition and thyroid function on peripheral neuropathy in patients with type 2 diabetes mellitus (T2DM)

Methods

A total of 100 patients with type 2 diabetes mellitus (T2DM) who underwent glycemic management at the author's hospital from August 2020 to August 2021 were selected as study subjects. Based on the results obtained from the quantitative sensory nerve testing device, patients with a range current perception threshold (R-CPT) within the normal range were included in the control group (n=49), while those with R-CPT below the normal range were assigned to the hyperalgesia group (n=51). Both groups of T2DM patients underwent biochemical tests, thyroid function analysis, body composition analysis (including body fat content, body fat percentage, visceral fat area, etc.), and R-CPT measurement. The differences in body fat composition and thyroid function between the two groups were compared, and the correlation between 2000 Hz, 250 Hz, and 5 Hz R-CPT and body fat composition was analyzed.

Results

The body mass index (BMI), body fat content, body fat percentage, visceral fat area, trunk fat mass, lower limb fat mass, and free thyroxine (FT4) in the hypersensitivity group of T2DM patients were all higher than those in the control group (all $P < 0.05$). In T2DM patients, 2000Hz R-CPT was negatively correlated with BMI, waist circumference, waist-to-hip ratio, FT4, visceral fat area, and HCY ($P < 0.05$), while 250Hz R-CPT was negatively correlated with FT4 ($P < 0.05$). 5Hz R-CPT showed no significant correlation with any body composition parameters ($P > 0.05$). Logistic regression analysis revealed that body fat content and FT4 were risk factors for peripheral neuropathy in T2DM patients ($P < 0.05$).

Conclusion

In the pre-neuropathy stage of T2DM patients, obesity and high body fat content are significant factors influencing the progression of peripheral neuropathy.

Comprehensive Assessment of Neuropathy and Metabolic Parameters in Type 1 Diabetic Patients with or Without Using Continuous Glucose Sensors.

Bordács B, Várkonyi Á, Valkusz Z, Nyiraty S, Pósa A, Menyhárt A, Lengyel C, Kempler P, Kupai K, Várkonyi T.

Abstract:

The present study was conducted in type 1 diabetic (T1DM) patients to evaluate the metabolic and glycemic control as well as the manifestations of neuropathy. The impact of continuous glucose monitoring (CGM) on the measured parameters was also analyzed. A total of 61 T1DM patients (age: 42.5 ± 1.8 years, DM duration: 22.8 ± 1.6 years, mean $\pm$ SE) participated in the study. In total, 24 patients had CGM sensors and 37 did not. Cardiovascular autonomic neuropathy was assessed using cardiovascular reflex tests. Peripheral sensory function was evaluated by a Neurometer and calibrated tuning fork on the upper and lower limbs. Metabolic status was characterized by the determination of triglycerides, high-density lipoprotein (HDL), low-density lipoprotein (LDL), total cholesterol, and glycated haemoglobin (HbA1c). A positive correlation was found between HbA1c and triglyceride levels ($r = 0.28$, $p < 0.05$). CGM users and non-users differed in triglyceride (0.9 ± 0.1 vs. 1.24 ± 0.12 mmol/L, $p < 0.05$), HDL cholesterol (1.7 ± 0.1 vs. 1.4 ± 0.1 p < 0.05 mmol/L), and HbA1c (7.5 ± 0.2 vs. $8.3 \pm 0.3\%$, $p < 0.05$) levels as well. Significant differences were found for the Valsalva ratio, Neurometer, and calibrated tuning fork results between CGM users and non-users. This study found a significant correlation between HbA1c and triglyceride levels in T1DM. CGM use resulted in improved metabolic parameters and less autonomic and sensory nerve damage. As a novel finding, CGM is presumed to prevent both micro-, and macrovascular complications and, by this way, potentially reducing mortality rates

Establishment of a risk regression equation for type 2 diabetes mellitus peripheral neuropathy based on multivariate regression analysis.

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Medical College

Objective

The risk regression equation of diabetic peripheral neuropathy (DPN) was established based on the results of multi-factor Logistic regression analysis.

Methods

A retrospective study was conducted on clinical data of 110 patients with type 2 diabetes mellitus (T2DM) admitted to the Affiliated Hospital of Weifang Medical University from March 2021 to March 2024. Based on the presence or absence of peripheral neuropathy (DPN), the patients were divided into the T2DM group (n=82, pure T2DM) and the DPN group (n=28, with DPN). The clinical characteristic indicators of the two groups were compared, and a multivariate logistic regression analysis was performed to identify the associated factors of T2DM complicated by DPN, establishing a risk regression equation for DPN.

Results

The DPN group exhibited significantly higher levels of age, proportion of patients with a history of hypertension, insulin resistance index (homeostatic model assessment of insulin resistance, HOMA-IR), fasting plasma glucose (FPG), glycated hemoglobin A1c (HbA1c), and serum Wnt1-inducible signaling pathway protein 1 (WISP1) compared to the T2DM group, with all differences being statistically significant ($P < 0.05$). Multivariate logistic regression analysis revealed that serum WISP1, HOMA-IR, FPG, and HbA1c were associated with the development of DPN in T2DM patients (all $P < 0.05$). Based on the results of multivariate logistic regression analysis, a risk regression equation for T2DM complicated by DPN was established as $Y = 0.454 + 1.333 \times (\text{HOMA-IR}) + 0.895 \times (\text{FPG}) + 1.904 \times (\text{HbA1c}) + 1.150 \times (\text{serum WISP1})$. The area under the curve (AUC) for DPN prediction by this equation was 0.837, with sensitivity and specificity of 0.857 and 0.659, respectively.

Conclusions

Serum WISP1, HOMA-IR, FPG, and HbA1c are risk factors for T2DM complicated with DPN. The risk regression equation established based on these factors can help assess the risk of DPN.

C-peptide: an essential ally in microvascular complications of type 2 diabetes mellitus and obesity

Esze R, Barna S, Fülöp P, Kempler P, Mikó M, Páll D, Paragh G, Somodi S, Emri M, Képes Z, Garai I, Káplár

Abstract

Background

In order to investigate microvascular complications in metabolic diseases, we aimed to investigate cerebral and peripheral microcirculation in relation to peripheral neuropathy and laboratory biomarkers in type 2 diabetes mellitus (T2DM) and obesity.

Methods

Based on the degree of neuropathy (NP), study participants (40 T2DM and 30 obese individuals) were classified into no-NP, mild-NP and severe-NP subgroups. After the injection of Technetium-99 m hexamethylpropylene amine oxime, both T2DM and obese participants underwent single-photon emission computed tomography/computed tomography ([99mTc]Tc-HMPAO SPECT/CT) and SPECT-only examinations to assess lower limb and brain perfusion; respectively. Peripheral nerve function was evaluated with a neurometer and glycaemic markers were measured from plasma in both groups.

Results

Compared to the obese individuals, lower extremity perfusion was significantly reduced in the diabetic subjects ($p < 0.005$), while it showed a positive correlation with C-peptide levels and negative association with HbA1c values. A U-shape pattern of peripheral microcirculation was observed between the NP groups, indicating a surprisingly better perfusion in the severe-NP group than in the mild one, with the highest levels in obese patients. Since changes in the C-peptide levels exhibited a similar U-shaped trend across the NP subgroups, we suggest a positive correlation between C-peptide levels and the extent of peripheral perfusion. Although, C-peptide values and cerebral microcirculation correlated positively ($\rho = 0.27$), brain perfusion did not show any differences neither between the diabetic and the obese patients, nor between the NP subgroups (at $p < 0.05$).

Conclusions

Establishing the link between neuropathy and peripheral microcirculation, C-peptide seems to be a promising biomarker for the prediction of microvascular alterations in metabolic diseases. Of note, the dominance of metabolic factors over microvascular damage in the development of obesity-related neuropathy should be emphasized as well.

Efficacy of Semaglutide Combination with Metformin in the Treatment of Diabetic Peripheral Neuropathy and Its Impact on Body Weight.

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Objective

To investigate the efficacy of semaglutide combined with metformin in the treatment of type 2 diabetes mellitus complicated by peripheral neuropathy (DPN) and its effect on body weight.

Methods

This prospective study enrolled 80 patients with diabetic peripheral neuropathy (DPN) who received treatment at Heilongjiang Provincial Hospital from January 2023 to February 2024. The patients were randomly assigned to an observation group (n=40) or a control group (n=40) using a random number table. The observation group received metformin + mecobalamin + semaglutide, while the control group received metformin + mecobalamin. The treatment duration was 6 weeks. The clinical efficacy of both groups was compared, including pre-treatment and post-6-week treatment blood glucose-related parameters [fasting blood glucose and 2-hour postprandial blood glucose (2hPG), glycated hemoglobin (HbA1c), insulin resistance index (HOMA-IR)], body mass index (BMI), Toronto Clinical Score System (TCSS) score, current sensory threshold (CPT) of bilateral median and common peroneal nerves, and bilateral gastrocnemius nerve conduction velocity (CV).

Results

The total effective rate in the observation group was 95.00%, significantly higher than that in the control group (80.00%), with a statistically significant difference ($P<0.05$). After 6 weeks of treatment, the blood glucose-related indicators (fasting blood glucose, 2hPG, HbA1c, and HOMA-IR) in the observation group were significantly lower than those in the control group, with statistically significant differences ($P<0.05$). After 6 weeks of treatment, the BMI and TCSS scores in the observation group were (24.68 ± 1.19) kg/m² and (7.72 ± 1.23) points, respectively, both significantly lower than those in the control group [(25.60 ± 1.22) kg/m², (9.34 ± 1.17) points], with statistically significant differences ($P<0.05$). After 6 weeks of treatment, the CPTs of the left median nerve, right median nerve, left common peroneal nerve, and right common peroneal nerve at 2000, 250, and 5 Hz in the observation group were significantly lower than those in the control group, with statistically significant differences ($P<0.05$). After 6 weeks of treatment, the NCVs of the left gastrocnemius nerve and right gastrocnemius nerve in the observation group were (45.62 ± 4.51) m/s and (43.79 ± 4.17) m/s, respectively, both significantly higher than those in the control group [(39.06 ± 4.05) , (40.36 ± 4.01) m/s], with statistically significant differences ($P<0.05$).

Conclusions

Semaglutide combined with metformin demonstrates favorable efficacy in the treatment of diabetic peripheral neuropathy (DPN), effectively controlling blood glucose and body weight, significantly improving clinical symptoms and insulin resistance, enhancing nerve conduction velocity, and reducing damage to sensory nerve subtypes

Study on mechanism of nerve fiber injury in diabetic neuropathy

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Objective

To explore the relationship between different nerve fiber injuries and the high sensitivity C reactive protein, to identify the type of nerve fiber injuries in patients with type 2 diabetic peripheral neuropathy by the sensory nerve quantitative detector.

Methods

The study enrolled 246 participants with type 2 diabetes admitted in Endocrine Department of The Second Artillery General Hospital PLA from March, 2020 to December, 2021. The participants were divided into 4 groups according to their medical history, clinical symptoms, signs and the performance of diabetic peripheral neuropathy, combined with the quantitative sensory detector test results. The patients were divided into Group without peripheral neuropathy (60 cases), Group with coarse myelinated nerve fibers lesion (60 cases), Group with fine myelinated nerve fibers lesion (59 cases) and Group without myelinated nerve fibers lesion (59 cases). All of the patients' gender, age, blood pressure, body mass index (BMI), duration of diabetes and blood biochemical values were obtained. The changes of high sensitivity C reactive protein were observed between groups. And the analysis of variance and multiple χ^2 test were adopted for the comparison between groups. Then, all subjects were evaluated based on Self-Rating Depression Scale (SDS) and Self-Rating Anxiety Scale (SAS).

Results

hs-CRP was (5.76 ± 5.21) mg/L in crude pulp group, (4.07 ± 3.77) mg/L in fine pulp group, (3.83 ± 3.49) mg/L in non-pulp group and (2.75 ± 2.34) mg/L in non-neuropathy group, respectively. hs-CRP in coarse pulp group was significantly higher than that in fine pulp group, no pulp group and no neuropathy group ($P < 0.05$). The CPT of each group was (20.16 ± 6.64) in the coarse pulp group, (16.78 ± 4.66) in the fine pulp group, (17.02 ± 4.61) in the non-pulp group, and (9.19 ± 1.85) in the non-neuropathy group, which was significantly higher in the neuropathy group than in the non-neuropathy group ($P < 0.05$). There were no significant differences in CPT among neuropathy groups ($P > 0.05$). Two-factor correlation analysis indicated that hs-CRP was positively correlated with CPT in the crude pulp group (r value = 0.885, $P < 0.01$). SDS and SAS in the crude pulp group were (32.8 ± 9.4) and (31.2 ± 9.9), respectively. Fine pulp group (43.8 ± 8.2), (42.2 ± 8.6); No pulp group (50.6 ± 10.8), (50.6 ± 10.8); without neuropathy group (52.3 ± 11.5), (51.0 ± 11.6).

Conclusion

hs-CRP may play a role in the pathogenesis of coarse myelinated nerve fibers lesions. The peripheral neuropathy of coarse myelinated nerve fiber damage in type 2 diabetic may be associated with vascular injuries.

Effect of modified Huangqi Guizhi Wuwu decoction combined with traditional Chinese medicine foot bath on diabetic peripheral neuropathy and its influence on current perception threshold

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Objective

To study the effect of modified Huangqi Guizhi Wuwu decoction combined with traditional Chinese medicine foot bath in the treatment of diabetic peripheral neuropathy and its influence on current perception threshold (CPT).

Methods

A total of 100 patients with diabetic peripheral neuropathy admitted in our hospital from January 2020 to January 2021 were selected and randomly divided into control group and observation group by coin tossing method, with 50 cases in each group. The control group was treated with conventional mecobalamin, and the observation group was treated with modified Huangqi Guizhi Wuwu decoction combined with traditional Chinese medicine foot bath. The therapeutic effects of the two groups were compared.

Results

The total effective rate of treatment in the observation group was higher than that in the control group ($P<0.05$). The duration of foot ulcer granulation tissue and foot ulcer healing time in the observation group were shorter than those in the control group, and the Visual Analogue Score (VAS) score was lower than that in the control group ($P<0.05$). After treatment, the neurological symptoms, nerve reflex, sensory function scores and Toronto Clinical Scoring System (TCSS) total scores of the two groups decreased, and those in the observation group were lower than the control group ($P<0.05$). The CPT of median nerve, ulnar nerve, superficial peroneal nerve and sural nerve in the observation group were lower than those in the control group at 5, 250 and 2 000 Hz ($P<0.05$). After treatment, the levels of tumor necrosis factor- α (TNF- α), interleukin-6 (IL-6) and C reactive protein (CRP) in the two groups decreased, and those in the observation group were lower than the control group ($P<0.05$).

Conclusion

The modified Huangqi Guizhi Wuwu decoction combined with traditional Chinese medicine foot bath has a significant clinical effect on patients with diabetic peripheral neuropathy.

Plantar pressure changes in diabetic peripheral neuropathy and its relationship with nerve conduction, sensory current thresholds and inflammatory factors

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Aim

To investigate the plantar pressure changes in diabetic peripheral neuropathy (DPN) and its relationship with nerve conduction, sensory current thresholds and inflammatory factors. Methods 590 cases with type 2 diabetes

mellitus

complicated with DPN were included and divided into a control group (no diabetic foot, n = 320) and an observation group (diabetic foot, n = 270) according to whether they had a diabetic foot or not. Another healthy population with physical examination at the same time was included as a blank group (n = 150). Fasting blood glucose (FBG), 2 h postprandial blood glucose (2 hPG), glycated hemoglobin (HbA1c), blood fat, peak pressures in different areas of the plantar foot, motor/ sensory nerve conduction velocity (NCV), current sensory threshold (CPT), and levels of inflammatory factors [interleukin-1 β (IL-1 β), IL-10, tumor necrosis factor- α (TNF- α) and macrophage inflammatory protein-1 α (MIP-1 α)] were compared in each group. The correlation of plantar pressure changes with nerve conduction, sensory current thresholds, and inflammatory factors was analyzed.

Results

Peak plantar pressure, FBG, 2 hPG, IL-1 β , IL-10, TNF- α , MIP-1 α , HbA1c and CPT levels in different regions of the plantar foot in the blank, control, and observation groups were sequentially increased, and NCV was sequentially decreased ($P < 0.05$). Pearson correlation analysis showed that IL-1 β , IL-10, NCV, CPT, TNF- α and MIP-1 α were positively correlated with plantar pressure in different areas of the plantar foot ($P < 0.05$).

Conclusion

Elevated peak plantar pressures in patients with DPN are closely related with nerve conduction, sensory current thresholds, and inflammatory factors, and may provide a clinical reference

No clear evidence of neuropathy among patients with high risk for the development of prediabetes/diabetes-a pilot study

Anna E Körei, Magdolna Békeffy, Adrienn Menyhárt, Karola Osgyán, Ildikó Istenes, Viktor J Horváth, Péter Kempler

Introduction

Autonomic and sensory neuropathy have been observed in both prediabetes and manifest diabetes mellitus. However, there is a lack of available data regarding whether patients at a moderate or high risk of developing diabetes, yet without a current diagnosis of prediabetes or diabetes, exhibit an increased prevalence of neuropathy.

Methods

FINDRISC (Finnish Diabetes Risk Score) was used to classify individuals at risk (≥ 12 points, $n = 44$; control < 12 points, $n = 28$). HbA1c levels $> 5.6\%$ served as exclusion criteria, and patients with known medical conditions predisposing to neuropathy were also excluded. Cardiac autonomic function (Ewing tests) and peripheral sensory neuropathy (Neurometer and Q-sense) were assessed by standardized protocols, and their potential association with increased FINDRISC points was analyzed using a regression model.

Results

Mean age was 46.7 ± 14.3 years in the control and 55.7 ± 14.1 years in the increased risk group. Male/female ratio did not differ. Individuals with increased risk of diabetes were more obese (BMI: 29.9 ± 12.5 kg/m² vs. 25.9 ± 8.9 kg/m²). Additionally, hypertension was more frequent among them (68.2% vs. 17.9%), and their lipid parameters were also less favorable. Parasympathetic neuropathy was present in both groups (56.8% vs. 32.1%, respectively). Sympathetic neuropathy was not found. Sensory nerve dysfunction was of low prevalence in the high-risk group and did not occur in healthy controls. In multiple logistic regression analysis, HbA1c exhibited an independent association with parasympathetic neuropathy (OR: 5.9; 95% CI: 1.08-32.68; $p < 0.041$).

Discussion

An increased risk of developing prediabetes/diabetes does not appear to have a strong correlation with an increased likelihood of developing autonomic or sensory neuropathy. However, the etiology behind the occurrence of parasympathetic autonomic neuropathy in healthy individuals remains unknown.

Genetic Factors Associated with the Development of Neuropathy in Type 2 Diabetes.

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Abstract

Neuropathy is a serious and frequent complication of type 2 diabetes (T2DM). This study was carried out to search for genetic factors associated with the development of diabetic neuropathy by whole exome sequencing. For this study, 24 patients with long-term type 2 diabetes with neuropathy and 24 without underwent detailed neurological assessment and whole exome sequencing. Cardiovascular autonomic function was evaluated by cardiovascular reflex tests. Heart rate variability was measured by the triangle index. Sensory nerve function was estimated by Neurometer and Medoc devices. Neuropathic symptoms were characterized by the neuropathy total symptom score (NTSS). Whole exome sequencing (WES) was performed on a Thermo Ion GeneStudio S5 system determining the coding sequences of approximately 32,000 genes comprising 50 million base pairs. Variants were detected by Ion Reporter software and annotated using ANNOVAR, integrating database information from dbSNP, ClinVar, gnomAD, and OMIM. Integrative genomics viewer (IGV) was used for visualization of the mapped reads. We have identified genetic variants that were significantly associated with increased (22–49-fold) risk of neuropathy (rs2032930 and rs2032931 of recQ-mediated genome instability protein 2 (RMI2) gene), rs604349 of myosin binding protein H like (MYBPHL) gene and with reduced (0.07–0.08-fold) risk (rs917778 of multivesicular body subunit 12B (MVB12B) and rs2234753 of retinoic acid X receptor alpha (RXRA) genes). The rs2032930 showed a significant correlation with current perception thresholds measured at 5 Hz and 250 Hz for n. medianus ($p = 0.042$ and $p = 0.003$, respectively) and at 5 Hz for n. peroneus ($p = 0.037$), as well as the deep breath test ($p = 0.022$) and the NTSS ($p = 0.023$). The rs2032931 was associated with current perception thresholds ($p = 0.003$ and $p = 0.037$, respectively), deep breath test ($p = 0.022$), and NTSS ($p = 0.023$). The rs604349 correlated with values measured at 2000 ($p = 0.049$), 250 ($p = 0.018$), and 5 Hz ($p = 0.005$) for n. medianus, as well as warm perception threshold measured by Medoc device ($p = 0.042$). The rs2234753 showed correlations with a current perception threshold measured at 2000 Hz for n. medianus ($p = 0.020$), deep breath test ($p = 0.040$), and NTSS ($p = 0.003$). There was a significant relationship between rs917778 and cold perception threshold ($p = 0.013$). In our study, genetic variants have been identified that may have an impact on the risk of neuropathy developing in type 2 diabetic patients. These results could open up new opportunities for early preventive measures and might provide targets for new drug developments in the future.

Clinical efficacy of oral administration of modified *Saposhnikovia miltiorrhiza* decoction combined with transcutaneous electrical stimulation on diabetic peripheral neuropathy with yin deficiency and fire hyperactivity and its effects on nerve function and oxidative stress index.

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The Third Affiliated Hospital of Henan University of Chinese Medicine

Objective

To observe the efficacy of modified Sangpi Decoction combined with transcutaneous electrical stimulation on diabetic peripheral neuropathy (DPN) with yin deficiency and fire hyperactivity syndrome, and to evaluate its effects on nerve function and oxidative stress indicators.

Methods

A total of 112 patients with DPN (diabetic polyneuropathy) diagnosed with yin deficiency and fire excess syndrome, admitted to Zhengzhou Hospital of Traditional Chinese Medicine and the Third Affiliated Hospital of Henan University of Chinese Medicine, were enrolled. They were divided into two groups according to the order of consultation, with 56 cases in each group. The control group received mecobalamin tablets (0.5 mg per dose, 3 times daily, orally) and intravenous infusion of lipoic acid injection (0.6 g dissolved in 150 mL of normal saline, once daily). The treatment group received oral administration of modified Sangpi Decoction (composed of mulberry bark, kudzu root, coptis, astragalus, bupleurum, dogwood bark, safflower, salvia, corydalis, chicken blood vine, asparagus, ophiopogon, aconite, licorice tablets) in addition to the control group's treatment. The decoction was prepared by boiling 1 inch of scallion white in 100 mL of water (1 dose daily). Simultaneously, percutaneous electrical stimulation was applied to six acupoints alternately (Shousanli, Hegu, Shaohai, Waiguan, Zusanli, Sanyinjiao, Yanglingquan, Xuehai, Taixi, Chengshan, Fenglong, and Ashi) for 20–30 minutes per session, once daily. The efficacy of both groups was evaluated after 8 consecutive weeks of treatment.

Results

In the treatment group, 32 cases showed marked improvement, 20 cases were effective, and 4 cases were ineffective, with an effective rate of 92.86% (52/56). In the control group, 20 cases showed marked improvement, 24 cases were effective, and 12 cases were ineffective, with an effective rate of 78.57% (44/56). The comparison between the two groups was statistically significant ($P < 0.01$). After treatment, the scores for neurological symptoms, neurological reflexes, sensory function, and the total Toronto Clinical Symptom Scale (TCSS) were significantly reduced in both groups, with the treatment group showing lower scores than the control group, and the difference was statistically significant ($P < 0.01$). The serum ferritin (SF) and malondialdehyde (MDA) levels were significantly reduced in both groups, with the treatment group showing lower levels than the control group, and the difference was

statistically significant ($P<0.01$). The serum superoxide dismutase (SOD) and reduced glutathione (GSH) levels were significantly increased in both groups, with the treatment group showing higher levels than the control group, and the difference was statistically significant ($P<0.01$). At frequencies of 5 Hz, 250 Hz, and 2000 Hz, compared with the control group, the current sensory thresholds (CPT) of the median nerve, ulnar nerve, superficial peroneal nerve, and gastrocnemius nerve in the treatment group were significantly reduced, with the difference being statistically significant ($P<0.01$).

Conclusion

The modified oral administration of *Saposhnikovia miltiorrhiza* decoction combined with transcutaneous electrical acupoint stimulation demonstrates definitive efficacy in treating DPN with yin deficiency and fire excess syndrome. It effectively alleviates clinical symptoms, reduces oxidative stress responses, enhances the body's antioxidant capacity, and mitigates damage to sensory nerve subpopulations, warranting further clinical investigation.

Clinical Application of Sensory Nerve Conduction Threshold Assessment in the Diagnosis of Diabetic Peripheral Neuropathy

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Objective

To analyze the clinical efficacy of sensory nerve conduction threshold assessment in the diagnosis of peripheral neuropathy in diabetic patients.

Methods

A total of 719 patients with type 2 diabetes mellitus admitted to the hospital from April 2018 to June 2019 were selected as the primary study subjects. Based on the presence of peripheral neuropathy, the patients were divided into a neuropathic group and a non-neuropathic group. The sensory nerve conduction thresholds of the two groups were compared at different frequencies.

Results

The sensory nerve conduction threshold assessment demonstrated diagnostic efficacy in both patient groups. Notably, significant differences in sensory nerve conduction thresholds were observed between the two groups at various frequencies, with the lesion group showing markedly higher values compared to the non-lesion group. The comparative differences between the two groups were statistically significant ($P < 0.05$).

Conclusion

In the diagnosis of peripheral neuropathy in diabetic patients, the application of sensory nerve conduction threshold assessment can effectively improve the accuracy of lesion diagnosis. It is of significant importance for predicting disease progression and early detection of complications such as foot ulcers, making it worthy of clinical promotion and application.

Peripheral and Autonomic Neuropathy Status of Young Patients With Type 1 Diabetes Mellitus at the Time of Transition From Pediatric Care to Adult-Oriented Diabetes Care.

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Introduction:

The prevalence of neuropathic lesions in young patients with type 1 diabetes mellitus (T1DM) at the time of transition from pediatric care to adult-oriented diabetes care is poorly studied. A comparative study with healthy volunteers to assess the possible neuropathic condition of this special population and to identify the potential early screening needs has not been performed yet. The results may provide important feedback to pediatric diabetes care and a remarkable baseline reference point for further follow up in adult diabetes care.

Patients and methods:

Twenty-nine young patients with T1DM [age: 22.4 ± 2.9 years; HbA1c: $8.5 \pm 2.1\%$, diabetes duration: 12.2 ± 5.8 years; (mean $\pm$ SD)] and 30 healthy volunteers (age: 21.5 ± 1.6 years; HbA1c: $5.3 \pm 0.3\%$) were involved in the study. Autonomic function was assessed by standard cardiovascular reflex tests. Complex peripheral neuropathic testing was performed by Neurometer®, Neuropad®-test, Tiptherm®, Monofilament®, and Rydel-Seiffer tuning fork tests.

Results:

T1DM patients had significantly higher diastolic blood pressure than controls (80 ± 9 vs. 74 ± 8 mmHg, $p < 0.01$), but there was no significant difference in systolic blood pressure (127 ± 26 vs. 121 ± 13 mmHg). Cardiovascular reflex tests had not revealed any significant differences between the T1DM patients and controls. No significant differences with Neurometer®, Neuropad®-test, and Monofilament® were detected between the two groups. The vibrational sensing on the radius on both sides was significantly impaired in the T1DM group compared to the controls with Rydel-Seiffer tuning fork test (right: 7.5 ± 1.0 vs. 7.9 ± 0.3 ; left: 7.5 ± 0.9 vs. 7.9 ± 0.3 , $p < 0.05$). The Tiptherm®-test also identified a significant impairment in T1DM patients (11 sensing failures vs. 1, $p < 0.001$). In addition, the neuropathic complaints were significantly more frequently present in the T1DM patient group than in the controls (9 vs. 0, $p < 0.01$).

Conclusion:

In this young T1DM population, cardiovascular autonomic neuropathy and cardiac morphological alterations could not be found. However, Rydel-Seiffer tuning fork and Tiptherm®-tests revealed peripheral sensory neurological impairments in young T1DM patients at the time of their transition to adult diabetes care.

Correlation between lower extremity arterial disease in patients with type 2 diabetes mellitus and current perception Threshold

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Objective

To detect the current perception threshold (CPT) of patients with type 2 diabetes mellitus to analyze the correlation between lower extremity arterial disease and lower extremity nerve injury at early diabetes mellitus.

Methods

A total of 130 patients with type 2 diabetes mellitus were enrolled in the study. The blood lipid levels including TC, TG, HDL, LDL and glycometabolism indexes including FBG and HbA1C were detected, moreover, the ultrasonic artery examination and sensory nerve quantitate detection were performed. In addition the CPT values in both lower extremities shallow peroneal nerve and deep peroneal nerve at 2, 000Hz, 250Hz, 5Hz were measured. Then according to whether the patients had blood lipid abnormality or lower extremity arterial disease, these patients were divided into four groups.

Results

The CPT values in both lower extremities shallow peroneal nerve and deep peroneal nerve at 5Hz in blood lipid abnormality group were significantly higher than those in normal blood lipid group ($P < 0.01$). Moreover the CPT values in both lower extremities shallow peroneal nerve and deep peroneal nerve at 250Hz and 5Hz in lower extremity arterial disease group were significantly higher than those in non lower extremity arterial disease group ($P < 0.01$).

Conclusion

CPT detection can early discover sensory nerve lesion of patients with type 2 diabetes mellitus, and dyslipidemia and lower extremity arterial disease may accelerate the occurrence and development of both lower extremities DPN.

Clinical significance of evaluation of current perception threshold in early diagnosis and intervention of type 2 diabetic peripheral neuropathy.

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Objective

To detect current perception threshold (CPT) of patients with type 2 diabetes mellitus to screen out the patients with early diabetic peripheral neuropathy (DPN), and to analyze the severity of large and small fiber nerve damage in order to provide theoretical basis for early diagnosis and intervention of DPN.

Methods

A total of 130 patients with type 2 diabetes mellitus were enrolled in the study. The serum levels of TC, TG, HDL, LDL, FBG, HbA1c were detected, and sensory nerve was quantitatively detected. Moreover the CPT value in four limbs at 2, 000Hz, 250Hz, 5Hz were measured. According to CPT, these patients were divided into two groups: normal CPT group and abnormal CPT group. Then the blood lipid levels, glycometabolism parameters and CPT value were observed and compared between two groups to analyze the influencing factors on early DPN.

Results

Among 130 patients, 85 patients had sensory nerve damages, and the levels of BMI, TC, LDL, FBG, HbA1c in sensory nerve damage group were significantly higher than those in control group ($P < 0.05$ or $P < 0.01$), moreover the CPT values in four limbs at 250Hz and 5Hz frequency were significantly higher than those in control group ($P < 0.01$). Binary Logistic regression analysis showed that TC and HbA1c were independently related to the DPN (OR = 45.052, 13.499, respectively, $P < 0.01$).

Conclusion

The CPT detection can early find out sensory nerve damages of patients with type 2 diabetes mellitus, which often display damages of small fiber nerve. Moreover the higher levels of TC and HbA1c are independent risk factors of early DPN.

Therapeutic effects of compound Danshen dripping pills on early peripheral neuropathy in patients with type 2 diabetes mellitus.

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Objective

To observe the therapeutic effects of compound Danshen dripping pills on early diabetic peripheral neuropathy (DPN) in patients with type 2 diabetes mellitus.

Methods

A total of 130 patients with type 2 diabetes mellitus were enrolled in the study, who underwent sensory nerve quantitative detection, and the current perception threshold (CPT) of four limbs at 2000Hz, 250Hz, 5Hz were measured. According to whether CPT was abnormal, these patients were divided into normal sensory nerve group (control group) and sensory nerve injury group, and the patients in both groups were treated by basic treatment of anti-diabetes. Moreover sensory nerve injury group was redivided into mecobalamine treatment group and combination treatment group, the patients in mecobalamine treatment group and combination treatment group, on the basis of control group, were treated by mecobalamine, and the patients in combination treatment group, on the basis of mecobalamine treatment group, were treated by compound Danshen dripping pills, with a treatment course of 6 months for the three groups.

Results

After treatment the CPT value was obviously improved in mecobalamine treatment group and combination treatment group ($P < 0.05$ or $P < 0.01$). The therapeutic effects in combination treatment group were superior to those in mecobalamine treatment group ($P < 0.05$ or $P < 0.01$).

Conclusion

The compound Danshen dripping pills can effectively reduce CPT value of damaged sensory nerve so as to improve DPN of patients with type 2 diabetes mellitus.

Rules of TCM in Treating Tumor-Related Sleep Disorders.

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Objective

To study the rules of TCM in the treatment of tumour-related sleep disorders based on the medical literature database.

Methods

By searching CNKI database, Wanfang database and Chinese biomedical literature database, the literature research database of TCM treatment of cancer-related insomnia was constructed. SPSS 24. 0 statistical software was used for analysis and statistics.

Results

There were 114 kinds of drugs used to treat tumour-related insomnia, 498 times in total. Among them, TCM was mainly classified as tonifying medicinal, tranquilizing medicinal, heat-clearing medicinal, blood-activating and stasis-resolving medicinal, and damp-draining diuretic, accounting for 72. 9% of the total utilization rate. Sweet, bitter and pungent were the main flavors, accounting for 85. 3% of the total utilization rate. Cold, warm and mild were the main medicinal properties, accounting for 96. 0% of the total utilization rate. The related meridians were mainly attributed to the heart, liver, spleen and lung, accounting for 65. 1% of the total utilization rate.

Conclusion

For the clinical diagnosis and treatment of tumor-related insomnia, the treatment is mainly based on deficiency. The main clinical medicines are tonifying medicinal, tranquilizing medicinal and heat-clearing medicinal.
Key Words: tumor; sleep disorder; tonifying medicinal; tranquilizing medicinal; heat-clearing medicinal; blood-activating and stasis-resolving medicinal; damp-draining diuretic

Correlation between glycated hemoglobin and damage of different sensory nerve subsets in diabetes patients

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Objective

The correlation between glycated hemoglobin and damage of three different sensory nerve subsets in diabetes patients was investigated through evaluation of damage of three different sensory nerve subsets in type 2 diabetes patients.

Methods

200 cases of type 2 diabetes patients were divided into three groups in accordance with HbA1c value (A group: HbA1c $\leq 7.5\%$, B group: $7.5\% < \text{HbA1c} \leq 9\%$, C group: HbA1c $> 9\%$). Then damage extent of sensory nerve subsets and current threshold value (CPT value) of three groups were compared.

Results

The CPT value of unmyelinated fiber in bilateral median nerve — ulnar nerve of A group was lower than that of B group and C group ($P < 0.05$). The CPT value of thick myelinated fibers in bilateral median nerve — ulnar nerve of C group was significantly higher than that of A group and B group ($P < 0.05$), and no significant difference between group A and group B. The CPT value of unmyelinated fiber and fine myelinated fibers in left superficial peroneal nerve — deep peroneal nerve of B, C group was significantly higher than A group ($P < 0.05$). The CPT value of unmyelinated fiber in right superficial peroneal nerve — deep peroneal nerve of C group was significantly higher than A, B group ($P < 0.05$).

Conclusion

The Degree of damage in three different subsets sensory nerve of glycemic control beyond standard type 2 diabetes patient was significantly higher than those glycemic control up to standard patient. The better glycemic control, crude sensory nerve myelinated fibers and unmyelinated fibers may benefit more.

Clinical research on quantitative sensory testing instrument for early diabetic nerve injury of the lower limbs

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Objective

By the methods of quantitative detection of sensory nerve, clinical study was conducted to quantify assessment for patients with type 2 diabetes lower limb nerve injury.

Methods

In 41 patients with type 2 diabetes mellitus, 32 male patients, 9 cases of female, the age ranged from 41 to 86 years old, course of disease was 1 month to 30 years. 41 patients were divided into type 2 diabetes group with 16 patients, type 2 diabetes with dyslipidemia group 25 patients. Using the neurometer, collecting current perception thresholds (CPT) testing at 2 000, 250 and 5 Hz was performed on peroneal nerves, and all the patients according to disease duration less than 5 years and over 5 years were divided into two groups. Biochemical parameters of the groups were tested.

Results

Detected the 41 cases of type 2 diabetes patients, double lower limbs current perception threshold anomaly were a total of 39 cases (the single foot nerve damage in 13 cases, double foot nerve damage in 26 cases), 2 cases were normal. Compared with type 2 diabetes group, the 250, 5 Hz CPT in type 2 diabetes with dyslipidemia group was significantly higher ($P < 0.05$), in the course of disease less than 5 years and more than 5 years of two groups, sural nerve of CPT threshold and score had no statistical significance ($P > 0.05$).

Conclusion

The result of sensory nerve quantitative detection found the patients had nerve damage before clear clinical sense, a part of patients may also have single foot nerve damage in early stage. Sensory nerve quantitative detection can early diagnose the thin unmyelinated nerve fiber damage and quantify the severity in type 2 diabetes mellitus patients, in the diagnosis of early DPN damage especially

Exploration of the significance of quantitative detection instrument of sensory nerve in the diagnosis of diabetic peripheral neuropathy .

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Objective

To explore the significance of quantitative detection instrument of sensory nerve in the diagnosis of diabetic peripheral neuropathy.

Methods

A retrospective analysis was conducted on the clinical data of 523 diabetic patients hospitalized in our department from April to July 2015, summarizing the application and efficacy of the quantitative sensory nerve testing device.

Results

There were 345 cases with neurological symptoms and signs, among which 337 cases (97.7%) had elevated CPT values; 178 cases without any neurological symptoms or signs had elevated CPT values (63.5%, 113 cases), while 35 cases (19.7%) had decreased CPT values, with an abnormal rate of 83.1%.

Conclusion

Quantitative sensory nerve testing is characterized by its simple, non-invasive procedure and high sensitivity and specificity. For diabetic patients, sensory nerve function assessment enables early detection of peripheral neuropathy, allowing for proactive preventive measures to avoid the onset and progression of complications, thereby improving patients' quality of life and reducing financial burdens.

The application of current perception threshold in evaluating the diabetic nerve fiber damage.

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Objective

To investigate the value of current perception threshold (CPT) in evaluating the diabetic sensory nerve fiber damage.

Methods

218 patients with type 2 diabetes (T2DM) were divided into two groups named symptomatic group (n = 109) and asymptomatic group (n = 109). Quantitative sensory nerve detector was used to test the CPT of different parts of the body at different degrees of stimulation (2000 Hz, 250 Hz and 5 Hz).

Results

The proportion with abnormal CPT in symptomatic group (88.1%) was higher than that in asymptomatic group (46.8%) ($P < 0.01$). The CPT of different parts at various degrees of stimulation between two groups had significant difference ($P < 0.05$). In symptomatic group, 40.4% presented with numbness (numbness subgroup), 13.8% with tingling (tingling subgroup), and 43.1% with both numbness and tingling symptoms (numbness + tingling subgroup). Damage of sensory nerve fiber in numbness subgroup mainly occurred at 2000 Hz, and in tingling subgroup and numbness + tingling subgroup at 2000 Hz and 250 Hz.

Conclusion

The CPT of different degrees of stimulation showed that the coarse, fine and nonmyelinated nerve fibers were all damaged in T2DM patients with neurological symptoms, especially in A β and A δ nerve fibers.

Application of sensory nerve in the quantitative detection of diabetes patients

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Abstract

The incidence of diabetes mellitus has shown an increasing trend year by year. Its common complication—diabetic peripheral neuropathy (DPN)—is one of the primary factors leading to disability and affecting quality of life, and it is also a major reason for some patients to seek medical attention. In recent years, with growing attention to diabetic complications and advancements in diagnostic techniques, there has been increasing emphasis on diabetic peripheral neuropathy. Sensory nerve function testing in diabetic patients can facilitate early detection of peripheral neuropathy, enable preventive measures to avoid complications, improve patients' quality of life, and reduce economic burdens. From August to November 2012, quantitative sensory nerve testing was performed on the feet of 413 diabetic patients hospitalized in our department. The methodology is reported as follows.

Retrogression of Nervous Fibers According to the Age of Patients with Diabetes Mellitus (DM).

Han D.

Purpose

This study was performed to discover the possible onset time of diabetic neuropathy by age of diabetic patients, and to provide the knowledge necessary for preventing or managing diabetic neuropathy.

Subjects

The subjects of this study were outpatients who visited D Hospital Department of Neurology with complaints of significant neuropathic symptoms including dullness, numbness and paraesthesia.

Methods

Stimulations of 5 Hz, 250 Hz and 2,000 Hz were generated with a Neurometer CPT (Neurotron Inc., Baltimore, MD, USA) and delivered selectively to C fibers, A-delta fibers and A-beta fibers. The intensity of the stimulations of 5 Hz, 250 Hz and 2,000 Hz was incrementally increased as much as 0.01 mA.

Result

The results of this experiment show that the period of retrogression of nervous fibers was different significantly according to the age of patients with diabetes mellitus. Especially, in the case of individuals in their 50's, A β , A δ , and C fibers in both the right and left lower limbs significantly changed within a period of 2 months. In the case of individuals in their 60's, A β and C fibers of the right lower limb meaningfully changed 2 months after the onset of the disease, and A β , A δ , and C fibers of the left lower limb also significantly changed within a period of 2 months.

Conclusion

We discovered that patients suffering from DM especially in their 50's or 60's should be thoroughly followed for their condition, right from the onset of DM, in order to prevent the retrogression of nervous fibers.

Study on the Changes and Significance of Hypoxia Inducible Factor-1 α in Type 2 Diabetes and its Peripheral Neuropathy.

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Objective

To detect the levels of hypoxia inducible factor-1 α (HIF-1 α) and vascular endothelial growth factor (VEGF) in diabetic patients with or without peripheral neuropathy and healthy subjects. To investigate the changes of serum levels of HIF-1 α and VEGF in diabetes, their influencing factors and the relationships with diabetic peripheral neuropathy (DPN). To analyze the risk factors for diabetic peripheral neuropathy.

Methods

Depending on whether the merger of diabetic peripheral neuropathy, 99 patients with type 2 diabetes were divided into two groups, the DM group (T2DM, n = 51) and diabetic peripheral neuropathy group (DPN, n = 48), 42 healthy subjects were taken as control group (NC, n = 42). Enzyme-linked immunosorbent assay (ELISA) was used to determinate the level of serum HIF-1 α and VEGF. Biochemical indicators of the three groups were tested and the age and duration of disease were recorded down. The serum HIF-1 α and VEGF levels and the influencing factors were analyzed among the three groups and risk factors for DPN were discussed.

Results

1. The serum levels of HIF-1 α and VEGF in group T2DM were (635.26 $\pm$ 180.56), (51.18 $\pm$ 24.72), and in group DPN were (486.23 $\pm$ 136.01), (36.12 $\pm$ 19.34), both of them were significantly higher than that of group NC (165.85 $\pm$ 61.30), (10.92 $\pm$ 2.64), ($p < 0.01$). The patients in group T2DM had higher serum levels of HIF-1 α and VEGF than that in group DPN ($p < 0.01$). Both group T2DM and group DPN had higher levels of BMI, FPG, HbA1c, TG and SBP than that of group NC ($p < 0.05$ and $p < 0.01$ respectively). The duration of disease and the level of HbA1c in group DPN were higher than that in group T2DM ($p < 0.05$ and $p < 0.01$ respectively). IV

2. Multiple regression analysis showed the duration of the disease, levels of HbA1c and FPG were negatively correlated with serum levels of HIF-1 α and VEGF. Result of Pearson method for the analysis of correlation showed serum levels of HIF-1 α and VEGF were significantly positively correlated in three groups ($p < 0.01$).

3. Logistic regression analysis showed the duration of diabetes and the level of HbA1c were significant risk factors for DPN ($p < 0.01$).

Conclusions

1. The increased serum levels of HIF-1 α and VEGF in diabetics with or without peripheral neuropathy have protective effects on early diabetes and DPN.

2. The prolonged duration of disease and the toxicity of high blood glucose eventually lead to decrease of serum HIF-1 α and VEGF levels. Lack of this protection mechanism may be one of the causes of DPN.

3. The duration of diabetes and the level of HbA1c are significant risk factors for DPN. Severe continued hypoxia can lead HIF-1 α to be cell toxicity and aggravate DPN.

Application of electrical current threshold measurement in early diagnosis of diabetic peripheral neuropathy

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Abstract

Diabetic peripheral neuropathy (DPN) is primarily caused by chronic hyperglycemia and represents one of the most common chronic complications of diabetes. The reported incidence of DPN ranges from 27.4% to 81.6% globally [1,2], with significant variations in literature attributed to differences in diagnostic methods and tools. A recent systematic review of various risk stratification systems unequivocally identified DPN as a major risk factor for diabetic foot ulcers [3]. Foreign studies have also reported that DPN is a critical risk factor for lower limb amputation [4]. Early implementation of appropriate interventions in high-risk diabetic neuropathy patients can reduce ulcer incidence by 60% and amputation rates by 85% [5]. Therefore, there is an urgent need for a sensitive and reliable diagnostic method for early DPN detection. Through in-depth research on DPN and comparative analysis with other diagnostic tools, it has been found that the current threshold (CPT) may be beneficial for early diagnosis of DPN.

Investigation of cardiac autonomic and peripheral sensory neuropathy in diabetic and nondiabetic patients with hypertension.

Legrady P, Bajcsi D, Lengyel C, Varkonyi TT, Fejes I, Kempler P, Abraham G.

Abstract

Peripheral sensory function and cardiac autonomic neuropathy were studied in 18 nondiabetic and 10 type-2 diabetic hypertensives compared with 11 healthy controls. All the patients were treated with antihypertensive drugs. Cardiac autonomic neuropathy using Ewing method was detected in all patient groups. The current perception threshold values on peroneal nerve at 250 Hz in nondiabetic group and at 250 Hz and at 5 Hz in diabetic group were found increased compared with the controls. In conclusion, so-called typical complications of diabetes can be observed in nondiabetic hypertensives also. Our data might support the essential role of vascular factors in the development of neuropathy.

Effects of monochromatic infrared energy therapy on diabetic feet with peripheral sensory neuropathy: a randomised controlled trial.

Nawfar SA, Yacob NB

Introduction

Peripheral diabetic neuropathy, which is a cause of increasing morbidity and mortality following foot ulcers and amputations, is a burden to health and the economy. Various adjunct treatments to improve neuropathy have been introduced into the market; one such treatment is monochromatic infrared energy (MIRE) therapy, which claimed to produce promising results. This study aimed to evaluate the effects of MIRE on diabetic feet with peripheral neuropathy.

Methods

A randomised controlled, single-blinded study was conducted at Hospital Universiti Sains Malaysia from February 2008 to October 2008. A total of 30 feet from 24 patients were studied. Neuropathy was screened using the Michigan neuropathy scoring instrument, followed by an assessment of the current perception threshold using a neurometer at frequencies of 2,000 Hz, 250 Hz and 5 Hz. The feet were randomised to receive either daily MIRE or sham treatment for a total of 12 treatments. Each foot was then reassessed using the neurometer at six weeks and three months following treatment.

Results

The data obtained was analysed using a non-parametric test to compare the pre- and posttreatment groups. No significant difference was found between the neuropathic foot of diabetic patients in both the MIRE and sham groups.

Conclusion

No improvement of neuropathy was observed following MIRE treatment in the neuropathic feet of diabetic patients.

Diabetic peripheral neuropathy is associated with increased arterial stiffness without changes in carotid intima-media thickness in type 2 diabetes.

Kim ES, Moon SD, Kim HS, Lim DJ, Cho JH, Kwon HS, Ahn CW, Yoon KH, Kang MI, Cha BY, Son HY.

Objective

This study was conducted to investigate the association of diabetic peripheral neuropathy (DPN) with both arterial stiffness and intima-media thickness (IMT).

Research Design And methods

We conducted a cross-sectional analysis of 731 subjects with type 2 diabetes. DPN was diagnosed on the basis of neuropathic symptoms, insensitivity to a 10-g monofilament, abnormal pin-prick sensation, and abnormal current perception threshold. Arterial stiffness was assessed by cardio-ankle vascular index (CAVI), and IMT was assessed by B-mode ultrasonography.

Results

Patients with DPN had higher CAVI than those without DPN in multivariate adjusted models, whereas no differences in IMT were observed between patients with and without DPN after adjustment for age and sex. In the multivariate analysis, CAVI was a significant determinant of DPN (odds ratio 1.36 [95% CI 1.13–1.65], $P = 0.001$).

Conclusions

DPN is significantly associated with arterial stiffness without carotid intimal changes in patients with type 2 diabetes.

Detection and Risk Factor Analysis of Peripheral Neuropathy in Type 2 Diabetes Mellitus

Li Dongying, Yang Jinkui

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Objective

The Neurometer CPT/C neurologer was used to detect the diabetic peripheral neuropathy (DPN) and to understand the incidence of DPN.

Materials and methods

A total of 209 patients with type 2 diabetes mellitus (DM) hospitalized in the Department of Endocrinology at Beijing Tongren Hospital from January to December 2007 were selected (diabetes group), including 113 males and 96 females, aged 27–80 years (mean: 56.6 ± 11.3 years), with disease duration ranging from 15 days to 30 years. Thirty healthy controls were matched in age and gender. The DPN was assessed using the Neurometer CPT/C nerve measurement device, with the index fingers of both hands and the big toes of both feet of the patients and healthy controls selected as test points to evaluate the function of the median nerve and common peroneal nerve. The current perception thresholds (CPT values) were measured at frequencies of 2000 Hz, 250 Hz, and 5 Hz, respectively. The CPT results were analyzed using the NEUVAI software. Detailed clinical indicators of the diabetic patients were recorded, and their relationship with DPN was analyzed.

Results

All CPT values in the type 2 diabetes group were significantly higher than those in the healthy control group ($P < 0.05$ or $P < 0.01$). The lower extremity CPT values in the type 2 diabetes group were significantly higher than those in the upper extremity ($P < 0.05$ or $P < 0.01$). The foot CPT values at various frequencies were classified according to UAER, following the diagnostic and therapeutic criteria for diabetes in the 2006 ADA edition. The results were divided into: a normal UAER group ($n=135$, $UAER < 20 \mu g/min$), a microalbuminuria group ($n=43$, $20 \mu g/min \leq UAER < 200 \mu g/min$), and a macroalbuminuria group ($n=31$, $UAER \geq 200 \mu g/min$). The CPT values in the macroalbuminuria group were significantly higher than those in the normal UAER group ($P < 0.05$). The CPT values in the macroalbuminuria group were also significantly higher than those in the microalbuminuria group, with a statistically significant difference at 5Hz ($P < 0.05$). The foot CPT values at various frequencies were further classified according to fundus status: a normal fundus group ($n=109$), a background retinopathy group ($n=78$), and a proliferative retinopathy group ($n=22$). The CPT values in the proliferative retinopathy group were significantly higher than those in the normal fundus group ($P < 0.05$), and the CPT values in the background retinopathy group were significantly higher than those in the normal fundus group, with a statistically significant difference at 5Hz ($P < 0.05$). Logistic regression analysis of risk factors for type 2 diabetes peripheral neuropathy (DPN) revealed that HbA1c and disease duration were independent risk factors for DPN.

Conclusion

(1) Type 2 diabetes peripheral neuropathy may involve both small and/or large nerve fibers, but A δ and C-type small or unmyelinated nerve fibers innervating pain and temperature sensation are more commonly affected than A β large nerve fibers. (2) Neurometers (CPT/C) are instrumental in the early detection of type 2 diabetes peripheral neuropathy. (3) Elevated blood glucose levels and disease progression exacerbate type 2 diabetes peripheral neuropathy.

ANTI-OXIDANT TREATMENT IN DIABETIC PERIPHERAL NEUROPATHY

Givi Kurashvili, Ramaz Kurashvili, Liana Tsutskiridze, Elena Shelestova, Mzia Dundua. Georgian Diabetes Center, Tbilisi, Georgia

BACKGROUND AND AIMS

Peripheral neuropathy (DPN) affects 30% of diabetic persons, positively correlates with increased mortality. Though no drugs exist that influence DPN pathogenic mechanisms, anti-oxidant treatment (α -lipoic acid (ALA), has been shown to improve nerve fibers function in diabetes mellitus. The aim of the study was to assess the efficacy of intensive insulin therapy and antioxidant alpha-lipoic acid (ALA) treatment in patients with neuropathy of various severity.

DESIGN AND METHODS:

The effects of the anti-oxidant ALA (600mg thioctic acid) in combination with intensive insulin therapy were studied in a 3-week trial in 89 (49 males / 40 females, mean age - 46 ± 6.51 yrs, mean HbA1c - $8.7 \pm 2.2\%$, diabetes duration >6 months) type 2 diabetic insulinuser patients with peripheral neuropathy but without overt macrovascular complications and/or nerve damage of non-diabetic origin, who were divided into 3 groups based on the peripheral neuropathy severity. Peripheral nerve function was assessed at baseline prior to infusion and at final visit by NEUROMETER® R-CPT neuroselective sensory nerve evaluation method, using three neuroselective sinusoid waveform frequencies (5, 250 and 2000 Hz), automated double-blind methodology (± 20 μ Amperes, $p < 0.006$). It is claimed to discriminate between neuropathic and non-neuropathic patients and to be able to test different nerve fiber types with different frequencies of electric stimulus. The R-CPT was measured at two sites - the distal phalanx of the hallux in both feet (lateral and medial aspects of the toes). Impairment severity was distinguished as mild hyperesthetic (R-CPT score <6)/hypoesthetic (R-CPT score 14-17) 45 patients, 50.56%, moderate hypoesthetic 30 patients 33.71% (R-CPT score 18-21) and severe hypoesthetic 14 patients 15.73% (R-CPT score >21). RESULTS: Sensory function in the feet improved from baseline after above mentioned antioxidant treatment and intensive insulin therapy in 28 Gr.1 (62.22%), and 13 Gr. 2 (43.33%) patients. In case of severe neuropathy R-CPT score did not change.

CONCLUSION:

Efficacy of antioxidant treatment in combination with intensive insulin therapy in T2 DM subjects negatively correlates with severity of DPN.

Evaluation of exocrine pancreatic function in patients with type 1 and type 2 diabetes.

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Medicine, Semmelweis University, Budapest, Hungary.

Background and aims

Although the impairment of pancreatic exocrine function in patients (pts) with non-pancreatic diabetes (DM) is documented, its incidence and consequences are not clearly known. The aim of our study was to assess the exocrine pancreatic function in pts with type 1 or 2 DM.

Materials and methods

The stool elastase activity of 146 pts with non-pancreatic DM was measured. Cardiovascular reflex tests (CRT), peripheral sensory function (applying Neurometer; Neurotron Inc. Baltimore, MD), retinopathy, HbA1c, BMI, microalbumin excretion (MAU) were measured and the quality of life (QoL) was assessed by an EORTC QLQ-C30 questionnaire.

Results

28% of all pts had an affected exocrine pancreatic function. Two groups (n=21 and n=10) were selected from pts based on decreased or normal elastase (mean elastase of pts: 141 ± 11 vs 417 ± 37 $\mu\text{g/g}$, $p < 0.00001$). The duration, age, BMI, HbA1c, MAU and retinopathy frequency did not differ significantly between the groups: (duration: 16.2 ± 2.7 vs 16.3 ± 3.6 years, $p = 0.98$; age: 58.7 ± 2.6 vs 60.3 ± 4.3 years, $p = 0.74$; BMI: 27.4 ± 1.98 vs 30.5 ± 1.27 , kg/m^2 $p = 0.08$; HbA1c: 8.25 ± 0.3 vs 8.98 ± 0.2 % $p = 0.17$; MAU: 20 vs 16 % $p = 0.98$, retinopathy: 50 vs 48 %; $p = 0.93$ decreased vs normal elastase group). A CRT (30/15 ratio) was lower in pts with impaired elastase (0.98 ± 0.01 vs 1.03 ± 0.02 , $p = 0.04$), but differences in the overall autonomic neuropathy (AN) scores were not significant (AN score: 4.35 ± 0.75 vs 3.9 ± 0.38 , $p = 0.50$). The threshold of perception of both limbs showed a non-significant tendency to increase in pts with low elastase (n. medianus 2000 Hz: 3.07 ± 0.6 vs 2.49 ± 0.55 mA, $p = 0.64$, 250 Hz: 2.26 ± 0.6 vs 0.96 ± 0.2 mA $p = 0.16$, 5 Hz: 1.68 ± 0.63 vs 0.66 ± 0.2 mA $p = 0.42$, n. peroneus: 2000 Hz: 5.10 ± 0.76 vs 3.61 ± 0.87 mA $p = 0.24$, 250 Hz: 3.91 ± 0.81 vs 2.1 ± 0.78 mA $p = 0.26$, 5 Hz: 2.82 ± 0.8 vs 1.85 ± 0.75 mA $p = 0.42$). QoL scores were not significantly different between the groups.

Conclusion:

Decreased stool pancreatic elastase activity can be found in almost one third of diabetic patients, and it might be related to a neuronal dysfunction without affecting further complications. Prospective trials with a higher number of patients and the investigation of the effect of enzyme substitution are needed to clarify the clinical role of exocrine pancreas function in non-pancreatic diabetes

Assessment of sensory neuropathy in patients with diabetic foot problems

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Abstract

Objectives

To study the incidence and extent of peripheral sensory neuropathy in diabetic patients without diabetic foot problems (DFPs) with b5, 5–10 and N10 years duration of diabetes using three different modalities of testing: Pin-Prick Testing, 5.07 Semmes-Weinstein Monofilament Testing (SWMT) and Rapid-Current Perception Threshold (R-CPT) measurements using the Neurometer.

Methods

Our study population consisted of 60 patients (120 feet) treated for diabetes mellitus in the Division of Endocrinology at the National University Hospital. No patient had any DFPs. Twenty-two, 21 and 17 patients had duration of diabetes of b5, 5–10 and N10 years, respectively. All patients were tested for sensory neuropathy using Pin-Prick Testing using a standardized protocol, SWMT and the Neurometer.

Results

There was a significantly higher incidence of sensory neuropathy detected by both the Pin-Prick Test and the Neurometer as compared to the SWMT. Also, in all three modalities, there was a significant increase in incidence of sensory neuropathy detected in diabetics with N5 years duration of diabetes. In addition, the Pin-Prick Test showed an increase in extent of sensory neuropathy with a longer duration of diabetes.

Conclusions

The Pin-Prick Test was found to be a simple, cheap and useful diagnostic tool for detection of sensory neuropathy in diabetics without DFPs. In addition, it could accurately delineate the extent of neuropathy in the lower limb — additional useful information not obtainable with SWMT or Neurometer. Even for patients with b5 years duration of diabetes, the incidence of sensory neuropathy detected was considerable. The incidence of neuropathy detected continued to increase with length of duration of diabetes. Hence, we recommend screening of patients for neuropathy as soon as they are diagnosed with diabetes. D 2008 Elsevier Inc. All rights reserved.

The Neurometer: Validation and Comparison with Conventional Tests for Diabetic Neuropathy

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Abstract

"The Neurometer® CPT is a portable constant current sine wave stimulator, which has recently been advocated for the Quantification of peripheral nerve dysfunction by the measurement of detection thresholds for constant current stimulation. Stimuli are applied through surface electrodes at three frequencies and a forced choice method is used to determine the minimum amplitude of detection. The possible application of the Neurometer® CPT to the diagnosis and measurement of diabetic neuropathy was evaluated. The preliminary Neurometry results in comparison to those of conventional nerve testing techniques, including thermal and vibration detection thresholds, are discussed. It appears that the device may be a useful screening instrument which could give a fairly comprehensive idea of the functional integrity of different nerve fibre populations, and a full assessment takes only 10 to 15 min, in contrast to conventional alternatives."

Results

"...Comparison of the Neurometer® CPT with conventional tests of peripheral nerve function, showed significant correlations between current perception threshold for 2 kHz stimulation and measures of large fibre function... Low frequency current perception threshold (5 Hz) correlated significantly with a measure of small fibre function..."

Discussion

"The Neurometer® CPT certainly appears to provide a quick, simple, and pain free non-invasive method of assessing peripheral nerve function... The low variability achieved with the Neurometer® CPT, however, suggests that it may be superior to many conventional tests such as biothesiometry. Neurometry... requires less time than measuring thermal thresholds and electrophysiological assessments. In addition it is not complex, and can probably be operated reliably by inexperienced personnel."

Current Perception Thresholds: A New Method for the Assessment of Peripheral Sensory Neuropathy in Diabetes Mellitus

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Abstract

“The Neurometer® CPT is a portable constant current sine wave stimulator, which has recently been advocated for the Quantification of peripheral nerve dysfunction by the measurement of detection thresholds for constant current stimulation. In order to assess its potential usefulness in the Quantification of diabetic neuropathy, detection thresholds for constant current electric sine wave stimulation were measured at three different frequencies in 29 healthy control subjects and 87 diabetic patients. Significant differences in CPTs of three different frequencies (5Hz, 250Hz, 2000HZ) were found in the diabetic group as compared with those in the healthy control group. We have carried out the first independent assessment of the device in the assessment of diabetic peripheral neuropathy, with comparative data from conventional electrophysiological and objective sensory testing techniques (motor nerve conduction velocity (MCV), sensory nerve conduction velocity (SCV), F-latency, and thermal detection thresholds (TDT)). Non-parametric correlation tests demonstrated a significant relationship between high frequency CPT and tests of large fiber function (250 Hz CPT vs median SCV, $r=0.3$, $p<0.05$; 250Hz CPT vs F-latency, $r=0.41$, $p<0.01$; 2000Hz CPT vs F-latency, $r=0.32$, $p<0.01$). Low frequency CPT correlated with TDT, a measure of small fiber function ($r=0.42$, $p<0.05$). Moreover, CPTs of three frequencies were correlated with duration of diabetes. This means that peripheral nerve dysfunction, including small fiber dysfunction and large fiber dysfunction, may progress synchronously with duration. It is concluded that the device maybe a simple and comprehensive way of assessing peripheral nerve function and that it provides information about different nerve fiber types.”

A Comparison of Nerve Conduction Velocities and Current Perception Thresholds as Correlates of Clinical Severity of Diabetic Sensory Neuropathy

M.S. Rendell, et. al.

Creighton Diabetes Center, Omaha, NE

Abstract

"Nerve conduction velocities (NCVs) are the standard measurements used to confirm the presence or absence of diabetic neuropathy. NCVs were contrasted with the newer technique of measurement of alternating current perception thresholds (CPTs) in assessing the quantitative level of correlation with severity of diabetic sensory neuropathy. A very detailed, scored neurological history (symptoms) and physical examination, emphasizing sensory assessment, was conducted on 71 individuals with diabetic neuropathy of varying degrees of severity. Sensory and motor NCVs and CPTs at 5, 250, and 2000 Hz of the upper and lower extremities were determined for these individuals. In addition, vibration thresholds (VTs) were measured as a third modality. Twenty eight individuals underwent repeated evaluations at 2, 6, 10 and 12 months after the initial procedures. Using the results of 169 complete evaluations, correlations were determined between physical scores (PS) and symptom scores (SS) and NCVs. NCV correlations with the SS were weaker than with the PS. The strongest of the correlations were found between the PS and motor NCVs of the median nerve ($\rho=0.29$) and the tibial nerve ($\rho=0.38$). Normal NCVs were present in the face of very significant historical and physical abnormality. Correlations of the SS and PS with both VTs and CPTs were higher than with the NCVs. CPTs proved the more effective as predictors of both symptomatic and physical impairment. NCVs appear to lack the resolving power necessary to evaluate subtle differences in clinical state of diabetic sensory neuropathy. The supplementary use of current perception testing may improve the quantitative assessment of this condition."

Prevalence of Hyperesthesia Detected by Current Perception Threshold Test in Subjects with Glucose Metabolic Impairments in a Community

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Dept. of Public Health, Nagoya City University Medical School, Nagoya

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Objective

“Recent studies reported that hyperesthesia may be an indicator of early diabetic polyneuropathy. Using the current perception threshold (CPT) test, which stimulates peripheral sensory nerve fibers by three different frequencies (2,000, 250, and 5 Hz), we investigated the relationship between hyperesthesia and glucose metabolic impairment in a community.”

Methods

“The number of subjects, aged 40 to 79 years, was 2,074. The CPT values at each frequency were classified into three categories (hyperesthesia, normal, and hypoesthesia). Subjects were also subgrouped into three groups (normal, insulin resistance, and diabetes) according to glucose metabolic status, and those with hypoesthesia at each frequency were excluded in the analyses.”

Results

“The prevalence of hyperesthesia at 2,000, 250, and 5 Hz in male diabetic subjects were 14.1, 15.6, and 7.7%, respectively, and 22.2, 24.5, and 16.4% respectively in female diabetic subjects. In logistic regression analysis adjusted for age, females with diabetes showed a significantly high odds ratio (OR) for hyperesthesia at 2,000 Hz (OR, 2.42; 95% confidence interval (95%CI), 1.18 to 4.97) and 250 Hz (OR, 2.65; 95% CI, 1.31 to 5.37). In male diabetic subjects, a significantly high odds ratio for hyperesthesia was seen at 250 Hz (OR, 2.09; 95%CI, 1.07 to 4.05).”

Conclusion

“Our results suggested that hyperesthesia may emerge coupled with developing diabetes, supporting the precedent hypothesis.”

Improvement of Sensory Impairment in Patients with Peripheral Neuropathy

J. Joseph Prendegast, MD, Galdina Miranda, MA, and Manuel Sanchez, MA
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Objective

“To report the findings in 27 patients with peripheral neuropathy (21 with lower extremity sensory impairment associated with diabetic peripheral neuropathy and 6 with other causes), who received treatment with monochromatic near-infrared photoenergy (890 nm) delivered by the Anodyne Therapy System (ATS).”

Method

“All enrolled patients exhibited abnormal sensory perception (either hyperesthesia or hypoesthesia based on a qualifying examination with the Neurometer CPT (current perception threshold) (baseline CPT). The patients received 10 ATS treatments (each lasting 40 minutes) during a 2-week period and then underwent CPT retesting to determine the extent of improvement of sensory impairment in myelinated and unmyelinated sensory fibers of the peroneal nerve.”

Results

“All patients obtained improvement in sensory impairment in comparison with baseline CPT measures, and 16 of the 27 patients achieved normal sensory responses in all nerve fiber subpopulations. Ten patients had been tested previously (initial CPT) and did not exhibit spontaneous improvement in sensory impairment during a mean period of 27 months before baseline CPT. After receiving the ATS Treatments, however, this group of patients showed improvement in comparison with both initial CPT results and baseline CPT.”

Conclusion

“On the basis of the data from this study, the ATS seems to be a safe and effective treatment to improve sensory impairment associated with peripheral neuropathy due to diabetes and other causes.”

Current Perception Threshold and Sympathetic Skin Response in Diabetic and Alcoholic Polyneuropathies

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Nishijo, Y ., Mizutani, T .

Department of Neurology, Nihon University School of Medicine, Tokyo .

Objective

“Correlation between current perception threshold and sympathetic skin response was investigated in patients with diabetic or alcoholic polyneuropathy.”

Methods

“Current perception threshold was measured using Neurometer CPT/C, and the sympathetic skin response was measured using Neuropack Σ.”

Patients

“Fourteen patients with diabetic polyneuropathy and 10 patients with alcoholic polyneuropathy were studied.”

Results

“There was a significant negative correlation between the current perception threshold to 5 Hz stimulation and the amplitude of sympathetic skin response.”

“There were no significant correlations between the nerve conduction velocity and the Current Perception Threshold or the amplitude of the Sympathetic Skin Response.”

Conclusion

“Since both current perception threshold to 5 Hz stimulation and sympathetic skin response are related to C fibers, these two are considered to be impaired concurrently in diabetic and alcoholic polyneuropathies.”

Evaluation of Quantitative and Selective Sensory Fiber Dysfunction in Patients with Cirrhosis

Nan-Nan Zhang, Zhi-Yong Wang, Jian-Min Chen, Zhi-Peng Yan, Guo-Xin Ni, Jun Ni.

Background:

Chronic liver disease has been reported to be associated with peripheral neuropathy. However, which sensory fibers are affected remains unknown. The objective of this study was to examine the function of sensory nerve fibers in patients with cirrhosis using the current perception threshold (CPT) test, as well as the correlation between blood biochemical indicators related to cirrhosis and CPT values.

Methods:

We recruited 44 patients with liver cirrhosis and 37 healthy controls of the same age and gender. The Neurometer® system for the CPT test was used to stimulate the median nerve on the right index finger, as well as the deep and superficial peroneal nerves on the right hallux, using three distinct parameters (2000 Hz, 250 Hz, and 5 Hz). Comparative analysis was performed on the CPT values of the sensory nerves. Additionally, the correlation between CPT values and biochemical blood indicators in the study participants was analyzed.

Results:

Under 2000 Hz electrical stimulation, there was a significant difference between the cirrhosis and healthy control groups in the median nerve as well as the deep and superficial peroneal nerves ($p < 0.05$). In addition, the median nerve CPT value of the cirrhosis group was significantly higher than that of the control group at an electrical stimulation frequency of 250 Hz ($p = 0.005$). There was no correlation between CPT values and blood biochemical indicators.

Conclusion:

According to the results, the sensory peripheral neuropathy in liver cirrhosis is mainly manifested as A β fiber neuropathy.

Fiber selectivity of peripheral neuropathy in patients with Parkinson's disease

Yi-Tong Xiong, Man-Hua Liu, Han-Ying Gu, Kai Li, Jin-Ru Zhang, Xiao-Yu Cheng, Hong Jin, Jing Chen, Cheng-Jie Mao, Chun-Feng Liu

Objective:

To determine the function of each type of peripheral nerve fiber and investigate the possible role of levodopa (LD) in peripheral neuropathy (PN) in Parkinson's disease (PD) patients.

Methods:

We enrolled 60 patients with idiopathic PD. All PD patients were divided into three groups: levodopa exposure >3 years (LELD), levodopa exposure ≤ 3 years (SELD) and de novo patients with PD (NOLD). The current perception threshold (CPT), which was measured by Neurometer at 2000, 250 and 5 Hz, the level of homocysteine, Vitamin B12 and folic acid in plasma, were compared with those of sex- and age-matched healthy controls (HCs).

Results:

Current perception threshold was higher at 250 Hz ($p < .05$) and 5 Hz ($p < .05$) in the LELD group than the NOLD, SELD, and control group. CPT was lower at 5 Hz in the NOLD than in the HCs group ($p < .05$). The CPT of the more affected side of PD patients was positively correlated with H-Y stage at 5 Hz current stimulation ($r = .42$, $p = .01$). Multivariate logistic regression analysis showed that elevated homocysteine levels were the risk factor of sensory nerve injury in PD patients ($p < .01$). Serum homocysteine levels were positively correlated with levodopa (LD) daily dose, LD equivalent daily dose, and LD cumulative lifetime dose ($p < .05$).

Conclusions:

Peripheral neuropathy in PD patients can occur in the early stage of PD exhibiting as hyperesthesia and is fiber selectivity, especially for A δ and C nerve fibers. PN in PD patients is related to PD itself and long-term LD exposure. Elevated plasma homocysteine is a risk factor for PN in PD patients.

Application value of sensory nerve quantitative detector in evaluating the degree of nerve root injuries of two methods in treatment of cervical spondylotic radiculopathy

Gao Xin, Yang Jianrong, Wang Cheng, Lian Zhanxiong, Liang Bin, Liu Chaofeng, Deng Xiangqiang, Luo Yang, Huang Woning, Deng Lisheng.

Objective

To explore the application value of sensory nerve quantitative detector in evaluating the degree of nerve root injuries before and after musculoskeletal ultrasound-guided blade needle and traditional blade needle in the treatment of cervical spondylotic radiculopathy.

Methods

One hundred and twenty patients with cervical spondylotic radiculopathy admitted to the People's Hospital of Guangxi Zhuang Autonomous Region from January 2018 to November 2019 were selected, and they were divided into group A and group B by random number table method, with 60 cases in each group. In the group A, 5 cases lost, and 55 cases were eventually included. In the group B, 7 cases lost, and 53 cases were eventually included. The group A was treated with musculoskeletal ultrasound-guided blade needle, and the group B was treated with traditional blade needle. The sensory nerve quantitative detector was used to evaluate the nerve injuries of the affected sides of the two groups before and after treatment, and these nerve injuries were compared between the two groups.

Results

Under the detection conditions of 2 000 Hz, 250 Hz and 5 Hz, there were no significant differences in the quantitative detection results of the affected side sensory nerves (C6, C7, and C8) of the patients in the two groups before treatment ($P > 0.05$). After treatment, the sensory nerve functions of C6, C7, and C8 in the two groups were improved compared with those before treatment ($P < 0.05$), and the grade of the quantitative detection. 414 · Chinese Journal of New Clinical Medicine, May 2022, Volume 15, Number 5 Results of sensory nerve in the group A was lower than that in the group B, and the difference was statistically significant ($P < 0.05$).

Conclusion

Sensory nerve quantitative detector can objectively evaluate the degree of nerve root injury, which has a certain reference significance for guiding the follow-up treatment.

The Study on the pathogenesis of migraine

Hao Yuyan, Yang Qian, Xiao Zheman

Department of Neurology, People's Hospital of Wuhan University

Objective

To explore the pain threshold, current perception threshold and pain tolerance threshold of migraine patients in the interpartial period of headache, so as to clarify their sensory sensitivity.

Methods

From September 2019 to June 2021, 27 migraine patients and healthy subjects with matched age, gender and education level were collected in Department of Neurology, People's Hospital of Wuhan University. During the interpartial period of migraine, the pain perception threshold (PPT) of the bilateral first trigeminal nerve and median nerve was measured by the Von Frey fiber, and the current perception thresholds (CPT) of the bilateral first trigeminal nerve and median nerve and the pain tolerance threshold (PTT) of the bilateral median nerve were recorded by sensory nerve quantitative detector.

Results

In our study, no significant statistical differences were found between PPT and CPT and healthy controls, but PTT values were significantly decreased compared with the control group.

Conclusion

The reduced threshold of pain tolerance during interpartial period may be related to central sensitization, which may be caused by abnormal sensory inputs of A δ and C fibers

Comparative Study of CPT and H Reflex in Lumbar Radiculopathy

Chen Haiping, Cheng Shu, Li Xuan, Huang Lefen, Zhang Wei

Department of Rehabilitation Medicine, China Resources Wugang General Hospital

Objective

The correlation between the current perception threshold (CPT) test and the H-reflex of the tibial nerve in patients with lumbosacral radiculopathy was observed.

Methods

Thirty patients with lumbar disc herniation and lumbosacral nerve root disease were selected to measure the current sensory threshold and the H reflex of tibial nerve.

Results

Both CPT testing and H-reflex examination can effectively evaluate lumbosacral radiculopathy. Patients with a CPT grade of 4.34 or higher exhibit abnormal H-reflex, while those with a CPT grade below 4.34 have normal H-reflex.

Conclusion

The CPT test demonstrates sensitivity in the diagnosis of lumbosacral radiculopathy, and its consistency with the H-reflex examination may be relatively high.

Chen Application of Current Threshold Measurement in Lumbar Radiculopathy .

Haiping, Li Xuan, Huang Lefen, Zhang Wei

Department of Rehabilitation Medicine, China Resources Wugang General Hospital

Objective

To investigate the change of current perception threshold (CPT) in patients with lumbar radiculopathy.

Methods

From September, 2014 to October, 2015, 86 patients with lumbar radiculopathy from lumbar disc herniation were measured with CPT in different frequencies (5, 250 and 2000 Hz) on proximal and distal points of affected dermatome of both legs.

Results

The CPT grades of both proximal and distal points were higher in the affected legs than in the contralateral legs ($t=1.659$, $P<0.001$). The abnormal CPT grades counted for 46.36% for both points, 35.45% for only distal points and 35.45% for only proximal points. CPT was abnormal in all the patients, and 93.6% of them appeared at 250 Hz, 57.4% at 2000 Hz, and 29.8% at 5 Hz.

Conclusion

CPT is sensitive in lumbar radiculopathy, especially in multiple frequencies and test points.

Olfactory ensheathing cell transplantation inhibits P2X4 receptor overexpression in spinal cord injury rats with neuropathic pain

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Abstract

Cell-based therapy is a promising strategy to alleviate neuropathic pain caused by spinal cord injury (SCI). We transplanted olfactory ensheathing cells (OECs) into SCI rats with neuropathic pain and quantitatively detected the sensory nerve function. The expression levels of P2X4 receptor (P2X4R), 200 kD neurofilament heavy polypeptide (NF200), and glial fiber acidic protein (GFAP) were measured by immunofluorescence and Western blot analyses. Results showed that NF200 expression significantly increased, GFAP expression decreased, and sensory nerve function improved. In addition, OEC transplantation inhibited the overexpression of P2X4R, which plays an important role in neuropathic pain. Thus, OEC is a candidate target for the treatment of sensory functional loss and P2X4R-mediated neuropathic pain caused by SCI.

Application of Current Threshold Measurement in Clinical Practice.

Yang Chenhui, Zhang Jie

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Abstract

Current perception threshold (CPT) testing, a neuroquantitative sensory assessment method developed in recent years, utilizes electrical stimulation to detect and quantitatively evaluate sensory nerve function. The earliest study on CPT for neural function assessment was conducted by Smith et al. [1] in 1986, who described it as "an objective, neuroselective method that can detect the functional integrity of over 90% of sensory nerve fibers—including both large-diameter and small-diameter myelinated and unmyelinated fibers—using specific electrical stimuli."

The Analyses Of Correlation And Influencing Factors Betw Een Som Atosensory Evoked Potential Current Threshold And Current Perception Threshold

Song Jianghua, Yuan Xiaodong, Lü Shujuan, Zhou Lifu, Zhang Yingjie, Li Gang, Lei Jun, Wang Shujuan

Objective

To investigate the correlation between sensory evoked potential (SEP) current threshold and cortical sensory current threshold (CPT) in normal adults, and to identify their influencing factors, thereby providing objective theoretical guidance for determining appropriate stimulation intensity, standardizing somatosensory evoked potential testing in our laboratory, and facilitating subsequent brain function research in patients with somatosensory disorders.

Methods

A total of 89 healthy adults were selected, including 49 males and 40 females, with a mean age of (52.75 ± 15.09) years. The participants were stratified by age: the young group (20–40 years) comprised 7 males and 13 females; the middle-aged group (40–60 years) included 20 males and 13 females; and the elderly group (≥ 60 years) consisted of 20 males and 16 females. Bilateral posterior tibial nerve stimulation was alternately applied to the medial malleoli, followed by measurement of CPT and SEPCT in both lower limbs. The correlation between these parameters and their influencing factors were analyzed.

Results

Male subjects exhibited significantly higher SEPCT and CPT values compared to female subjects, with their SEPCT/CPT ratio being markedly lower than that of females ($P < 0.05$). Elderly male subjects showed significantly higher SEPCT and SEPCT/CPT values than middle-aged male subjects, and their SEPCT values were higher than those of young male subjects ($P < 0.05$). In female subjects, both SEPCT and CPT mean values increased gradually with age ($P < 0.05$), whereas the SEPCT/CPT ratio remained relatively constant, showing no significant differences among groups ($P > 0.05$). There was a positive correlation between SEPCT mean value and CPT mean value.

Conclusion

In conducting SEP clinical examinations and related research, male subjects may receive a stimulation current intensity approximately 4.40 times SEPCT/CPT, while elderly male subjects may be given slightly higher SEPCT. Female subjects may receive a stimulation current intensity approximately 6.13 times SEPCT/CPT.

Study on sensory nerve conduction in children with sensory integration dysfunction

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Objective

To quantitatively assess the differences in sensory nerve fiber conduction between children with sensory integration dysfunction (SID) and normal children.

Methods

The sensory current threshold (CPT) was used to evaluate the sensory nerve myelinated fibers ($A\beta$), myelinated fibers ($A\delta$) and unmyelinated fibers (C) of the trigeminal nerve, median nerve and superficial peroneal nerve in 128 children with SID and 96 normal children.

Results

1) Sensory abnormalities in children with sensory integration dysfunction (SID): The trigeminal nerve exhibited the highest incidence of sensory abnormalities (63.28% on the left side and 72.66% on the right side). Statistically significant differences were observed in the incidence of sensory abnormalities between the left and right trigeminal nerves and the median nerve at three frequencies: 2000 Hz, 250 Hz, and 5 Hz ($P < 0.05$), whereas no statistically significant difference was found in the superficial peroneal nerve. 2) Differences in CPT at various sites between the two groups: Children with SID showed higher CPT values at the median nerve and superficial peroneal nerve at 2000 Hz and 250 Hz compared to normal children, with a statistically significant difference at 2000 Hz ($P < 0.05$). 3) Correlation between sensory integration scores and CPT: The sensory integration scores of children with SID were negatively correlated with CPT at various sites at 2000 Hz and 250 Hz ($P < 0.05$).

Conclusion

Compared with normal children, the sensory nerve conduction function of children with SID was abnormal, especially in the coarse myelinated fibers ($A\beta$) and the fine myelinated fibers ($A\delta$).

Age-related changes in the somatosensory processing of tactile stimulation-An fMRI study

Stefan Brodoehl, Carsten Klingner, Otto W Witte , Katharina Stieglitz

Abstract

Age-related changes in brain function are complex. Although ageing is associated with a reduction in cerebral blood flow and neuronal activity, task-related processing is often correlated with an enlargement of the corresponding and additionally recruited brain areas. This supplemental employment is considered an attempt to compensate for deficits in the ageing brain. Although there are contradictory reports regarding the role of the primary somatosensory cortex (SI), currently, there is little knowledge about age-related functional changes in other brain areas in the somatosensory network (secondary somatosensory cortex (SII), and insular, anterior (ACC) and posterior cingulate cortices (PCC)). We investigated 16 elderly (age range, 62–71 years) and 18 young subjects (age range, 21–28 years) by determining the current perception threshold (CPT) and applying functional magnetic resonance imaging (fMRI) using a 3.0 Tesla scanner under tactile stimulation of the right hand. CPT was positively correlated with age. fMRI analysis revealed significantly increased activation in the contralateral SI and ipsilateral motor cortex in elderly subjects. Furthermore, we demonstrated age-related reductions in the activity in the SII, ACC, PCC, and dorsal parts of the corpus callosum. Our study revealed dramatic age-related differences in the processing of a simple tactile stimulus in the somatosensory network. Specifically, we detected enhanced activation in the contralateral SI and ipsilateral motor cortex assumingly caused by deficient inhibition and decreased activation in later stages of somatosensory processing (SII, cingulate cortex) in elderly subjects. These results indicate that, in addition to over-activation to compensate for impaired brain functions, there are complex mechanisms of modified inhibition and excitability involved in somatosensory processing in the ageing brain.

Reproducibility of current perception threshold with the Neurometer vs the Stimpod NMS450 peripheral nerve stimulator in healthy volunteers: an observational study **Reproductibilité du seuil de perception du courant avec les stimulateurs des nerfs périphériques Neurometer vs. Stimpod NMS450 chez des volontaires sains: une étude observationnelle.**

Ban C. H. Tsui, MD • Timothy J. Shakespeare, MBBS • Danika H. Leung • Jeremy H. Tsui
• Gareth N. Corry, PhD,

Purpose

Current methods of assessing nerve blocks, such as loss of perception to cold sensation, are subjective at best. Transcutaneous nerve stimulation is an alternative method that has previously been used to measure the current perception threshold (CPT) in individuals with neuropathic conditions, and various devices to measure CPT are commercially available. Nevertheless, the device must provide reproducible results to be used as an objective tool for assessing nerve blocks.

Methods

We recruited ten healthy volunteers to examine CPT reproducibility using the Neurometer and the Stimpod NMS450 peripheral nerve stimulator. Each subject's CPT was determined for the median (second digit) and ulnar (fifth digit) nerve sensory distributions on both hands – with the Neurometer at 5 Hz, 250 Hz, and 2000 Hz and with the Stimpod at pulse widths of 0.1 msec, 0.3 msec, 0.5 msec, and 1.0 msec, both at 5 Hz and 2 Hz. Intraclass correlation coefficients (ICC) were also calculated to assess reproducibility; acceptable ICCs were defined as $C \geq 0.4$.

Results

The ICC values for the Stimpod ranged from 0.425–0.79, depending on pulse width, digit, and stimulation; ICCs for the Neurometer were 0.615 and 0.735 at 250 and 2,000 Hz, respectively. These values were considered acceptable; however, the Neurometer performed less efficiently at 5 Hz (ICCs for the second and fifth digits were 0.292 and 0.318, respectively).

Conclusion

Overall, the Stimpod device displayed good to excellent reproducibility in measuring CPT in healthy volunteers. The Neurometer displayed poor reproducibility at low frequency (5 Hz). These results suggest that peripheral nerve stimulators may be potential devices for measuring CPT to assess nerve blocks.

Correlation of current perception threshold and somatosensory evoked potential in diabetes

Zheng W, He Y, Chen L.

Objective

To study the relationship between current perception threshold (CPT) and somatosensory evoked potential (SEP) in diabetes.

Methods

Both CPT and SEP were recorded in 66 diabetic patients. Both the CPT scores (measured at 2000 Hz, 250 Hz, and 5 Hz stimulations) and SEP (peak latency at ERB's point [Lat ERB] and popliteal fossa [Lat PF]; interpeak latency of "ERB to 7th cervical vertebra" [lat ERB-C7] and "popliteal fossa to lumbar vertebra" [lat PF-FO]) were recorded in both upper and both lower limbs, separately. t-tests and correlation analyses were performed to assess relationships between CPT and SEP tests.

Results

After adjustment for height and/or age, CPT scores at 2000 Hz were significantly correlated with Lat ERB (left: $p = 0.408$, $P < 0.05$; right: $p = 0.297$, $P < 0.05$), lat ERB-C7 (left: $p = 0.238$, $P < 0.05$; right: $p = 0.385$, $P < 0.05$), and Lat PF ($p = 0.216$, $P < 0.05$), and those at 250 Hz were moderately correlated with Lat ERB (left: $p = 0.234$, $P < 0.05$; right: $p = 0.306$, $P < 0.05$). CPT scores at 5 Hz were not significantly correlated with any SEP measurements ($P > 0.05$).

Conclusions

Both CPT scores at 2000 Hz and SEP may reliably determine large-fiber function in diabetic neuropathy.

Evaluation of the pathophysiology of classical trigeminal neuralgia by blink reflex study and current perception threshold testing

Ming Feng Liao • Meng Lee • Mei Jen Hsieh • Mei Yun Cheng • Jiann Der Lee • Hsu Huei Weng • Long Sun Ro

Abstract

We recruited 49 patients with classical trigeminal neuralgia (TN) according to the latest guidelines of the International Classification of Headache Disorders, and divided them into an acute (B30 days onset; 13 patients) and a chronic ([30 days onset; 36 patients) group. We used blink reflex study and current perception threshold (CPT) testing to evaluate the painful facial areas and contralateral non-painful areas of patients with classical TN. CPT 5 Hz examinations, which correlate with unmyelinated fiber function, showed significantly decreased CPTs in the acute stage (11.62 ± 6.99 vs. 18.69 ± 9.66 , $P = 0.025$), but significantly increased CPTs in the chronic stage (26.67 ± 18.65 vs. 19.69 ± 13.70 , $P = 0.010$) on the painful side when compared with the contralateral nonpainful side. However, CPTs at 250 Hz (Ad) and 2000 Hz (Ab) examinations did not show significant differences between the painful and non-painful sides. In contrast, only three (3/49) patients showed an abnormal trigeminal nerve stimulation on the ipsilateral painful side by blink reflex study. The findings suggest that classical TN is not a simple large-myelinated nerve fiber dysfunction but a more complex process with a main dysfunction of unmyelinated nerve fibers.

Current perception threshold in subacute Myelo-Optico-Neuropathy

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Tokyo, Japan

Abstract

Subacute myelo-optico-neuropathy (SMON) is caused by the ingestion of clinoquinol, which was previously used to treat diarrhea. Most of patients with SMON still experience serious neurological symptoms such as dysesthesia, sensory loss, motor weakness and visual impairment. However, there are few methods to evaluate the degree of sensory disturbances. The current perception threshold (CPT) examination has been reported to be useful for the evaluation, detection, screening, and diagnosis of peripheral nervous system diseases. In the CPT examination, 5Hz, 250Hz and 2000Hz stimulation has been considered to stimulate C fibers, A-f A fibers, and A- δ f A fibers, respectively. We used the $\sim$ Neurometer CPT/C to measure CPT. CPT was measured at the index finger and the near the external malleolus on the right side. We studied seven SMON patients (mean age: 71.9 $\pm$ 8.3 years) and seven age-matched controls (mean age: 71.3 $\pm$ 6.3 years). All patients showed numbness, dysesthesia, or pain of the lower extremities, but did not exhibit sensory disturbances of the upper extremities. The CPT to 250Hz stimulation and the CPT to 2000Hz stimulation in SMON group were significantly higher than those in control group, whereas the CPT to 5Hz stimulation in SMON group were significantly lower than those in control group. These results suggest that A-f A and A- δ f A fibers are impaired in patients $\wedge$ with SMON. C fibers are also impaired, but the mechanism of the impairment of C fibers is different from that of A-f A and A- δ f A $\wedge$ fibers. This may be related to the gate control theory. When A-f A $\wedge$ fibers are impaired, the gate control which is related to the slow pain does not work effectively. Therefore, CPT to 5 Hz which is related to C fibers may be lower. In conclusion, the CPT is useful in the detection and evaluation of sensory disturbances of the lower extremities in SMON.

Hypoaesthesia occurs with sensory hypersensitivity in chronic whiplash e Further evidence of a neuropathic condition

Andy Chien , Eli Eliav , Michele Sterling

Abstract

Hypersensitivity to a variety of stimuli has been shown in whiplash associated disorders and may be indicative of peripheral nerve involvement. This cross-sectional study utilised Quantitative sensory testing (QST) including vibration, thermal, electrical detection thresholds as an indirect measure of primary afferents that mediate innocuous and painful sensation. Pain thresholds and psychological distress (SCL-90-R) were also measured. Thirty-one subjects with chronic whiplash (>3 months, NDI: 49–17) and 31 controls participated. The whiplash group demonstrated elevated vibration, heat and electrical detection thresholds at most hand sites compared to controls ($p < 0.05$). Electrical detection thresholds in the lower limb were no different from controls ($p = 0.83$). Mechanical and cold pain thresholds were lower in the whiplash group ($p < 0.05$) with no group difference in heat pain thresholds ($p > 0.1$). SCL-90 scores were higher in the whiplash group but did not impact on any of the sensory measures. A combination of pain threshold and detection measures best predicted the whiplash group. Sensory hypoaesthesia and hypersensitivity co-exist in the chronic whiplash condition. These findings may indicate peripheral afferent nerve fibre involvement but could be a further manifestation of disordered central pain processing.

Neurometer Diagnostic Sensory Evaluationm

Joseph A. Cione, DPM, and John Cozzarelli

Abstract

Neurometer sensory nerve conduction technology has been used for sensory neurological evaluations since it was registered by the US Food and Drug Administration in 1986. The evaluation is an automated electrodiagnostic procedure that objectively quantifies the functioning of both unmyelinated and myelinated sensory nerve fibers at any cutaneous site. It is routinely used for the objective determination of painless current perception thresholds (CPTs) (see Figure 1). The stimulus is neuroselective and evokes responses that quantify the functional integrity of each of the 3 major subpopulations of sensory nerve fibers. Specifically, A- A , and C fiber groups are selectively stimulated by sinusoid waveform currents of 2000 Hz, 250 Hz, and 5 Hz, respectively. The Neurometer CPT/C can evaluate and document sensory nerve impairments at any cutaneous or mucosal site. The sensory nerve conduction threshold (sNCT)/CPT evaluation is extremely sensitive, detecting and quantifying hyperesthesia in early-stage progressive neuropathy and hypoesthesia in more advanced conditions (see Table 1). The software included with the sNCT device performs a standardized analysis, stores the patient's CPT values, and generates a report detailing the condition of the nerves tested (see Figure 2). These evaluations are based on comparisons with standardized ranges of healthy CPT measures and their ratios.

Selective activation of primary afferent fibers evaluated by sine-wave electrical stimulation

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Abstract

“Transcutaneous sine-wave stimuli at frequencies of 2000, 250 and 5 Hz (Neurometer) are thought to selectively activate A α , A δ and C afferent fibers, respectively. However, there are few reports to test the selectivity of these stimuli at the cellular level. In the present study, we analyzed action potentials (APs) generated by sine-wave stimuli applied to the dorsal root in acutely isolated rat dorsal root ganglion (DRG) preparations using intracellular recordings. We also measured excitatory synaptic responses evoked by transcutaneous stimuli in substantia gelatinosa (SG) neurons of the spinal dorsal horn, which receive inputs predominantly from C and A δ fibers, using in vivo patch-clamp recordings. In behavioral studies, escape or vocalization behavior of rats was observed with both 250 and 5 Hz stimuli at intensity of ~0.8 mA (T5/ T250), whereas with 2000 Hz stimulation, much higher intensity (2.14 mA, T2000) was required. In DRG neurons, APs were generated at T5/T250 by 2000 Hz stimulation in A α , by 250 Hz stimulation both in A α and A δ , and by 5 Hz stimulation in all three classes of DRG neurons. However, the AP frequencies elicited in A α and A δ by 5 Hz stimulation were much less than those reported previously in physiological condition. Within vivo experiments large amplitude of EPSCs in SG neurons were elicited by 250 and 5 Hz stimuli at T5/ T250. These results suggest that 2000 Hz stimulation excites selectively A α fibers and 5 Hz stimulation activates noxious transmission mediated mainly through C fibers. Although 250 Hz stimulation activates both A δ and A α fibers, tactile sensation would not be perceived when painful sensation is produced at the same time. Therefore, 250 Hz was effective stimulus frequency for activation of A δ fibers initiating noxious sensation. Thus, the transcutaneous sine-wave stimulation can be applied to evaluate functional changes of sensory transmission by comparing thresholds with the three stimulus frequencies.”

Dissociable Brain Activation Responses to 5-Hz Electrical Pain Stimulation: A High-field Functional Magnetic Resonance Imaging Study

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Background

To elucidate neural correlates associated with processing of tonic aching pain, the authors used high-field (3-T) functional magnetic resonance imaging with a blocked parametric study design and characterized regional brain responses to electrical stimulation according to stimulus intensity—response functions.

Methods

Pain was induced in six male volunteers using a 5-Hz electrical stimulus applied to the right index finger. Scanning sequences involved different levels of stimulation corresponding to tingling sensation (P1), mild pain (P2), or high pain (P3). Common effects across subjects were sought using a conjunction analyses approach, as implemented in statistical parametric mapping (SPM-99).

Results

The contralateral posterior/mid insula and contralateral primary somatosensory cortex were most associated with encoding stimulus intensity because they showed a positive linear relation between blood oxygenation level-dependent signal responses and increasing stimulation intensity ($P1 < P2 < P3$). The contralateral secondary somatosensory cortex demonstrated a response function most consistent with a role in pain intensity encoding because it had no significant response during the innocuous condition (P1) but proportionally increased activity with increasingly painful stimulus intensities ($0 < P2 < P3$). Finally, a portion of the anterior cingulate cortex (area 24) and supplementary motor area 6 demonstrated a high pain—specific response (P3).

Conclusions

The use of response function modeling, conjunction analysis, and high-field imaging reveals dissociable regional responses to a tonic aching electrical pain. Most specifically, the primary somatosensory cortex and insula seem to encode stimulus intensity information, whereas the secondary somatosensory cortex encodes pain intensity information. The cingulate findings are consistent with its proposed role in processing affective—motivational aspects of pain.

Regeneration of Peripheral Nerve Gaps with a Polyglycolic Acid-Collagen Tube

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Objective

The aim of this study was to report by means of objective methods on the effectiveness of a nerve reconstruction procedure using a bioresorbable tube in two patients. Our previous successes in regenerating canine peripheral nerves across long distances (80-mm gaps) using a bioabsorbable tube have led us to investigate the value of such a tube for the treatment of human patients with chronic nerve injuries.

Methods

The device was made from a cylindrically woven polyglycolic acid tube filled with a collagen sponge. It was designed to be resorbed after nerve regeneration. Peripheral sensory nerve defects in two patients with neuroma and pain were reconstructed using this tube. Patient 1 (a 62-year-old man) had a 20-mm defect of the proper digital nerve, and Patient 2 (a 56-year-old woman) had a 65-mm defect of the superficial peroneal nerve.

Results

After surgery, both patients recovered from the unpleasant sensations and intolerable pain. In Patient 1, functional recovery was objectively identified at 2 months, and conduction velocity of the nerve recovered to 49.1 m/s. In Patient 2, conduction velocity of the nerve was determined to be 16.9 m/s at 5 months. Current perception threshold testing indicated that sensory nerve function had been recovered by 65 days after surgery.

Conclusion

This work represents the first precise clinical evaluation, performed under objective evaluation criteria, of sensory recovery achieved using a nerve tube, suggesting that the use of a polyglycolic acid-collagen tube has the potential to become a viable alternative to conventional autografting for the repair of peripheral nerve defects

Pain Threshold in Patients with Chronic Lumbar Radiculopathy

Rao Jilun, Zhang Quanwei, Liao Shicheng

Abstract

The issue concerning the treatment of the patients with chronic lumbar radiculopathy is very important in clinical practice. How to evaluate the degree of pain in these patients objectively is a major concern of many researchers. Our research studied the chronic lumbar radiculopathy in chronic low back pain patients who have pain longer than 6 months. The radiculopathy will be confirmed by nerve conduction velocity study and electromyography. Their pain will be evaluated by Pain visual analog scale, Algometer for pressure pain threshold, and Neurometer for current perception threshold. Also, Oswestry Low back disability Questionnaire and Beck depression inventory will be combined with the data above to build the multidimensional pain model of the patients with chronic lumbar radiculopathy. Subsequently, the clinical guide of a comprehensive rehabilitation program will follow the model.

Current Perception Threshold Testing in Fabry's Disease

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Taipei, Taiwan

Abstract

"We investigated 16 patients with Fabry's disease (eight hemizygous men and eight heterozygous women) in one family. We used constant current perception threshold (CPT) testing, which evaluated three major sensory nerve fiber populations, to assess subjective complaints of pain and paresthesia. We also examined clinical and biochemical features and compared the values to CPTs and nerve conduction studies (NCS) in detecting the sensory neuropathy. Our results showed that CPT testing at low frequencies (5 and 250 Hz) was significantly more sensitive than at a higher frequency (2kHz) and NCS* in detecting sensory neuropathy in patients with Fabry's disease."

Discussion

"...abnormal current perception was higher in frequencies at 5 Hz and 250 Hz (37.5% and 50%, respectively) than 2 kHz (0%). CPT testing has some advantages. It is easy to perform and can provide a multimodal diagnostic evaluation by testing three major sensory nerve fiber sub-populations within each test site. Furthermore, lower frequencies (5 Hz and 250 Hz) appear to be the most effective in detecting involvement of C and A_δ fibers respectively. Also, range analysis of CPT testing detected both abnormally low (hyperesthetic) and abnormally high (hypoesthetic) CPT values when compared with healthy groups. Testing is useful in subjects with Fabry's disease who have spontaneous burning pain, paresthesia or hyperesthesia."..."Because selective involvement of smaller myelinated and unmyelinated fibers occurs in Fabry's disease, neurological examination and standard NCSs are usually normal. Large myelinated fiber functions are usually preserved despite the fact that median nerve compression at the wrist is more frequent in these patients than in healthy subjects. This is consistent with our findings that compound action potentials, sensory nerve action potentials, and conduction velocities were all within the reference ranges.

The sensitivity of CPTs can be enhanced by testing at multiple body sites and with all three frequencies (5, 250, and 2000 Hz) of stimuli. Testing at more than one location allows the assessment of within site and between site ratios, which are extremely sensitive to early stages of peripheral neuropathy. Combining all modalities including range and ratio analyses can significantly increase the sensitivity to detect peripheral sensory impairment in diabetic and uremic neuropathies but did not do so in our patients with Fabry's disease"

Unmyelinated Fibre Pathology in Diabetic Patients with Mild Neuropathy

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Abstract

"We studied the unmyelinated fibre pathology in sural nerve biopsies of 15 diabetic patients (mean age 47 years, 8 type 1, mean duration of diabetes 16.3 years) and compared them with 8 age-matched controls. The results were also related to neuropathy symptom score (NSS) and quantitative sensory testing including current perception threshold (CPT) assessed with a Neurometer. There was no difference in the mean unmyelinated fibre density between diabetic patients and controls ($50511 \text{ fibres/mm}^2 \pm 6084 \text{ SE}$ vs 56059 ± 5054) but the fibre diameter in diabetic patients was smaller ($0.521 \mu\text{m} \pm 0.034$ vs 0.876 ± 0.18 , $p < 0.001$). An increase was found in the unassociated Schwann cell profile density (36205 ± 4039 vs 8905 ± 1105 , $p < 0.0001$), the total Schwann cell profile density (61393 ± 4472 vs 44805 ± 3616 , $p < 0.02$) and the % of unassociated Schwann cell profile density (58.11 ± 4.25 vs 20.83 ± 3.09 , $p < 0.0001$). A positive correlation was found between NSS and the unassociated Schwann cell profile density $r = 0.55$, $p < 0.05$), unmyelinated fibre density and CPT at 250 Hz $r = 0.58$, $p < 0.05$) and fibre diameter and CPT at 2 kHz $r = 0.59$, $p < 0.05$). No correlation existed between any unmyelinated fibre pathology and myelinated fibre density, warm thermal threshold, vibration perception threshold and electrophysiology. We conclude that unmyelinated fibre pathology with increased degeneration rates and axonal atrophy are present in patients with early neuropathy and that CPT may be of use in assessing this abnormality. "

Current Perception Threshold: an Adjunctive Test for Detection of Acquired Demyelinating Polyneuropathies

Daniel L. Menkes, Michael R. Swenson and Howard W. Sander

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Abstract

"Current Perception Threshold (CPT) evaluation quantifies the sensory threshold to transcutaneous electrical stimulation of three sensory fiber subtypes: A-beta (2000 Hz), A-delta (250 Hz) and C fibers (5 Hz). Demyelinating polyneuropathies tend to affect larger myelinated fibers before smaller unmyelinated fibers, and they usually begin at the proximal nerve roots or terminal axons, due to relative weakness of the blood-nerve barrier in these locations. Axonal polyneuropathies tend to affect smaller fibers before larger fibers, in a distal to proximal gradient. Ten patients with demyelinating polyneuropathy and ten patients with axonal polyneuropathy underwent CPT testing. CPT comparisons were made with regard to side-to-side asymmetries, fiber type involvement, and the ratio of fiber types involved. The C2, lateral antebrachial cutaneous, and sural distributions were examined bilaterally. Demyelinating polyneuropathies were detected with 50% sensitivity and 100% specificity. This diagnostic sensitivity is similar to that of published criteria based upon motor nerve conduction. CPT testing can distinguish demyelinating from axonal polyneuropathies. It may be particularly helpful in patients with predominantly sensory symptoms in whom EMG/NCS data may be equivocal, or in patients who decline EMG/NCS studies."

Age and Gender Differences in Skin Sensory Threshold Assessed By Current Perception in Community-Dwelling Japanese

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Department of Epidemiology, National Institute for Longevity Sciences, Nagoya, Japan

Abstract

"The purpose of this study was to investigate age and gender differences in current perception thresholds (CPT) in Japanese citizens. CPT values at frequencies of 2000, 250 and 5 Hz reflect different types of peripheral sensory nerve functions. Since there have been only a limited number of reports which investigated CPT values in community-dwelling people, little is known about variations with age and gender. The present study therefore concentrated on a large population of 1632 individuals (men; 818 mean age $\pm$ standard deviation 59.4 ± 10.9 , women; 814, 59.4 ± 11.1) in a Japanese community. Significant gender differences in CPT values at 250 and 5 Hz were observed. Multiple comparisons among 4 age groups (40s, 50s, 60s, and 70s) showed age-related differences in CPT values at 2000 and 250 Hz in both genders. However, age and gender interactions with reference to CPT values appeared to be different between these latter two frequencies. At 5 Hz, only men showed age-related variations. These results indicated gender differences in fiber-specific aging changes."

Neuropathy with Anti-Myelin-Associated Glycoprotein Antibodies; Quantitative Sensory Testing and Response to Intravenous Immunoglobulin

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Introduction

"The neuropathy associated with Anti-MAG antibodies is typically demyelinating and predominately sensory. The role of quantitative sensory testing in the evaluation and treatment of patients with this disease has not previously been investigated."

Objectives

"To characterize the sensory changes in neuropathy associated with Anti-MAG antibodies by QST, and determine the response to therapy with intravenous human immunoglobulins (IVIg)."

Methods

"Ten patients with Anti-MAG neuropathy were evaluated clinically and by QST, measured at the large toe at 3 stimulation frequencies; 2000 Hz, 250 Hz, and 5 Hz (Neurometer CPT/C, Neurotron, Inc.). Four of the patients were examined following a 3 month course of treatment with IVIg. Three of the four had muscle weakness in addition to the sensory loss."

Results

"All ten patients had clinical evidence for large fiber sensory loss with impairment of position and vibration. In all ten, QST values at 2000 Hz were above the normal range (613-999, mean 892; normal range 179-523, mean 322, S.D. 110). At 250 Hz, QST values in 8 of 10 patients were above the normal range (195-538, mean 323; normal range 44-208; mean 125; S.D. 52). At 5 Hz, QST values in 3 of 10 patients were above the normal range (59-375, mean 145; normal range 18-170; mean 73, S.D. 34). Following IVIg treatment, there was improvement of QST scores in all 4 patients who received treatment. There was also improvement in strength in the 3 treated patients who manifested weakness."

Conclusions

"QST in patients with Anti-MAG neuropathy is consistent with a characteristic pattern of large fiber sensory loss. Therapy with IVIg can improve both sensory and motor functions."

fMRI Mapping of CNS Activations Following Noxious Heat and Electrical Stimuli

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Introduction

“We have recently demonstrated that fMRI activation in the CNS can be reproducibly measured following controlled noxious heat stimuli. Our results are in agreement with those emission tomography (PET). The aim of this study was to determine fMRI activation by electrical stimuli and compare it with activation produced by noxious heat (46C).”

Method

“Eight normal right-handed male volunteers (age: 33.5 ± 7.7) were used for the electrical and six of the eight for noxious heat stimuli... For the electrical protocol a commercial stimulator (Neurometer, Neurotron Inc.) Was modified to be MRI-comparable. Current was delivered to the dorsum of the left hand with gold plated electrodes (Goldtrode, Neurotron Inc.). Three different frequencies were used: 5, 250 and 2000Hz. Current levels (mA) necessary to produce noxious stimulus were determined by psychophysical testing before scanning and they were matched to produce a visual analog scale (VAS) score of 7 (0-10) for each frequency... The location was chosen to overlap that stimulated by the electrodes. 4 epochs of 25 s long of 46C were interleaved with 30 s of neutral (35C) temperature. For all the functional scans subjects had their eyes closed and VAS scores were obtained after each functional scan. For the noxious heat stimulus the VAS scores (0-10) were 8.3 ± 1.5 and for the electrical stimulus: 7.0 ± 0 .”

Magnetic Resonance

“The fMRI protocol consists of a sagittal localizer followed by a 3D sagittal SPGR scan (1.2 mm in-plane 2.8 mm thick); 20 slices (7 mm thick) are prescribed perpendicular to the AC-PC line and covering all the frontal lobes to most of the cerebellum. This prescription is used for the following flow-compensated and High Resolution weighed scans. The actual functional scans are taken using an asymmetric spin echo sequence to be sensitive to the BOLD effect. Functional scans are prescribed on the same 20 slices (3.125 mm in-plane, TR/TE= 2.5/70) and 100 images per slice are collected.”

Results and Discussion

“We have found that noxious heat and electrical stimuli activated mostly the same CNS areas as seen in PET studies (anterior and posterior cingulate, somatosensory cortex, thalamus, insula, frontal lobes). The noxious thermal stimuli have been traditionally accepted as a “natural stimuli”, mediated by unmyelinated C-fibers. We observed similar areas of activation using electrical stimuli at 5 Hz. Adaptation to noxious heat was observed and correlates with psychophysical data (VAS scores). Furthermore, it is in agreement with time courses seen in previous studies of peripheral nociceptor adaptation to heat stimuli. However, no adaptation was observed to noxious electrical stimuli. This can be putatively explained by electrical stimuli bypassing peripheral nociceptors and directly stimulating nerve fibers.”

Clinical Neurophysiology Laboratory Tests to Assess the Nociceptive System in Humans

Rose M. Dotson, M.D.

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"This paper presents some currently available neurophysiological tools that are helpful in the clinical setting to evaluate and document neuropathic disturbances that maybe associated with pain. The specific tests described in this discussion are quantitative sensory tests (QST's) autonomic tests (AT's), micro-neurography (MCNO), and laser evoked potentials (LEP's). Quantitative sensory testing of the nociceptive system includes the thermal stimulation (TST) and current threshold (CPT) tests."

"The Current Perception Threshold (CPT) is measured by a microprocessor-controlled electrical neurostimulator and two electrodes coated with conductive gel firmly applied to the skin within the distribution of a cutaneous nerve or dermatome. The stimulator of the commercially available equipment delivers a sinusoidal constant alternating current at three different stimulus frequencies, 5, 250, and 2,000 Hz, and intensities of 0.01 to 9.99 mA. The electrical current stimulates nerve fibers directly because the intensity is far below that required to stimulate the actual receptors in the skin. There is evidence that different stimulation frequencies activate different classes of sensory nerve fibers. The perceived sensation is different for each of the three frequencies of stimulation. MCNG studies have also shown that direct stimulation of single nerve fibers with an intraneural microelectrode results in distinct sensory perceptions. Sinusoidal percutaneous stimulation at a frequency of 5 Hz seems to activate C fibers, the small-diameter slow-conducting axons, which have higher electrical thresholds and require longer stimulus duration. The somewhat larger diameter, faster-conducting A α fibers respond best to stimulation at a frequency of 250 Hz. Finally, 2,000 Hz stimulation activates the large, fast conducting AB fibers that have the lowest electrical thresholds and require less time for activation."

"The CPT technique has a high sensitivity (> 92%) for detecting neuropathies when the test includes multi sites and all three frequencies. The coefficient of variation for the CPT in normal subjects and in patients with neuropathy is 5 to 27.5%."

"Comparisons with nerve conduction studies, TST, vibration threshold studies, and somatosensory evoked potential studies support the neuro-selective nature of this technique. Histopathological and pharmacological studies also provide even further support for the ability of this technique to selectively evaluate the three types of sensory nerve fibers with stimulus frequency variation."

Current Perception Threshold (CPT) in Syringomyelia

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Abstract

"A feature characteristic of Syringomyelia is a dissociated sensory loss. Damage to the decussating pain and temperature fibers in the anterior commissure leads to a segmental dissociation of sensory disturbances with a sparing of vibration and position senses. This condition of dissociated sensory loss was used as a model to assess the neuroselectivity of the diagnostic Current Perception Threshold (CPT) evaluation."

"Seven patients diagnosed by MRI with cervical syringomyelia (18-56 yrs) were compared with 15 age matched controls (21-60 yrs). Each subject received a neurological clinical evaluation, including the assessment of sensory function. Standardized single-blind forced-choice testing methodology was employed for current perception threshold evaluations (5, 250, and 2000 Hz) that were conducted bilaterally (C6 and C8 dermatome) using a Neurometer® CPT quantitative sensory test device (Neurotron, Inc., Balto., MD)."

"The Syringomyelia subjects' thresholds were significantly elevated in comparison with the controls (5 Hz and 250 Hz ($p<0.001$). There was no significant difference at 2000 Hz. There was a significant correlation between the clinical assessment of dissociated sensory loss and current thresholds ($r=0.73$; $p<0.01$). Current threshold sensitivity was 100% and the specificity was 93%."

"The findings from the study demonstrate current threshold to various stimulus sinusoidal rates to effect different afferent fibers as a measure of dissociated sensory loss."

Neuropathy of Uremia: Evaluation by Nerve Conduction Velocity versus Neurospecific Current Perception Threshold

S.A. Weseley, et. al.

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Abstract

"Normal peripheral nerve conduction is a marker of adequate dialytic therapy in the ESRD population. Decreasing nerve function detected by periodic testing indicates insufficient dialysis. The standard test for the quantitative evaluation of nerve integrity is the nerve conduction test (NCT). A study of 34 dialysis patients proves that the measurement of current perception threshold (CPT) is equally effective to NCT in defining peripheral nerve function ($r=0.81$, $p<0.001$). The superiority of the CPT examination is discussed."

Discussion

"Additional considerations for the evaluation of a neurometric procedure include patient compliance and clinical utility. NCT evaluations are routinely available but they are seldom employed on dialysis patients due to poor compliance secondary to its aversive stimulus. In contrast, the CPT stimulus is painless - an aspect of this methodology which is naturally welcomed by patients."

"...the ability to perform the CPT test during a dialysis session makes obtaining a neurological assessment convenient for the patient. The Neurometer device is portable and battery operated, and is therefore, electrically safe and easy to use around the dialysis equipment. These features of the CPT testing procedure will increase patient compliance for neurological assessment, while providing a clinical test that is both reliable and sensitive."

Neurological Complications in Chronic Uremia Management

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Introduction

"Polyneuropathy is one of the most common consequences of chronic renal failure... The majority of patients are asymptomatic, requiring electrophysiological testing to confirm the abnormality. Uremic polyneuropathy is a distal "dying-back" metabolic polyneuropathy... Sensory nerve conduction is apparently more sensitive than motor nerve conduction. The effect of dialysis on uremic polyneuropathy is variable, but signs and symptoms usually stabilize or improve slowly. The trend to short dialysis strategies is a cause for heightened awareness, and "under dialysis" has been an issue in morbidity and mortality among end-stage renal disease (ESRD) patients in the United States. Infact, the health of the peripheral nerve is an important quantitative longitudinal measure of dialysis adequacy in the non-diabetic uremic."

Methods

"...the neuroselective current perception threshold (CPT) routinely in our dialysis population since 1991. The CPT evaluation is conducted with a portable, battery-operated (6V) Neurometer® CPT diagnostic neurostimulator, using a standardized, single-blind, forced-choice testing methodology. CPT is measured bilaterally at the distal phalange of the great toe (peroneal nerve), which is the earliest site for detecting uremic neuropathy, as well as at both the distal phalange of the second finger (median nerve) and the fifth finger (ulnar nerve) to screen for carpal tunnel syndrome. Measurements are made at three frequencies... representing selective stimulation of Types C, B, and A afferent fibers, respectively."

Results

"...as expected, diabetics have significantly more severe neuropathy than do non-diabetics ($p < 0.003$). Severe neuropathy was highly predictive of 1-year mortality in non-diabetics."

Conclusions

"Monitoring simultaneously the peripheral nerve, as well as markers of somatic and visceral protein stores... should offer the possibility of developing a "risk profile" in the ESRD population."

Current perception threshold and the HAVS Stockholm sensorineural scale

Ron House, Kristine Krajnak, Michael Manno and Lina Lander

Background

It is important to determine which tests of sensorineural dysfunction identify the neurological damage from hand–arm vibration exposure.

Aims

To examine the association between the hand–arm vibration syndrome (HAVS) Stockholm sensorineural scale stages and tests of peripheral neurological function including measurement of current perception threshold (CPT) and nerve conduction.

Methods

All the subjects were men who were assessed for HAVS with a medical and occupational history and physical examination to determine the Stockholm stage, CPT testing at frequencies of 5, 250 and 2000 Hz for the median and ulnar nerves and measurement of nerve conduction carried out in a blinded fashion.

Results

A total of 155 of the 157 recruited subjects agreed to take part in the study, a 99% participation rate. CPT was statistically significantly increased ($P < 0.001$) in both Stockholm sensorineural Stages 1 and 2 in comparison to Stage 0 for every frequency and nerve combination. However, CPT could not discriminate well between Stages 1 and 2. There was no association between median or ulnar neuropathy measured by nerve conduction and the Stockholm stages. Polychotomous multinomial logistic regression indicated that the CPT measurements at 2000 Hz, corresponding to damage to large myelinated nerve fibres, were most predictive of both Stockholm Stages 1 and 2 in comparison to Stage 0.

Conclusions

Neuropathy measured by nerve conduction was unrelated to the Stockholm scale stages. CPT was increased above Stage 0 but did not distinguish well between the higher stages of the Stockholm scale.

Current Perception Threshold: Reproducibility and Comparison with Nerve Conduction in Evaluation of Carpal Tunnel Syndrome

J.J. Katims, et. al.

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Abstract

"Neuro-selective current perception threshold (CPT) values quantify peripheral nerve integrity, and provide an index of adequate hemodialysis (HD). Evaluation of polyneuropathy (PN) by CPT correlates with nerve conduction testing (NCT). CPT is convenient, painless and may be performed during HD. Early detection of carpal tunnel syndrome (CTS), a complication of uremia, permits curative intervention. Utility of CPT and NCT measurements in detecting CTS in 29 stable HD patients were evaluated. Reproducibility of seven CPT determinations over 4 weeks was determined in each of 9 HD patients. The coefficient of variation for repeated 2000 Hz CPT measures was 6%. PN was detected by CPT in 92% of the patients and by NCT in 79% ($r=0.79$, $p<0.001$). In 38% of the hands there was a CPT impairment in both the median and ulnar nerves of which 25% were symptomatic for CTS. CPTs consistent with CTS (sufficiently greater impairment of the median vs ulnar nerve) were observed in 31% of the hands with combined median and ulnar nerve CPT abnormalities, and 11% were identified with CTS by NCT. The unique ability of the CPT exam to quantify hyperesthesia may account for its superior CTS detection sensitivity. These findings demonstrate that repeated CPT determinations are consistent, and are diagnostic for CTS."

Discussion

"The apparent stability of short-term repeated CPT measures, combined with its extreme sensitivity, enhances its utility for screening and evaluation of CTS and adequacy of dialysis therapy. This is especially important in uremic patients where symptoms resembling CTS often reflect polyneuropathy. Additionally, in contrast with NCT, the CPT technique employs a painless methodology that may be safely applied during dialysis therapy, facilitating compliance for repeat evaluation."

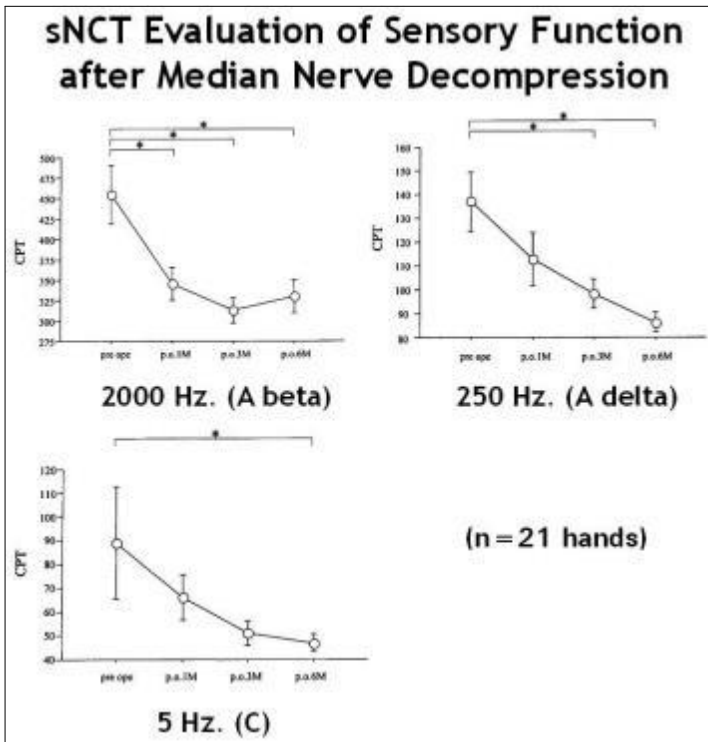
Evaluation of Sensory Function after Median Nerve Decompression in Carpal Tunnel Syndrome Using the Current Perception Threshold Test

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Abstract

“The recovery level for sensory function after carpal tunnel release for the treatment of idiopathic carpal tunnel syndrome (CTS) was assessed with the current perception threshold (CPT) test. Seventeen CTS patients (21 hands) were followed, and the CPTs at the index finger of each patient was measured preoperatively and at 1, 3, and 6 months postoperatively. After carpal tunnel release, there was significant recovery of CPT at all stimulation frequencies, indicating improvement of all sensory functions including sensations of temperature, pain, touch, and vibration.”



Current Perception Thresholds in Vibration-Induced Neuropathy

Youichi Kurozawa and Yoshiro Nasu

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San-in Rosai Hospital, Yonago, Japan.

Abstract

"The authors evaluated the usefulness of Current Perception Threshold (CPT) testing for the assessment of vibration-induced neuropathy (VIN)."

Subjects and Method

"Fifty-nine men... for hand-arm vibration syndrome... officially recognized by the Japanese Ministry of Labor... On the basis of the results of a clinical neurological examination and nerve-conduction test, researchers classified the men according to sensori-neural stages of the Stockholm workshop scales. Stage 2 was defined as intermittent or persistent numbness, as well as reduced sensory perception confirmed by subjective tests for tactile, esthesiometric and vibrotactile perception. Stage 3 was defined as intermittent or persistent numbness with reduced tactile discrimination or impaired nerve conduction."

"Twenty male volunteers... served as controls."

Results

"Stage 1-3 groups had significantly increased CPTs at 2000 Hz, compared with the control group. There was a significantly different CPT at 250 Hz between the stage 1 and stage 3 group."

Discussion

"Nerve-conduction velocity is dominated by the large myelinated fibers... CPT allows for quantitative and selective measurement of three different types of sensory nerve fibers. Large myelinated fibers, small myelinated fibers, and unmyelinated fibers... In the present investigation, the VIN groups had significant increases of CPT of the myelinated fibers, but not for the unmyelinated fibers."

"Thickness of finger skin is often found in operators who use vibratory tools. This thickness may contribute to the differences in temperature thresholds. Current output of the Neurometer is maintained constantly by a feedback circuit. The CPT test, therefore, is unaffected by skin thickness. The results of our study may support the findings of previous histological findings: demyelination is found predominantly in the peripheral nerves in the hands of men exposed to hand-arm vibration."

"We conclude, therefore, that the CPT evaluation is useful for the assessment of VIN."

Upper Extremity Cumulative Trauma Disorders (UECTDs) Screening Protocol - A Different Perspective

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Abstract

"Recent Bureau of Labor Statistics data revealed that carpal tunnel syndrome and wrist-related cases led all disabling conditions for lost days from work and prolonged recovery periods. In addition repetitive nature tasks led in "lost work days." Meat processing was recognized as a high risk focus. An UECTD management protocol was implemented in a poultry plant (Tyson Foods) of approximately 1100 employees (killing 1.3 million chickens per week). A screening protocol was implemented to identify individual workers experiencing UECTDs. Unique to the process was the emphasis on comparing the 'individual to themselves' rather than to 'normative data' (which may or may not be representative of the worker or the exposure). Screening was performed on a sequential basis to monitor changes from baseline. Screening tests included: hand strength, volumetric measures, sensory changes*, dexterity measures, joint motion, and symptom survey. To date, 1500 workers have been screened with an attendant decrease in upper extremity worker's compensation costs of over \$110,000.00 per year. Only one surgery as been performed (on a worker that had fallen out of the screening process). Previously approximately 20 surgeries were performed annually. This paper will present the protocol and ongoing analysis of the population data and its implications for UECTD case management."

* *Electrodiagnostic sensory testing by Current Perception Threshold (CPT) evaluation.*

The Relationship Between Peripheral Nerve Function and Markers of Lead Dose

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Objective

“To determine if bone lead with a half life of 25 years, is a better marker of lead dose than blood lead measures that reflect current, average or cumulative lead exposure when predicting peripheral nerve function.”

Background

“The literature reports lead neuropathy at blood lead concentrations above 60 µg/dl but no studies examine the association of peripheral nerve function and measures of cumulative lead exposure.”

Methods

“78 current smelter workers with a mean (SD) age of 44 (8.3) years and employment duration of 20 (5.6) years had Quantitative Sensory Testing** (QST) with current perception threshold using three different stimuli, 2000, 250 and 5 Hz, to the ring finger and second toe. Threshold, established by forced choice method, equaled a stimulus that was consistently felt at one intensity and not at a slightly lower intensity. We examined separate multiple linear regressions with adjustment for covariates, (age, smoking and alcohol use), to determine the contribution of four measures of lead dose: current blood lead (PbB), working lifetime-weighted average blood lead (WABL), working lifetime-integrated blood lead (IBL) and bone lead (PbBn), to QST assessment.”

Results

“Mean (SD) markers of lead dose included PbB 26 (7.1) µg/dl, WABL 42 (8.4) µg/dl, IBL 902 (301.7) µg yr/dl, and PbBn 41 (24.6) µg/(g bone mineral). We found no significant contribution of PbBn, PbB and WABL to QST with linear regression.”

Conclusions

“Bone lead is not associated with peripheral nerve function as measured with QST. Of the other markers of lead dose, IBL, a measure of cumulative lead exposure over years employed, more closely approximates the lead dose to the nerve. A dose effect relationship exists between IBL and QST. The time spent above a PbB concentration of 40µg/dl is the lead dose most critical for predicting QST.”

* This study was supported by the New Brunswick Occupational Health and Safety Commission

** QST testing performed with Neurometer® CPT/C devices

Chest tube insertion is one important factor leading to intercostal nerve impairment in thoracic surgery

Takuro Miyazaki, Tetsuya Sakai, Naoya Yamasaki, Tomoshi Tsuchiya, Keitaro Matsumoto, Tsutomu Tagawa, Go Hatachi, Koichi Tomoshige, Mariko Mine, Takeshi Nagayasu

Objectives

Chest tube insertion seems to be one important factor leading to intercostal nerve impairment. The purpose of this prospective study was to objectively evaluate intercostal nerve damage using current perception threshold testing in association with chest tube insertion.

Methods

Sixteen patients were enrolled in this study. Intercostal nerve function was assessed with a series of 2000-Hz (Ab fiber), 250-Hz (Ad fiber), and 5-Hz (C fiber) stimuli using current perception threshold testing (Neurometer CPT/C). Current perception threshold values at chest tube insertion were measured before surgery, during chest tube insertion and after removal of the chest tube. Intensities of ongoing pain were also assessed using a numeric rating scale (0–10).

Results

Current perception thresholds at each frequency after surgery were significantly higher than before surgery. Numeric rating scale scores for pain were significantly reduced from 3.3 to 1.9 after removal of the chest tube ($p = 0.004$). The correlation between current perception threshold value at 2000 Hz and intensity of ongoing pain was marginally significant ($p = 0.058$).

Conclusions

This is the first study to objectively evaluate intercostal nerve damage at chest tube insertion. The results confirmed that chest tube insertion has clearly deleterious effects on intercostal nerve function.

Objective Assessment of Nerve Injury after Greater Saphenous Vein Stripping

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Aim

The complication of nerve injury after greater saphenous vein stripping for varicosity is subjective, and a method for objective evaluation has never been established. The aim of this study was to evaluate postoperative sensory changes by quantitative assessment of current perception threshold (CPT), and to clarify the relation between CPT and symptoms.

Patients and Methods.

Between January 2003 and August 2005, 27 limbs in 18 patients were enrolled. Quantitative sensory function was determined through CPT using a Neurometer® (Neurotron, Inc., USA), with which saphenous nerve neural fiber selective minimum sensing values against three electrical stimuli (2000, 250, 5 Hz) were measured. CPT measurements were scheduled on the day before the operation, and 2e7 days, 1, 3, and 6 months after the operation.

Results

An increase in CPT value of more than 20% or decrease to below 50% compared to the preoperative value with at least two stimuli was defined as CPT abnormality. Subjective symptoms were observed in 13 limbs in the early postoperative period, and 10 limbs showed CPT abnormality. In 6 limbs with a CPT increase over 20% with all three stimuli, neurological symptoms continued for 6 months.

Conclusions

CPT evaluation provides an objective indication of neurological symptoms in the lower limb following varicose vein surgery.

A Quantitative Analysis of Sensory Function in Lumbar Radiculopathy Using Current Perception Threshold Testing

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Study Design

“Peripheral sensory functions in patients with radiculopathy resulting from lumbar disc herniation and in control individuals were analyzed using current perception threshold testing.”

Objective

“[T]o evaluate severity as sensory disturbance quantitatively in patients with lumbar radiculopathy.”

Summary of Background Data

“Subjective evaluation of severity as sensory disturbance associated with spinal disorder using conventional methods often is difficult. Current perception threshold evaluation is a recently proposed method for studying peripheral nerve dysfunction. This is a quantitative sensory test for analyzing functions of A-beta, A-delta, and C fibers.”

Method

“In this study 48 patients with lumbar radiculopathy resulting from lumbar disc herniation were examined. The mean age of the patients was 37.9 years. All the patients had pain distribution from the compression of one lumbar nerve root (L5 or S1), and unequivocal unilateral disc herniation of the corresponding level was shown by magnetic resonance imaging. Eleven healthy volunteers were used as control subjects. Their mean age was 38.2 years. Current threshold evaluation using a Neurometer device was performed at three frequencies: 2000, 250, and 5 Hz. The stimulus sites were located on the dorsal side of the first metatarsus (the L5 dermatome) and the dorsal side of the fifth metatarsus dermatome. These sites were investigated on both legs in all the patients and control subjects. The intensity of pain was scored using a visual analog scale.”

Results

“In the control group, there were no significant differences in current perception threshold values at any frequency between the left and right legs. In the patient group, the current perception threshold values in the affected legs were significantly higher than those in the contralateral legs at all frequencies. The current perception threshold values in the affected legs in the patient group were significantly higher than those in the control subjects at 2000 and 250 Hz, whereas there were no significant differences at 5 Hz. The current perception threshold values in the affected legs were significantly higher in patients with hyperesthesia than in those without hypesthesia at 2000 and 250 Hz, and in patients with severe pain than in those with less pain at 5 Hz.”

Conclusions

“Current perception threshold testing showed that the functions of A-beta, A-delta, and C fibers deteriorated in patients with radiculopathy.

Dorsal root entry zone microcoagulation for spinal cord injury-related central pain: operative intramedullary electrophysiological guidance and clinical outcome

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Daniel Lammertse, M.D. and Charlotte Starnes, R.N., M.S.N.

Department of Neurosurgery, Physical Medicine and Rehabilitation
and Neuroscience Laboratory, Craig Hospital, Englewood, Colorado

Object

“Surgically created lesions of the spinal cord dorsal root entry zone (DREZ) to relieve central pain after spinal cord injury (SCI) have historically resulted in modest outcomes. A review of the literature indicates that fair to good relief of pain is achieved in approximately 50% of patients when an empirical procedure is performed. This study was undertaken to determine if intramedullary electrical guidance in DREZ lesioning could improve outcomes in patients with SCI-induced central pain. Additionally, electrical data were used to determine if the spinal cord could be somatotopically mapped with regard to this pain of central origin.”

Methods

“Forty-one patients with traumatic SCI and intractable central pain underwent DREZ lesioning in which intramedullary electrical guidance was conducted. In nine patients, recording of DREZ-related spontaneous electrical hyperactivity guided the lesioning process. In 32 patients, recording of DREZ-induced evoked electrical hyperactivity during transcutaneous C-fiber stimulation (TCS) additionally guided lesioning. The follow-up period ranged from 1 to 7 years. The analyzed electrical data allowed for somatotopic mapping of the spinal cord.”

Conclusions

“Intramedullary electrical guidance of DREZ lesioning substantially improves pain outcomes in patients with traumatic SCI-induced central pain, compared with empiric technique. The best outcome occurs when DREZ-related spontaneous electrical hyperactivity and evoked hyperactivity during TCS are both used to guide the DREZ lesioning procedure. With such guidance, 100% relief of pain was achieved in 84% of patients and 50 to 100% relief of pain in 88%. Somatotopic mapping of the electrical data led to a proposed pain mechanism for below-level pain, implicating the sympathetic nervous system.”

Note: C-fiber stimulation, TCS, was obtained using a Neurometer® CPT/C device 5 Hz stimulus.

Quantitative Analysis of Sensory Functions After Lumbar Discectomy Using Current Perception Threshold Testing

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Sapporo Medical University, Sapporo, Japan

Abstract

“ANeurometer device is an electrical nerve stimulator used to determine the current perception threshold (CPT) evoked by stimulating A-beta fibers at 2,000 Hz, A-delta fibers at 250 Hz and C fibers at 5 Hz. CPT evaluation is used for analyzing peripheral nerve dysfunction. In this study, the sensory disturbance of the lower-extremity was quantitatively analyzed using CPT testing before and after lumbar discectomy. In 33 patients (L4/5: 16 and L5/S: 17), as subjective evaluations, tactile sensation and leg pain were assessed before and 2 weeks after surgery. In the subjectively improved group (n = 22), significant decreases in CPT at 2,000 and 250 Hz were noted postoperatively, whereas in the unchanged group (n = 11), no significant changes in CPT at any frequencies was noted. The leg pain improved in all patients. Likewise, CPT at 5 Hz, which stimulated C fiber, decreased significantly for both improved and unchanged groups. CPT measured by a Neurometer is very useful in assessing lower-extremity sensory functions before and after surgery for lumbar disc herniation.”

Current Perception Threshold/Quantitative Sensory Testing and MRI Findings In Patients with Signs and Symptoms of Cervical or Lumbar Disc Herniations: A Correlative Study of the Neurosensory Diagnosis of Discogenic Pain

David J. BenEliyahu, Stephen V. Tartaglia, and Ronald Spinelle
Selden, New York

Abstract

“Seventy consecutive patients with clinical signs and symptoms of intervertebral disc syndrome were evaluated with MRI and Current Perception Threshold Quantitative Sensory Testing (CPT/QST). CPT/QST functionally assesses a nerve’s ability to convey sensation. Of the seventy cases, fifty patients had both a positive MRI and positive CPT/QST exam. Of the 50 patients with positive MRI and CPT/QST tests, 42 were level-specific, giving CPT/QST an 84% sensitivity. McNemar’s Chi-square statistical analysis revealed good agreement for the full sample tested. In addition, the full sample had a 95% confidence interval for the probability of level-specific agreement for CPT/QST and MRI in patients with disc herniation. CPT/QST may be a useful tool to help the clinician assess the functional significance of MRI disc findings.”

The Effects of Vertebral Axial Decompression On Sensory Nerve Dysfunction In Patients with Low Back Pain and Radiculopathy

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The Advanced Spinal Institute, Ogden, Utah

Abstract

“Effective non-surgical decompression of the nerve root has not been available to this date. The vertebral axial decompression (VAX-D) therapeutic table has demonstrated an ability to significantly reduce intradiscal pressure to a negative 150mm Hg., allowing for disc decompression. The purpose of this study was to determine if VAX-D therapy could externally decompress the nerve root. Patients with radiculopathy and abnormal sensory function determined by the Current Perception Threshold (CPT) Neurometer® who had received VAX-D therapy were retrospectively studied. CPT readings on 22 peripheral nerves were taken before and after VAX-D therapy. Only patients with initial abnormal CPT readings, symptoms of sciatica, positive SLR, and positive imaging studies were reported on. The results after therapy were as follows: 14/22 nerves (64%) returned to normal function, 6/22 (27%) improved, 1/22 (4.5%) had no improvement and 1/22 (4.5%) showed deterioration. The average CPT grade before therapy was 6.36 and after therapy 2.09 (a score of zero indicates normal function). Overall improvement was 67% ($p < 0.05$). Theoretical considerations regarding the mechanism of action are expounded upon in this paper.”

Current Perception Thresholds in Toe-to-Digit Transplantation and Digit-to-Digit Replantation

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Introduction

“Toe-to-digit transplantation and digit-to-digit replantation provide excellent models to study possible different patterns of nerve regeneration and functional recovery when donor nerves are the same as or different from recipient nerves. It is reasonable to ask whether the transplanted toe behaves more like a normal finger or a normal toe, and whether the replanted digit can achieve complete functional recovery despite previous reports of poor recovery in sensory nerve function following nerve repair.”

“In our previous studies on the recovery of sensation, nerve conduction, and somatosensory evoked potentials (SEPs) to digital nerve stimulation, the transplanted toe achieved 70-90% of normal sensations, including temperature (cold and warm), pinprick, light touch, and vibration. However, two-point discrimination had the worst recovery with a mean of 2.9 mm for normal finger, 6.2 mm for normal toe, and 9.1 mm for transplanted toe. Nerve conduction and SEP findings indicated persistent impairment of digital nerve function.”

Methods

“Recovery of digital nerve function in toe-to-digit transplantation and digit-to-digit replantation was evaluated by transcutaneous constant current sine wave stimulation at 5-Hz, 250-Hz, and 2000-Hz frequencies to determine the current perception thresholds (CPT).”

Results

“For toe transplantation and digit replantation, the mean interval between injury and surgery was 9 months and 7 h, respectively, while the mean interval between surgery and CPT study was 52 months and 20 months, respectively. Control CPTs evoked by three frequency stimuli were obtained from contralateral corresponding normal finger and normal toe. Normal finger had significantly lower 250-Hz and 2000-Hz CPTs than normal toe, but the 5-Hz CPT was not different between them. Replanted digit achieved nearly complete recovery of these three frequency CPTs when compared to normal finger. In toe transplantation, 2000-Hz CPT was comparable to normal finger, while 5-Hz and 250-Hz CPTs were comparable to normal toe.”

Discussion

“The present findings suggest that the transplanted toe was intermediate between normal finger and normal toe, but more like normal toe than normal finger with regard to detection thresholds of the current-evoked sensation.”

A Correlative Electrophysiologic Study of Nerve Fiber Involvement in Carpal Tunnel Syndrome Using Current Perception Thresholds

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Objective

“To relate clinical severity of idiopathic carpal tunnel syndrome (CTS) to current perception threshold (CPT).”

Methods

“Subjects were 51 patients with CTS (involving 51 hands), and 50 healthy control subjects (50hands). Involved hands were grouped into three clinical grades (mild, moderate, severe). Using a neurometer (Neurotron, Baltimore, MD), we investigated the relationship between clinical grade and CPT abnormalities.”

Results

“In the mild CTS group, most hands showed CPT abnormalities only at 2000Hz stimulation. The moderate group included a higher percentage of hands showing abnormalities at both 2000 and 250Hz stimulation increased. The severe group included the highest percentage of hands with abnormal values at all frequencies tested.”

Conclusions

“CPT showed abnormalities appear progressively from ‘higher to lower, frequency stimulations relative to the increasing severity of CTS. “

Significance

“Sensory nerve fiber dysfunction apparently begins in larger fibers, extending stepwise to smaller fibers as the clinical grade of CTS progresses.”

Evaluation of chemotherapy-induced peripheral neuropathy using current perception threshold and clinical evaluations.

Griffith KA, Couture DJ, Zhu S, Pandya N, Johantgen ME, Cavaletti G, Davenport JM, Tanguay LJ, Choflet A, Milliron T, Glass E, Gambill N, Renn CL, Dorsey SG.

Objective

With the continuous emergence of novel and combination cancer drug regimens, chemotherapy-induced peripheral neuropathy (CIPN) has become increasingly prevalent. This study evaluated the relationship between clinically measured and self-reported measurements and the current sensory threshold (CPT). CPT is a neuroselective indicator for assessing sensory nerve function and can detect asymptomatic CIPN damage.

Methods

The data used in this secondary analysis were derived from a prospective observational study that utilized CPT to evaluate CIPN. A binary mixed model was employed to account for intra-group correlations between repeated patient measurements, and was applied to assess the relationship between CPT and various subjective measures (Neurological Pain Scale, FACT-GOGntx) and objective measurements (Quantitative Sensory Testing, Deep Tendon Reflexes, and Grip Strength) at each frequency (5, 250, and 2,000 Hz)

Results

The study subjects were 29 patients with various cancers receiving chemotherapy for the first time, with a mean age of 56.7 years (SD 10.4). According to the NCI CTC-AE criteria, 9 patients had a CIPN grade >1. The cold detection threshold was negatively correlated with the frequency of CPT 5 [b(95% CI) = -0.25 (-0.45, -0.05)] and CPT 2,000 [-0.75 (-11.8, -0.33)]. The FACT GOG-ntx Quality of Life (QoL) scale and its neurotoxicity and function subscales were negatively correlated with CPT 2,000 [with values of -0.18 (-0.35, -0.05), -0.22 (-0.42, -0.02), and -0.54 (-0.98, -0.09), respectively], indicating that QoL, impairment, and function deteriorated with the increase in sensory dullness.

Conclusions

CPT 2,000 may help identify which patient-reported outcomes (e.g., QoL) will deteriorate immediately.

Fractionated administration of carboplatin/paclitaxel reduces neurotoxicity in patients with advanced non-small cell lung cancer.

Ishii Y, Fujimoto S, Okazaki K, Miyoshi M, Furihata T, Hase I, Takizawa H, Kikkawa Y, Yamada I, Fukuda T.

Abstract

The combination of carboplatin/paclitaxel is commonly used as chemotherapy for advanced non-small cell lung cancer. However, the relatively high incidence of neurotoxicity remains a problem. This study was undertaken to determine whether the fractionated administration regimen can reduce the neurotoxicity. Patients with stage III or IV non-small cell lung cancer were randomized to the nonfractionated (NF) dose group, which received paclitaxel (200 mg/m²) and carboplatin (area under the concentration–time curve = 6) on day 1, or the fractionated dose (F) group, which received paclitaxel (100 mg/m²) and carboplatin (area under the concentration–time curve = 3) on days 1 and 8. The cycle was repeated every 3 weeks. Peripheral neuropathy was objectively evaluated by measuring the current perception threshold (CPT) in the median nerve using a neurometer. Fourteen and 13 patients were assigned to the NF and F groups, respectively. The incidence of subjective numbness was significantly lower in the F group (15.4%) than in the NF group (57.1%). The CPT value determined at 2000 Hz showed significant increases in the NF group compared with the pretreatment baseline, but no significant changes were observed in the F group. The response rate was comparable in both groups. The fractionated administration of carboplatin/paclitaxel combination therapy showed a significant reduction in neurotoxicity. Measurement of CPT by a neurometer is a useful tool to evaluate the neurotoxicity of anticancer drugs objectively.

Toxic Neuropathy

Jonathan S Rutchik,

MD, MPH, Assistant Professor, Department of Occupational and Environmental Medicine, University of California at San Francisco

Background

Lewis P. Rowland, in Merritt's Textbook of Neurology, defines the terms peripheral neuropathy and polyneuropathy as describing "the clinical syndrome of weakness, sensory loss and impairment of reflexes caused by diffuse lesions of peripheral nerves." The diagnosis most often is based on the clinical picture and is confirmed with electrodiagnostic techniques, most commonly electromyography (EMG) and nerve conduction studies. Facial nerve and blink reflex testing also are used commonly. Apparatuses, such as the neurometer, vibrometer, and sensory nerve perception threshold-testing device, often are used in research settings or to evaluate clusters of patients. Patients with toxic etiologies for neuropathy are less common than patients with other neuropathies such as those due to hereditary, metabolic, or inflammatory causes. Drug-related neuropathies are among the most common toxic neuropathies. Neuropathies from industrial agents (either from occupational or environmental sources), presenting after either limited or long-term exposure, are insidious.

Patients may present with subtle pain or weakness. Subclinical abnormalities found on electrodiagnostic testing may herald a progressive neuropathy if exposure continues at a similar dose. Attributing neuropathy to such an exposure often is difficult. In some patients, extensive search for an etiology may fail to uncover the exact cause of neuropathy.

Many chemicals are known to cause neuropathy in laboratory animals. Some of these have been associated with neuropathy in clinical epidemiologic studies, confirming their ability to injure the human peripheral nervous system (PNS). Other chemicals have been reported to be associated with PNS dysfunction and neuropathy on the basis of retrospective and cross-sectional epidemiologic studies. Designs for many of these studies have been criticized. Other associations have been made from many case reports and case series.

Human studies infrequently have associated exposure to environmental sources with peripheral neuropathy. As compared to nonexposed controls, exposed individuals have statistically significant differences in nerve conduction velocity (NCV) and EMG findings. Exposures have been estimated for duration and intensity based on point source extrapolation, a common method of environmental risk assessment. When reviewing the literature, a critical analysis of study designs and electrodiagnostic techniques is important.

An algorithm to assess patients with suspected neurotoxic illness is detailed in Medical/Legal Pitfalls. It describes occupational and environmental history as an important aspect of the medical history. In cases of positive occupational or environmental exposure, estimating dose and duration of exposure and level of protection afforded by personal protective equipment is emphasized. Government and professional organizations publish exposure limits for workers using various chemicals. Physicians may use this information to compare with industrial hygiene data.

Abnormal current perception thresholds measured by neurometer among residents in blackfoot disease-hyperendemic villages in Taiwan

Chin-Hsiao Tseng

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Abstract

“This study evaluated the possible existence of subclinical sensory nerve defects in residents of blackfoot disease (BFD)-hyperendemic villages in Taiwan characterized by long-term arsenic exposure from drinking water.

Eighty-five seemingly normal subjects living in BFD villages and 75 external normal controls without exposure were recruited. All subjects were 30-75 years old, without possible causes of peripheral neuropathy and suffered from no symptoms of peripheral neuropathy. Current perception threshold (CPT) was measured by Neurometer® at the trigeminal, median and superficial peroneal nerves with frequencies of 5, 250 and 2000 Hz. Results showed that the two groups were comparable in age, sex, body height and body weight. However, BFD residents had significantly 1.28-2.23-fold higher CPT than normal controls for all frequencies at the 3 nerves. If the mean values + 3 standard deviation (S.D.) derived from normal controls were used as cutoff points for defining abnormalities, 36 of the 85 (42.4%) residents in the BFD villages had at least one abnormal measurement. Site and frequency preferences were noted in the abnormal CPT of the BFD residents.

Longer nerves (superficial peroneal and median nerves) were involved more commonly than shorter one (trigeminal); and lower frequencies (5 and 250 Hz) were more commonly involved than the higher (2000 Hz). Stepwise regression analyses consistently showed that residency in BFD villages was significantly associated with higher CPT values after adjusting for age, sex, body height and body weight. In conclusion, abnormal CPT was observed in seemingly normal subjects without clinical neuropathy in the arseniasis-hyperendemic villages in Taiwan.”

Evaluation of the Neurotoxicity of Paclitaxel and Carboplatin by Current Perception Threshold in Ovarian Cancer Patients

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Abstract

“Objectives: Combination chemotherapy consisting of paclitaxel and carboplatin has recently started to be given as the regimen of first choice for epithelial ovarian cancer. One of its side effects, however, is neurotoxicity, and this neurotoxicity has been reported to be the dose-limiting factor. Since it is necessary to measure the severity of the neurotoxicity objectively and quantitatively, we evaluated it on the basis of Current Perception Threshold (CPT) values, which is easy and non-invasive.”

Method

“Sixteen patients with epithelial ovarian cancer were given paclitaxel (175 mg/m², 3 hours) and carboplatin (area under the curve of 5) every three weeks, and the CPT values were measured at two sites on the day before and several times after administration.”

Results

“All patients exhibited mild neurotoxicity, but it was never so severe that chemotherapy could not be continued. The CPT values peaked on day 4 during one course of chemotherapy, but decreased thereafter and returned almost to the baseline by three weeks, in the same way as the patients' complaints. The CPT values decreased with the number of courses, and patients' complaints gradually increased. The CPT values increased more in the cases previously treated with cisplatin than in the other cases. These changes were seen at 2,000 HZ, which generally corresponds to large, myelinated nerves.”

Conclusion

“There were correlations between the changes in the patients' CPT values and their degree of neurotoxicity. We expect to be able to predict severe neurotoxicity and evaluate the effect of drug therapy for neurotoxicity by measuring CPT values.”

Shenxie Zhitong Capsule Alleviates Diabetic Peripheral Neuropathy by Regulating Wnt/ β -catenin/Inflammatory Pathway

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Objective

To investigate the mechanism of Shenxie Zhitong Capsule (SXZT) on diabetic peripheral neuropathy (DPN) rats based on the Wnt/ β -catenin-inflammatory pathway.

Methods

Forty male SPF Wistar rats were allocated into two initial groups: 8 rats in the normal control group, and 32 rats for DPN modeling. After successful modeling, 27 rats were randomly divided into three groups (9 rats per group): model group, Chinese medicine (CM) group, and Western medicine (WM) group. The normal control group was fed a regular diet, while the other three groups received a high-fat diet combined with intraperitoneal injection of streptozotocin (STZ) to establish DPN. Following 6 weeks of drug intervention, the following parameters were measured: general physical signs, blood glucose, plantar photothermal pain threshold, caudal nerve current threshold, and mechanical withdrawal reflex threshold. The morphology of the sciatic nerve myelin sheath was observed via transmission electron microscopy. ELISA was used to detect the spinal cord levels of inflammatory factors [interleukin-6 (IL-6), interleukin-1 β (IL-1 β), tumor necrosis factor- α (TNF- α)]. Western Blot was employed to determine the expression of key proteins in the Wnt/ β -catenin signaling pathway (Wnt3a, Frizzled-4, and β -catenin).

Results

Compared with the model group, the CM group showed notable improvements in mechanical pain threshold, plantar thermal pain threshold, and caudal nerve current threshold ($P<0.05$). Additionally, the CM group exhibited reduced spinal cord levels of IL-6, IL-1 β , and TNF- α , as well as downregulated expression of Wnt3a, β -catenin, and Frizzled-4 ($P<0.05$, $P<0.01$). The sciatic nerve in the CM group displayed a more intact morphology and myelin sheath, with visible surrounding Schwann cells. Compared with the WM group, the improvement in plantar thermal pain threshold was milder in the CM group ($P<0.05$). The CM group still showed decreased spinal cord levels of IL-6, IL-1 β , and TNF- α ($P<0.01$), and more prominent downregulation of β -catenin and Frizzled-4 ($P<0.05$). Moreover, the sciatic nerve morphology was better preserved in the CM group.

Conclusions

SXZT can alleviate pathological pain caused by DPN. Its mechanism may involve inhibiting Wnt3a protein, modulating the Wnt/ β -catenin-inflammatory pathway in spinal dorsal horn astrocytes, and reducing the expression of inflammatory mediators, ultimately relieving DPN-induced chronic pain.

Post-stroke pain caused by peripheral sensory hypersensitization after transient focal cerebral ischemia in rats.

Kana Hyakkoku, Nanae Umeda, Shinji Shimada, Takahiko Imai, Yasuhide Morioka, Gaku Sakaguchi, Hideaki Hara

Abstract

The mechanisms underlying central post-stroke pain are not well understood and there is no satisfactory treatment. Here, in a rat model of stroke, we measured nociceptive threshold using current stimulation of primary afferent neurons in both hind paws. Male Wistar rats underwent middle cerebral artery occlusion (MCAO) for 50 min. Nociceptive thresholds for A β , A δ and C fiber stimulation (at 2000, 250, and 5 Hz, respectively, using a Neurometer), and neurological deficits, were measured for 23 days after MCAO. Sensory thresholds in both hind paws were significantly lower in MCAO model rats than in control rats for 23 days after MCAO, with the greatest difference seen in A δ fibers and the smallest in C fibers. Brain infarct area was measured histologically, and the correlation between neurological deficit and infarct size was examined. Neurological deficits were worse in animals with larger infarcts. Furthermore, correlations were observed between infarct size, neurological deficit, and sensory threshold of A δ fibers 1 day after MCAO. These findings indicate that rats develop hyperalgesia after MCAO and that sensory abnormalities in A δ fibers after cerebral ischemia may play an important role in post-stroke pain.

Assessment of Bladder Sensation in Mice With a Novel Device.

Bicer F, Kim JY, Horowitz A, Daneshgari F, Liu G.

Objective

To develop and test the efficacy of an implantable bladder electrode device that can be used with the Neurometer electrodiagnostic stimulator to assess fiber-specific afferent bladder sensation in the mouse.

Methods

We constructed a ball-tipped platinum electrode and surgically implanted it into the mouse bladder. The Neurometer was connected to the electrode to apply selective nerve fiber stimuli (250 Hz for Ad fibers and 5 Hz for C fibers) of increasing intensities to the bladder mucosa in the mouse to determine bladder sensory threshold (BST) values. Using 58 female C57BL/6J mice, we measured the temporal and interobserver consistency of BST measurements, the effects of intravesical administration of lidocaine and resiniferatoxin on the BST, and the effects of our device on voiding behavior and bladder mucosal integrity.

Results

BST values at 250 and 5 Hz did not vary significantly when measured 2, 4, and 6 days after device implantation, or when obtained by 2 blinded independent observers. Intravesical lidocaine yielded a transient increase in BST values at both 250 Hz and 5 Hz, whereas resiniferatoxin yielded a significant increase only at the 5 Hz stimulus frequency after 24 hours. Moderately increased micturition frequency and decreased volume per void were observed 4 and 6 days after device implantation. Histology revealed mild inflammatory changes in the area of the bladder adjacent to the implanted BST device.

Conclusion

Assessment of neuroselective bladder sensation in mice is feasible with our device, which provides reproducible BST values for autonomic bladder afferent nerve fibers.

Identification of the sensory nerve fiber responsible for lysophosphatidic acid-induced allodynia in mice.

Ohsawa M, Miyabe Y, Katsu H, Yamamoto S, Ono H

Abstract

Lysophosphatidic acid (LPA) has been considered one of the molecular culprits for neuropathic pain. Understanding how LPA changes the function of primary afferent fibers might be an essential step for clarifying the pathogenesis of neuropathic pain. The present study was designed to identify the primary afferent fibers (Ab, Ad, or C) participating in LPA-induced allodynia in ddY mice. Mechanical allodynia and thermal hyperalgesia were evaluated by the von Frey filament test and thermal paw withdrawal test, respectively. Sensory nerve fiber responsiveness was measured using a Neurometer. Daily repeated intrathecal treatment with LPA led to a decrease in the mechanical, but not thermal nociceptive threshold, and a reduction in the threshold for paw withdrawal induced by 2000-Hz (Ab fiber) and 250-Hz (Ad fiber), but not 5-Hz (C fiber) sine-wave electrical stimulation. When the transient receptor potential cation channel subfamily V member 1 (TRPV1) receptor agonist resiniferatoxin (RTX) was administered subcutaneously before the start of LPA treatment, LPA-induced mechanical allodynia and Ab and Ad fiber hypersensitivity demonstrated by neurometry were not affected, indicating that TRPV1-expressing nerve fibers (possibly C fibers) might not be essential for LPA-induced allodynia. LPA-induced allodynia was reversed by treatment with RTX at 7 days after the start of LPA treatment. Expression of TRPV1 on myelinated nerve fibers after repeated intrathecal LPA treatment was observed in the dorsal root ganglion. These results suggest that sensitization of Ab and Ad fibers, but not C fibers, contributes to the development of intrathecally administered LPA-induced mechanical allodynia. Moreover, increased or newly expressed TRPV1 receptors in Ab and Ad fibers are considered to be involved in the maintenance of LPA-induced allodynia.

Effect of Granulocyte Colony-Stimulating Factor on the Peripheral Nerves in Streptozotocin-Induced.

Kyung Ae Lee¹ , Kyung Taek Park² , Hea Min Yu³ , Heung Yong Jin¹ ,

Hong Sun Back¹ , Tae Sun Park

Abstract

There are controversial reports about the effect of granulocyte colony-stimulating factor (G-CSF) in peripheral nerve protection. Therefore, the present study aimed to investigate the effect of G-CSF on peripheral nerves in streptozotocin (STZ) induced diabetic rats. After STZ or vehicle injection, rats were divided into five groups (n=6) as follows: normal+vehicle, normal+G-CSF (50 µg/kg for 5 days), diabetes mellitus (DM)+vehicle, DM+G-CSF (50 µg/kg for 5 days), and DM+G-CSF extension (50 µg/kg for 5 days and followed by two injections per week up to 24 weeks). Our results showed that the current perception threshold was not significantly different among experimental groups. G-CSF treatment inhibited the loss of cutaneous nerves and gastric mucosal small nerve fibers in morphometric comparison, but statistical significance was not observed. The present results demonstrated that G-CSF has no harmful but minimal beneficial effects with respect to peripheral nerve preservation in diabetic rats.

Subdiaphragmatic Vagotomy Induces a Functional Change in Visceral A δ Primary Afferent Fibers in Rats.

SADAYOS^m FURUTA, KENJIRO MATSUMOTO, SYUNJI HORIE/ TSUTOMU SUZUKI AND MINORUNARITA

Abstract

Vagal nerves modulate not only physical homeostasis, but also pain transmission. It has been reported that subdiaphragmatic vagal dysfunction causes visceral pain. However, the functional changes in nociceptive primary afferent fibers under such visceral pain soon after subdiaphragmatic vagal dysfunction are not fully documented. The present study was designed to investigate changes in the sensitivity of primary afferent fibers in the distal colon using a Neurometer which individually stimulates C, AS and A β fibers. Under stimulation with a handmade stimulus electrode in the distal colon, the current threshold in the distal colon was recorded with high reproducibility. Subdiaphragmatic vagotomy significantly decreased the current threshold of A δ fibers in the distal colon with no change in the sensitivity of C or A β fibers. These results suggest that vagal dysfunction at an early stage may cause, at least in part, hypersensitivity of visceral A δ fibers.

The three isoforms of nitric oxide synthase distinctively affect mouse nocifensive behavior

Julia Finkel ,Virginia Guptill . Alfia Khaibullina , Nicholas Spornick , Olavo Vasconcelos , David J. Liewehr , Seth M. Steinberg , Zenaide M.N. Quezado

Abstract

Nitric oxide synthases (NOSs) have been shown to modulate thermal hyperalgesia and mechanical hypersensitivity in inflammatory and neuropathic pain. However, little is known about the effect of NOSs on baseline function of sensory nerve fibers. Using genetic deficiency and pharmacologic inhibition of NOSs, we examined the impact of the three isoforms NOS1, NOS2, and NOS3 on baseline nocifensive behavior by measuring current vocalization threshold in response to electrical stimulation at 5, 250, 2000 Hz that preferentially stimulate C, Aδ, and Aβ fibers. In response to 5, 250 and 2000 Hz, NOS1-deficient animals had significantly higher current vocalization thresholds compared with wild-type. Genetic deficiency of NOS2 was associated with higher current vocalization thresholds in response to 5 Hz (C-fiber) stimulation. In contrast, NOS3-deficient animals had an overall weak trend toward lower current vocalization thresholds at 5 Hz and significantly lower current vocalization threshold compared with wild-type animals at 250 and 2000 Hz. Therefore, NOSs distinctively affect baseline mouse current vocalization threshold and appear to play a role on nocifensive response to electrical stimulation of sensory nerve fibers.

A β and A δ but not C-fibres are involved in stroke related pain and allodynia: an experimental study in mice

Takami K, Fujita-Hamabe W, Harada S, Tokuyama S.

Objectives

Cerebral ischaemia is a leading cause of death and disability, including severe complications such as memory disturbance, palsy, and spasticity. Central poststroke pain (CPSP) is a complication of cerebral ischaemia, and is characterized clinically by spontaneous pain and attacks of allodynia and dysaesthesia. However, the detailed mechanisms of CPSP are not well established. Herein, we have examined alterations of the current stimulus threshold of primary afferent neurons or the nociceptive threshold against mechanical stimuli in mice receiving left middle cerebral artery occlusion (MCAO).

Methods

Alterations of current stimulus threshold and the development of mechanical allodynia in hind paws were measured after MCAO using a Neurometer and the von Frey filament test, respectively.

Key findings

Development of cerebral infarction was clearly observed on day 1 and day 3 after MCAO. For the estimation of current stimulus threshold measured by the Neurometer, the sensitivity of Ad and Ab fibres (at 2000 and 250 Hz stimulation, respectively) was significantly increased on day 3 after MCAO, while that of C fibres (at 5 Hz stimulation) was unaltered. In addition, the paw withdrawal threshold of the left hind paw as measured by the von Frey filament test was significantly decreased on day 1 and day 3 after MCAO when compared with day 0, while that in the right hind paw was not different.

Conclusions

The data suggested the development of bilateral hyperaesthesia in this model. Further, mechanical allodynia developed in the ipsilateral side to the MCAO. Potentially, myelinated A fibre-specific hypersensitization after stroke may have contributed to these symptoms.

Beneficial effects of exendin-4 on experimental polyneuropathy in diabetic mice.

Himeno T, Kamiya H, Naruse K, Harada N, Ozaki N, Seino Y, Shibata T, Kondo M, Kato J, Okawa T, Fukami A, Hamada Y, Inagaki N, Seino Y, Drucker DJ, Oiso Y, Nakamura J.

Objective

The therapeutic potential of exendin-4, an agonist of the glucagon-like peptide-1 receptor (GLP-1R), on diabetic polyneuropathy (DPN) in streptozotocin (STZ)-induced diabetic mice was investigated.

Research Design And Methods

The presence of the GLP-1R in lumbar dorsal root ganglion (DRG) was evaluated by immunohistochemical analyses. DRG neurons were dissected from C57BL6/J mice and cultured with or without Schwann cell- conditioned media in the presence or absence of GLP-1 (7–37) or exendin-4. Then neurite outgrowth was determined. In animal model experiments, mice were made diabetic by STZ administration, and after 12 weeks of diabetes, exendin-4 (10 nmol/kg) was intraperitoneally administered once daily for 4 weeks. Peripheral nerve function was determined by the current perception threshold and motor and sensory nerve conduction velocity (MNCV and SNCV, respectively). Sciatic nerve blood flow (SNBF) and intraepidermal nerve fiber densities (IENFDs) also were evaluated.

Results

The expression of the GLP-1R in DRG neurons was confirmed. GLP-1 (7–37) and exendin-4 significantly promoted neurite outgrowth of DRG neurons. Both GLP-1R agonists accelerated the impaired neurite outgrowth of DRG neurons cultured with Schwann cell-conditioned media that mimicked the diabetic condition. At the doses used, exendin-4 had no effect on blood glucose or HbA1c levels. Hypoalgesia and delayed MNCV and SNCV in diabetic mice were improved by exendin-4 without affecting the reduced SNBF. The decreased IENFDs in sole skins of diabetic mice were ameliorated by exendin-4.

Conclusions

Our findings indicate that exendin-4 ameliorates the severity of DPN, which may be achieved by its direct actions on DRG neurons and their axons.

Neuroprotective effect of the glucagon-like peptide-1 receptor agonist, synthetic exendin-4, in streptozotocin-induced diabetic rats.

Liu WJ, Jin HY, Lee KA, Xie SH, Baek HS, Park TS.

Background And Purpose

Glucagon-like peptide-1 (GLP-1) receptors are widely expressed in neural tissues and diminish neuronal degeneration or induce neuronal differentiation. The aim of this study was to investigate the effect of the GLP-1 pathway on peripheral nerves in streptozotocin-induced diabetic rats.

Experimental Approach

Diabetic and nondiabetic rats were treated with the GLP-1 receptor agonist, synthetic exendin-4 (i.p., 1 nmol·kg⁻¹ ·day⁻¹) or placebo for 24 weeks, and current perception threshold values, cAMP levels and nerve fibre size in the sciatic nerve were measured. We also investigated GLP-1 receptor expression, quantitative changes in PGP9.5-positive intraepidermal nerve fibres and cleaved caspase 3-stained Schwann cells by immunohistochemistry.

Key Results

GLP-1 receptor expression was detected in the sciatic nerve and skin. After exendin-4 treatment, the increase seen in current perception threshold values at 2000 and 250 Hz in diabetic rats was reduced. Also, the decrease in myelinated fibre size or axon/fibre area ratio in the sciatic nerve and the loss of intraepidermal nerve fibre in the skin of diabetic rats were ameliorated. These responses were closely associated with the attenuation of Schwann cell apoptosis and improvement in the cAMP level in exendin-4-treated diabetic rats, compared with placebo-treated animals.

Conclusion And Implications

Synthetic exendin-4 may prevent peripheral nerve degeneration induced by diabetes in an animal model, supporting the hypothesis that GLP-1 may be useful in peripheral neuropathy. The neuroprotection is probably attributable to GLP-1 receptor activation, antiapoptotic effects and restoration of cAMP content.

Enrichment of tissue-engineered skin with Schwann cells improves cutaneous nerve regeneration.

Blais, M. Grenier, M., Berthod, F.

Abstract

The use of autologous reconstructed skin appears to be a promising treatment for the permanent coverage of extensive burns. However, the capability of reconstructed skin transplanted on wounds to promote recovery of sensory perception is a major concern. Our aim was to develop a tissue engineered skin that stimulates nerve regeneration after transplantation on extensive burns. We developed a tissue-engineered skin made of fibroblasts and keratinocytes cultured in a collagen chitosan sponge. First, to study in vitro the influence of Schwann cells on nerve migration, we added sensory neurons (freshly obtained from dorsal root ganglia of mice embryos at E12) in the reconstructed skin enriched with or without Schwann cells (isolated from mouse sciatic nerves).

Second, to study in vivo the effect of Schwann cells on nerve regeneration, we grafted on nude mice our tissue-engineered skin enriched or not with Schwann cells. The current perception threshold of A-beta, A-delta and C nerve fibers in the graft was evaluated using a Neurometer® 90 days after transplantation. Schwann cells induced in vitro the migration of 2 times more neurites 14 days after the seeding of neurons, compared to the control ($p < 0,02$; $n = 5$). They secreted a basal membrane of laminin around axons and formed myelin sheaths. In vivo, their presence induced a 2 times increase in the number of neurites in the graft 60days after transplantation. Moreover, 90 days after graft, the sensibility of the mice grafted with reconstructed skin containing Schwann cells was similar to that of normal mouse skin for the large myelinated A-beta cutaneous nerve fibers, but was decreased in mice grafted with a reconstructed skin without Schwann cells. We concluded that Schwann cells induced faster and greater nerve regeneration in the tissue-engineered skin both in vitro and in vivo. This enhanced innervation achieved an efficient recovery of tactile sensation similar to the normal mouse skin only 90 days after graft.

Involvement of LPA1 receptor signaling in the reorganization of spinal input through A β -fibers in mice with partial sciatic nerve Injury

Weijiao Xie, Misaki Matsumoto, Jerold Chun and Hiroshi Ueda

Abstract

Lysophosphatidic acid receptor subtype LPA1 is crucial for the initiation of neuropathic pain and underlying changes, such as up-regulation of Ca²⁺ channel $\alpha 2\delta$ -1 subunit in dorsal root ganglia (DRG), up-regulation of PKC γ in the spinal dorsal horn, and demyelination of dorsal root fibers. In the present study, we further examined the involvement of LPA1 signaling in the reorganization of A β -fiber-mediated spinal transmission, which is presumed to underlie neuropathic allodynia. Following nerve injury, the phosphorylation of extracellular-signal regulated kinase (pERK) by A β - fiber stimulation was observed in the superficial layer of spinal dorsal horn, where nociceptive C or A δ -fibers are innervated, but not in sham-operated wild-type mice. However, the pERK signals were largely abolished in LPA1 receptor knock-out (Lpar1^{-/-}) mice, further supported by quantitative analyses of pERK-positive cells. These results suggest that LPA1 receptor-mediated signaling mechanisms also participate in functional cross-talk between A β - and C- or A δ -fibers.

Pharmacological switch in A β -fiber stimulation-induced spinal transmission in mice with partial sciatic nerve injury

Misaki Matsumoto, Weijiao Xie, Lin Ma and Hiroshi Ueda

Abstract

Background: We have previously demonstrated that different spinal transmissions are involved in the nociceptive behavior caused by electrical stimulation of A β -, A δ - or C-fibers using a Neurometer® in naïve mice. In this study, we attempted to pharmacologically characterize the alteration in spinal transmission induced by partial sciatic nerve injury in terms of nociceptive behavior and phosphorylation of extracellular signal-regulated kinase (pERK) in the spinal dorsal horn.

Results:

A β -fiber responses (2000-Hz), which were selectively blocked by the AMPA/kainate antagonist CNQX in naïve mice, were hypersensitized but blocked by the NMDA receptor antagonists MK-801 and AP-5 in injured mice in an electrical stimulation-induced paw withdrawal (EPW) test. Although A δ -fiber responses (250-Hz) were also hypersensitized by nerve injury, there was no change in the pharmacological characteristics of A δ -fiber responses through NMDA receptors. On the contrary, C-fiber responses (5-Hz) were hyposensitized by nerve injury. Moreover, A δ - and C-, but not A β -fiber stimulations significantly increased the number of pERKpositive neurons in the superficial spinal dorsal horns of naïve mice, and corresponding antagonists used in the EPW test inhibited this increase. In mice with nerve injury, A β - as well as A δ -fiber stimulations significantly increased the number of pERK-positive neurons in the superficial spinal dorsal horn, whereas C-fiber stimulation decreased this number. The nerve injury-specific pERK increase induced by A β -stimulation was inhibited by MK-801 and AP-5, but not by CNQX. However, A β - and A δ -stimulations did not affect the number or size of pERK-positive neurons in the dorsal root ganglion, whereas C-fiber-stimulation selectively decreased the number of pERKpositive neurons.

Conclusion:

These results suggest that A β -fiber perception is newly transmitted to spinal neurons, which originally receive only A δ - and C-fiber-mediated pain transmission, through NMDA receptor-mediated mechanisms, in animals with nerve injury. This pharmacological switch in A β - fiber spinal transmission could be a mechanism underlying neuropathic allody

Neurometer Measurement of Current Stimulus Threshold in Rats

Tetsu Kiso, Yukinori Nagakura, Takashi Toya, Naoyuki Matsumoto, Seiji Tamura,

Hiroyuki Ito, Masamichi Okada and Tokio Yamaguchi

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Research, Yamanouchi Pharmaceutical Co., Ltd., Tsukuba, Ibaraki, Japan

Abstract

"We examined the current stimulus threshold in rats with the Neurometer, a device used clinically for measuring perception and pain thresholds.

Although many studies have indicated the usefulness of this device in the quantification of nerve dysfunction in patients, we have found no published reports on the use of the Neurometer® CPT in animals. Transcutaneous nerve stimuli of the three sine-wave pulses produced by the Neurometer (at 2000, 250 and 5 Hz) were applied to plantar surface of rats. The intensity of each stimulation at which rats vocalized or were hardly startled was defined as the current stimulus threshold. With repeated stimulation, the thresholds were almost constant. Repeated topical application to the area around the stimulating electrode of a high concentration of capsaicin, which acts on small-diameter fibers, increased the thresholds at 250 and 5 Hz, but did not affect the 2000-Hz threshold. Intravenous morphine (2-5mg/kg) increased all three thresholds, whereas intrathecal morphine (20 or 80 µg) increased only the 5-Hz threshold. Intravenous injection of a minor tranquilizer, diazepam, at 1 mg/kg raised the thresholds at 2000 and 250 Hz, but did not affect the 5-Hz threshold. Higher dose of diazepam increased all three thresholds. These results suggest that the Neurometer® CPT makes possible selective examination of subsets of nerve fibers that differ in diameter not only in humans but also in animals. The present study in rats, in which we established a method of measurement, may provide helpful suggestions for the interpretation of data in humans."

Effects of Aging on Current Vocalization Threshold in Mice Measured by a Novel Nociception Assay

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“Background

Age-related changes in nociception have been extensively studied in the past decades. However, it remains unclear whether in addition to the increased incidence of chronic illness, age-related changes in nociception contribute to increased prevalence of pain in the elderly. Although a great deal of evidence suggests that nociception thresholds increase with aging, other studies yield disparate results. The aim of this investigation was to longitudinally determine the effect of aging on nociception.

Methods

The authors developed a nociception assay for mice using electrical stimuli at 2,000, 250, and 5 Hz that reportedly stimulate A α , A δ , and C sensory nerve fibers, respectively. A system was designed to automate a method that elicits and detects pain-avoiding behavior in mice. Using a Latin square design, the authors measured current vocalization thresholds serially over the course of mice's life span.

Results

For 2,000-Hz (A α), 250-Hz (A δ), and 5-Hz (C) electrical stimuli, current vocalization thresholds first decreases and then increases with aging following a U-shaped pattern ($P < 0.001$). In addition, average current vocalization thresholds at youth and senescence are significantly higher than those at middle age for the 250-Hz (A δ) and 5-Hz (C fiber) electrical stimulus ($P < 0.05$).

Conclusions

Using a novel and noninjurious nociception assay, the authors showed that over the life span of mice, current vocalization threshold to electrical stimuli changes in a U-shaped pattern. The findings support the notion that age-related changes in nociception are curvilinear, and to properly study and treat pain, the age of subjects should be considered.”

Clinical study on the improvement of facial redness in sensitive skin with soft mask.

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(Department of Dermatology, Shanghai Ninth People's Hospital, Shanghai Jiao Tong

University School of Medicine, ; Xiamen ZAOWOO Cosmetics Co., Ltd., ;

SGS-CSTC Standards Technical Services (Shanghai) Co., Ltd., ;

SGS-CSTC Standards Technical Services Co., Ltd.,

Xiamen Branch,China; Dermatology Hospital of Southern Medical University Cosmetic Testing Center

Abstract

The efficacy of a soft mask containing sodium alginate, camellia extract, trehalose, hydrolyzed corn starch, dipotassium glycyrrhizinate, and centella asiatica extract on sensitive red skin has been evaluated. 32 female participants were enrolled in a human efficacy evaluation trial using a soft mask once a day for 28 consecutive days, using objective instruments, image analysis, and positive and negative emotion scales. The results showed that the skin hemoglobin (EI value) and red area a^* value significantly decreased at all time points after using the sample ($P<0.05$); The transcutaneous water diversion loss rate (TEWL value), stratum corneum moisture content, average blood flow perfusion, and sensory nerve threshold (2 000 Hz) significantly improved after 28 days of sample use ($P<0.05$); The total score of positive emotions significantly increased by 26.02% ($P<0.05$), while the total score of negative emotions significantly decreased by 40.78% ($P<0.05$). Therefore, the soft mask has an improvement effect on sensitivity redness, mainly due to the improvement of skin barrier function, reduction of skin sensitivity, and alleviation of emotional stress.

Research Progress on Cosmetics Suitable for Sensitive Skin and Its Efficacy Evaluation Methods

Yang Yang, Chen Tian, Wei Zefeng, Zhang Rongxue, Wang Dongyu, Yu Qionghua

Standard Technical Service (Shanghai) Co., Ltd., Shanghai Academy of Preventive Medicine

Abstract

This article introduces the ingredient characteristics and related product types of cosmetics suitable for sensitive skin, with a focus on reviewing their efficacy evaluation methods. It provides a detailed discussion on in vitro methods, in vivo methods, and combined in vivo/in vitro approaches. The in vivo method is analyzed in depth from three perspectives: subject screening, instrument measurement methods, and subjective evaluation methods. The article also outlines key considerations in formulation design and efficacy evaluation processes, and provides an outlook on future development trends.

Evaluation Methods for the Human Efficacy of Soothing Cosmetics.

Qiu Simin, Zhao Chunxia, Zhang Dawei

ICAS Technology Service (Guangzhou) Co., Ltd..

ICAS Testing Technology Service (Shanghai) Co., Ltd.,

Abstract

The occurrence mechanism of the sensitive skin were summarized in this paper. The evaluation methods for human efficacy of soothing cosmetics were reviewed, including the induced human skin stimulation model method and the human open use evaluation method. Meanwhile, the similarities and differences, advantages and disadvantages, and applicable efficacy mechanisms were compared. It aims to provide a theoretical basis for the efficacy evaluation of this kind of cosmetics.

Scientific evaluation methods for soothing cosmetics efficacy.

Feng Faqing, Li Jing

Abstract

Under the influence of factors such as the aggravation of environmental pollution and changes in skincare and beauty habits, skin irritation occurs more frequently. Starting from the symptoms perceived by consumers, which mainly include erythema, itching, burning sensation, tightness, dryness, pain and other skin irritation states, this article reviews the possible mechanism and process, and sorts out the efficacy evaluation methods. At present, a variety of evaluation methods applied to food, medicine, clinical efficacy research and other fields have been reported, while there are few related reviews on soothing cosmetics efficacy. In this article, on the basis of the mechanism of triggering the skin irritation states, we review various evaluation methods on three pathways of skin inflammatory response, skin barrier and neural response, which are divided into laboratory tests (including biochemical methods, cell biological methods, three-dimensional recombinant skin models, animal and the animal alternative experiment methods), consumer use testing and human efficacy evaluation tests (including subjective, semi-subjective and objective instrumental evaluation methods), and overview their applications in efficacy evaluation of cosmetics, expecting to provide new ideas of scientific efficacy evaluation for soothing cosmetics.

Efficacy of pregabalin for the treatment of chronic pruritus of unknown origin, assessed based on electric current perception threshold.

JaeIn Lee, DongHyek Jang, JooYoon Bae, HyeJung Jung, MiYoun Park, JiYoung Ahn

Abstract

Chronic pruritus of unknown origin (CPUO) is defined as itching lasting more than 6 weeks in the absence of discernible skin lesions. Pregabalin is used to treat patients with CPUO. In this study, we aimed to investigate differences in the perception threshold of itch sensation between patients with CPUO and healthy individuals and to evaluate the efficacy of pregabalin for CPUO. At baseline, week 2, and week 4 after treatment initiation, the visual analogue scale (VAS) score was measured to assess pruritus severity, and electric current perception threshold (CPT) was measured at 250 and 5Hz using a NEUROMETER CPT/C stimulator. Twenty healthy individuals and 41 patients with CPUO were enrolled in this study. The patients with CPUO were categorised as those who responded to antihistamines (Antihistamine group), were not improved by antihistamines (Pregabalin group), and were not improved by antihistamines and pregabalin (Refractory group). The baseline CPT values were not significantly different between patients with CPUO and healthy control. Pruritus was improved in 7 of 10 patients in the Pregabalin group after treatment with pregabalin, showing decreased CPT at 5Hz. The sensitive C-fibres presented a high threshold to detect itch sensation, and this sensitivity decreased in response to treatment with pregabalin.

Selective Nerve Fibre Activation in Patients with Generalized Chronic Pruritus: Hint for Central Sensitization?

Manuel P Pereira, Konstantin Agelopoulos, Johannes Köllner, Gitta Neufang,

Martin Schmelz, Sonja Ständer.

Abstract

Central sensitization induces pain augmentation in chronic pain states. An analogous mechanism is speculated for chronic pruritus. This study compared patients with chronic pruritus (n=79) of different origins (atopic dermatitis, chronic pruritus on non-lesional skin, chronic prurigo) and healthy controls (HC, n=54) with regard to itch intensity and qualities of sensory symptoms after selective peripheral nerve fibre activation by electrical stimulation at 5 Hz (surrogate for C-fibre function) and 2,000 Hz (surrogate for A β -fibre function) using a Neurometer®. Electrically-induced itch was more intense in patients with chronic pruritus than in HC, but patients with chronic pruritus did not report “itch” more often than HC at 5 Hz. Stimulation at 2,000 Hz induced more pricking and tingling, but less throbbing in patients with chronic pruritus compared with HC. Treatment with cooling compound reduced clinical and experimental itch, but did not alter the distribution of sensory symptoms. These data show hyperknesis in chronic pruritus of various origins, arguing for common central sensitization mechanisms.

Evaluation Methods for the Applicability of Facial Sensitive Skin Cosmetics

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Shanghai Jahwa United Co., Ltd.

Objective

In order to study the safety and efficacy of single and long-term use of products for facial sensitive skin using the combined objective and subjective methods, and to preliminarily establish the evaluation methods for the applicability of facial sensitive skin cosmetics.

Methods

Sixty-six lactic acid sting test positive subjects were included in the study, and they were divided into two groups using two different sensitive skin facial creams. Single use sensory test was performed, and followed by four weeks use test with clinical evaluation, instrumental test and lactic sting test at baseline, two weeks and four weeks after using the products.

Results

There's no significant difference between facial cream ① and negative control at any time points under the single use sensory test. The score for itching, stinging and total sensory of facial cream ② after using for five minutes and 10 minutes were all significantly higher than negative control. After four weeks of using facial cream ①, the skin scales were significantly less than baseline. After two and four weeks of using facial cream ① and four weeks of using facial cream ②, the transepithelial water loss (TEWL) and blood speed were significantly lower than baseline. The stratum corneum hydration of both groups after using for two and four weeks were significantly higher than baseline, and the neural sensitivity of more than 30% of subjects were ameliorated. The total sensory score of lactic acid test of both groups after using for four weeks and the sting score of facial cream ① were significantly decreased.

Conclusion

By integrating single use sensory test, and long-term using test combined with objective measurements and lactic acid tests, we could better understand the skin sensory, reactions, tolerance and physiology to the use of sensitive skin cosmetics, in which

way could comprehensively and scientifically evaluate the applicability of sensitive skin cosmetics.

Itching sensation and neuronal sensitivity of the skin.

H. Ham, S.M. An, E.J. Lee, E. Lee, H.O. Kim and J.S. Koh,

Background

Sensitive skin is a universal term in the field of cosmetology. In addition, the development and demand for sensitive skin cosmetics is increasing. However, there is no appropriate method for detecting sensitive skin.

Methods

We analyzed the relationship between the frequency of response at each sensation (stinging, burning, and itching) during a lactic acid sting test and the current perception threshold (CPT) value of each frequency. To reconfirm this relationship, we analyzed differences of the CPT value (5 Hz) between the itch responder and non-itch responder groups.

Results

There is a significant correlation between itch sensation and CPT values of 5 Hz. The itch responder group showed significantly lower sensory perception value of 5 Hz than the non-itch responder group.

Conclusion

The CPT value (5 Hz) can be used for scanning for itching sensations when a cosmetic or its ingredients possibly cause the sensation.

Clinical value of CPT in the diagnosis of neural sensitive skin

Li Shuyuan, Wang Xuemin, Gao Yanrui, Chen Shuangyu, Liu Xiaoping, Dong Yaqi, Fan Guobiao

(Skin & STD Department, Tongji Hospital of Tongji University)

Objective

To investigate the clinical value of current perception threshold (CPT) in the diagnosis of neural sensitive skin.

Methods

According to the responses to lactic acid and capsaicin test, 60 subjects with self-reported sensitive skin were divided into two groups. Capsaicin or lactic acid test positive subjects were sensitive skin group and both test negative subjects served as normal controls. Capsaicin test positive was classified as neural sensitive skin. The skin nerve sensitivity in each group was assessed with CPT.

Results

The CPT at either 5 Hz or 250 Hz was significantly lower in capsaicin test positive subjects than in normal controls (at 5 Hz 6.67 ± 6.37 for capsaicin test positive and 11.90 ± 8.37 for normal; at 250 Hz 12.67 ± 7.61 for capsaicin test positive and 26.33 ± 13.75 for normal; $P < 0.05$ for both frequencies).

Conclusion

The change of skin nerve sensitivity can be reflected by the capsaicin test, and the extent of objective changes in the nerve sensitivity can be detected by the CPT test. The capsaicin test together with the CPT can be used to evaluate the cutaneous nerve sensitivity. Sensitive skin is associated with both unmyelinated C fibers and myelinated A δ fibers.

Pathogenesis and evaluation of self-perceived sensitive skin

Li Shuyuan, Wang Xuemin

Skin & STD Department, Tongji Hospital of Tongji University, Shanghai Dermatology Hospital,
Department of Dermatology and Cosmetics Research

Abstract

To introduce the definition, classification, pathogenesis and evaluation of self-perceived sensitive skin. In the discussion of the disease's pathogenesis, besides the damaged skin barrier function which had been demonstrated in previous studies, the role of the increased neural sensitivity and genetic factors also can not be ignored. An emerging non-invasive instrument known as neurometer (CPT tester) may play an important role in the detection of neural sensitivity of the sensitive skin.

The dimensions and characteristics of the subepidermal nerve plexus in human skin – Terminal Schwann cells constitute a substantial cell population within the superficial dermis

Christina M. Reinisch , Erwin Tschachler,

Background

The skin constitutes the largest sensorial organ. Its nervous system consists of different types of afferent nerve fibers which spread out immediately beneath the skin surface to sense temperature, touch and pain.

Objective

Our aim was to investigate the dimension and topographic relationship of the different nerve fibers of the subepidermal nerve plexus in human hairy skin and to analyze numbers and marker expression of terminal Schwann cells.

Methods

Nerve fibers and Schwann cells were investigated on dermal sheet preparations and thick sections of skin from various body regions of 10 individuals.

Results

The dimension of subepidermal nerve fibers varied between different body sites with highest values in chest skin (100–18 mm/mm²) and lowest in posterior forearm skin (53–10 mm/mm²). The majority of fibers (85.79%) were unmyelinated, thus representing C-fibers, of which 7.84% were peptidergic. Neurofilament-positive fibers (A-fibers) accounted for 14.21% and fibers positive for both neurofilament and myelin (Ab-fibers) for only 0.18%. The number of Schwann cells varied in accordance with nerve fiber length from 453–108 on chest skin to 184–58/mm² in skin of the posterior forearm. Terminal Schwann cells showed a marker profile comparable to Schwann cells in peripheral nerves with the notable exception of expression of NGFr, NCAM, L1CAM and CD146 on myelinating Schwann cells in the dermis but not in peripheral nerves.

Conclusion

Our data show that terminal Schwann cells constitute a substantial cell population within the papillary dermis and that both nerve fiber length and Schwann cell numbers vary considerably between different body sites.

Improvement of Nerve Regeneration in Tissue-Engineered Skin Enriched with Schwann Cells

Mathieu Blais, Myriam Grenier, and Francis Berthod

Abstract

The incorporation of Schwann cells in reconstructed skin (RS) could have a major role in achieving functional recovery of cutaneous sensory perception. We showed with a unique in vitro model of a tissue-engineered innervated reconstructed dermis that Schwann cells promoted a twofold increase in the number of sensory neurites migrating in the three-dimensional tissue as compared with the control. In addition, Schwann cells spontaneously colocalized along neurites and achieved the formation of myelin sheaths in vitro as assessed by transmission electron microscopy. We prepared RS samples enriched or not with Schwann cells and transplanted them on nude mice for 60–90 days. We demonstrated that Schwann cells induced a 1.8- and 1.7-fold increase in the number of nerve fibers migrating in the graft 60 and 90 days after transplantation, respectively. In addition, the RS sample enriched with Schwann cells had a current perception threshold similar to that of normal skin for the large and myelinated Ab-sensory fibers, in contrast with the control. Thus, we showed that the addition of Schwann cells to tissue-engineered skin not only enhanced nerve migration but also promoted myelin sheath formation in vitro and nerve function recovery in vivo.

Neuilly sur Seine, Quantitative Sensory Method: Research on Skin Sensation Under Chemical Substance Stimulation

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Computer Science Laboratory, University of Tours, France,
Department of Dermatology, University of Vienna, Austria

Background

The autonomic sensation of sensitive skin was previously defined as the immediate sensation of the skin or a transient visible response to various stimuli, ranging from environmental factors to contact stimuli. Experts study cutaneous sensation by analyzing the responses of cutaneous nerve fibers to stimuli.

Objective

In this study, our objective was to investigate the effects of topical application of non-irritating menthol on cutaneous nerve fibers. Two quantitative sensory testing (QST) methods were employed.

Methods

According to the established inclusion criteria, 29 white women aged 25-35 years with healthy skin were selected. The temperature threshold (TPT) and current threshold (CPT) were measured using a temperature sensation analyzer (TSA 2001, Medoc) and a current sensation analyzer (Neurometer®, Neurotron), respectively. Testing was performed on both the left and right cheeks. A TPT measurement was first conducted on the left cheek with and without 2% menthol application, followed by a CPT measurement on the right cheek with and without 2% menthol application

Results

We discovered that non-stimulatory doses of menthol can enhance the cold pain threshold (CPT) of class A neurons by altering the depolarization threshold of cutaneous nerves. These results align with earlier findings, indicating that both cold and menthol can induce membrane depolarization in a subset of primary afferent neurons. However, no effect of menthol on the cold or heat pain thresholds was observed. These conclusions, along with prior studies, demonstrate that menthol suppresses heat sensation in the lip skin without affecting temperature perception.

Conclusions

Our experimental findings indicate that topical application of 2% menthol can elevate the sensory threshold of A-class nerves, yet demonstrates no effect on thermal sensation. Two hypotheses may explain this conclusion: First, the measurement methodology employed may not accurately detect temperature perception changes induced by menthol application on the cheek. Second, menthol exhibits no influence on thermal sensation within the temperature range utilized in our study.

The Effect of Vibration Training on Hemisensory Dysfunction in Stroke Patients

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The Affiliated Tai'an City Central Hospital of Qingdao University、 College of Acupuncture and Massage, Shanghai University of Traditional Chinese Medicine、 .Wuxi County People's Hospital

Objective

To explore the clinical effect of vibration training combined with conventional rehabilitation therapy on hemisensory dysfunction in stroke patients.

Methods

A total of 50 stroke patients with hemisensory dysfunction who were hospitalized in the rehabilitation department of our hospital from January 2022 to December 2023 were selected and evenly divided into the treatment group and the control group with 25 patients in each group by random number table method. The control group received conventional rehabilitation therapy, while the treatment group received conventional rehabilitation therapy combined with vibration training. Before treatment and after 8 weeks of treatment, the Sensory Impairment Assessment Scale, Current Perception Threshold (CPT), Berg Balance Scale (BBS), and Modified Barthel Index were used for evaluation.

Results

After treatment, the sensory function score, BBS score, and Modified Barthel Index score of both groups were significantly higher than those before treatment ($P<0.05$), and the sensory function score, BBS score, and Modified Barthel Index score of the treatment group were significantly higher than those of the control group ($P<0.05$). After treatment, the CPT values at different frequencies (2000 Hz, 250 Hz, 5 Hz) in both groups were significantly lower than those before treatment ($P<0.05$), and the CPT values at different frequencies (2000 Hz, 250 Hz, 5 Hz) in the treatment group were significantly lower than those in the control group ($P<0.05$).

Conclusion

For stroke patients with hemisensory dysfunction, vibration training is helpful to improve their sensory dysfunction, balance function, and activities of daily living.

Application of Current Perception Threshold in the diagnosis of cervical spondylotic radiculopathy

Peng Rucheng, Huang Lefen, Chen Haiping

Objective

To observe the characteristics of nerve root cervical spondylosis by current sensory threshold test and analyze its diagnostic value.

Method

A total of 67 patients with unilateral radiculopathy cervical spondylosis admitted to Wuhan China Resources Wugang General Hospital from 2020 to 2022 were enrolled. CPT testing was performed on the corresponding dermatomes of both upper limbs at the injured cervical nerve root segments, with the affected side as the experimental group and the unaffected side as the control group. CPT scores were compared between the two groups. Based on the presence or absence of pain symptoms in the affected upper limb, the experimental group was further divided into a pain group and a non-pain group. The abnormal rates of CPT test results at three frequencies (2000 Hz, 250 Hz, and 5 Hz) were statistically analyzed for both the pain group and the non-pain group, with intra-group and inter-group comparisons conducted.

Results

In the experimental group, 92.54% of patients exhibited abnormal CPT test results, with CPT scores significantly higher than those in the control group ($t=15.653$, $P<0.001$). No statistically significant difference was observed between the pain group and the non-pain group in CPT scores ($t=0.070$, $P=0.944>0.05$). The abnormal rate of 5Hz CPT test results in the pain group was higher than that at 2000Hz and 250Hz ($P<0.001$ for the comparison between 2000Hz and 5Hz; $P<0.001$ for the comparison between 250Hz and 5Hz). The abnormal rates of 250Hz and 5Hz CPT test results in the pain group were also higher than those in the non-pain group ($P=0.029<0.05$ for the comparison between 250Hz in both groups; $P<0.001$ for the comparison between 5Hz in both groups).

Conclusion

CPT testing is an effective diagnostic method for cervical radiculopathy, demonstrating consistent evaluation efficacy in both pain and non-pain patients. Pain patients primarily exhibit abnormal 5Hz CPT test values.

Effects of Suspension Exercise Therapy Combined with Soft Tissue Manipulation on Upper Limb Sensory Function in Patients with Radicular Cervical Spondylosis

Yan Tao, Luo Bin, Gao Qiang, Wang Yan, Zhang Jiefeng.

Department of Rehabilitation Medicine, Taian City Central Hospital

Department of Rehabilitation Medicine, Wuxi County People's Hospital,

Objective

To observe the changes of upper extremity sensory function in patients with radicular cervical spondylosis and evaluate the treatment effect, by using the method of suspension exercise therapy (SET) and soft tissue manipulation.

Methods

A total of 72 patients with cervical spondylosis were divided into observation group (treated by SET combined with manipulation) and control group (treated by purely cervical traction) by simple random method. Both groups received 4-week continuous treatment for 6 times per week. The somatosensory evoked potential(SEP) , current perception threshold (CPT) before and after the treatment in two groups were separatedly tested, and changes in visual analogue scale (VAS) pain scores of the affected limbs were examined, so as to determine the effective rate of treatment.

Results

After treatment, the latency of SEP was shortened mainly in brachial plexus potential N9 and cervical spinal potential N13 in two groups ($P < 0.05$). The CPT levels and the VAS pain scores of the affected limbs were reduced in two groups ($P < 0.01$) , and the treatment effect in observation group was better than in control group ($P < 0.01$)

Conclusion

SET combined with soft tissue manipulation can effectively promote the repair of nerve sense function of cervical spondylotic radiculopathy

Clinical observation of α -lipoic acid combined with Mecobalamin in the treatment of diabetic peripheral neuropathy

Chen Qingfa, Huang Huayao, Chen Zhenqiang

Department of Rehabilitation Medicine, Union Hospital Affiliated to Fujian Medical University

Objective

To observe the clinical efficacy of lipoic acid combined with Mecobalamin in the treatment of diabetic peripheral neuropathy and its effect on improving the sensory nerve threshold.

Methods

A total of 100 patients with type 2 diabetes mellitus (T2DM) accompanied by varying degrees of neuropathy who visited our hospital from May 2016 to May 2017 were randomly divided into two groups. The control group received Mecobalamin 500 μ g via intravenous bolus once daily for 4 consecutive weeks. The treatment group received an additional 600 mg of L-thioctic acid dissolved in 250 mL of normal saline via intravenous drip once daily for 4 consecutive weeks. The therapeutic effects were observed. The current sensory threshold (CPT) of the bilateral median nerves and bilateral common peroneal nerves was measured before and after treatment using a Neurometer quantitative sensory testing device.

Results

The decrease of sensory threshold in the treatment group was significantly better than that in the control group.

Conclusion

The combination of lipoic acid and Mecobalamin significantly reduces the sensory nerve current threshold in patients with diabetic peripheral neuropathy, improves clinical symptoms, and demonstrates superior efficacy compared to Mecobalamin alone. No significant adverse reactions were observed during the drug therapy, making it suitable for clinical application and promotion

Research Progress of Quantitative Sensory Examination in Diabetic Foot

Chen Haiping, Li Xuan, Sun Jinwen, Zhang Wei.
China Resources Wugang General Hospital

Abstract

Diabetic sensory neuropathy is a common complication of diabetes mellitus. Many foot complications in diabetic patients originate from sensory neuropathy and mild autonomic and motor neuropathy. The lack of normal neuroprotective mechanisms in the feet combined with excessive mechanical stress is the primary factor contributing to foot ulcers and infections. Approximately 15% of diabetic patients in China will eventually develop foot ulcers, with a high disability rate due to diabetic foot. About 5% to 10% of cases require amputation, accounting for over 50% of all non-traumatic amputations. The relative risk of lower limb amputation in diabetic patients is 40 times higher than that in non-diabetic individuals. Peripheral neuropathy may be involved in 25% of diabetic patients, with distal symmetric polyneuropathy being the most common type of diabetic peripheral neuropathy, accounting for 95% of cases. It is the strongest risk factor for foot ulcers and amputation, yet up to 50% of patients remain asymptomatic. Early-stage neuropathy is reversible, and early diagnosis is of significant importance. The American Diabetes Association emphasizes that diabetic patients must undergo annual examinations for protective sensory loss.

Peripheral nerve fibers are classified into three types (A, B, and C) based on differences in nerve fiber excitability, diameter, and myelin sheath presence. Type A fibers are further subdivided into four subtypes: α , β , γ , and δ . Sensory nerve fibers typically comprise three major subgroups: thick myelinated fibers ($A\beta$) that transmit cutaneous tactile and pressure sensations; thin myelinated fibers ($A\delta$) that conduct temperature, pressure, fast pain, and other mechanical stimuli; and unmyelinated fibers (C), which account for over 90% of all nerve fibers and transmit temperature, slow pain, and various forms of nociceptive signals. This article reviews various examination methods for detecting sensory fiber subtypes, ranging from traditional simple screening techniques to modern complex quantitative assays. Different purposes require different methodologies, each with its own advantages and limitations

Short-term sensory and cutaneous vascular responses to therapeutic ultrasound in the forearms of healthy volunteers

Shaik SS, MacDermid JC, Birmingham T, Grewal R, Farooq B.

Background

Therapeutic ultrasound (US) is used for a variety of clinical pathologies and is thought to accelerate tissue repair and help with pain reduction via its thermal and nonthermal effects. The evidence on physiological effects of US on both sensory and vascular functions in humans is incomplete. Hence, the purpose of this study was to determine the short-term impact of two doses of US (3 MHz, 1:4, 0.25 W/cm², 5 min; 1 MHz, continuous, 0.8 W/cm², 3 min), on sensory and vascular responses in the healthy forearms.

Methods

Twenty healthy subjects were recruited (mean age, 29.6 ± 8.8 years) for the study. Superficial blood flow (SBF) in the distal forearms was determined using the tissue viability imaging system. Sensory perception thresholds (SPT) were determined from ring finger (C7, C8) to assess A-beta (at 2,000 Hz) and C fiber function (at 5 Hz), using a Neurometer CPT/C device. Subject's two hands were randomly allocated to group order (AB/BA). Scores were obtained before and immediately after the application of US and control. Differences in these were analyzed using repeated measures.

Results

Both 3 MHz pulsed US and 1 MHz continuous US showed small to moderate (effect size = 0.12 to 0.68), statistically significant reductions in SBF (3 MHz, mean change = 2.8 AU and 1 MHz, mean change = 3.9 AU, $p < 0.05$ respectively), skin temperature (2.5°C and 1.1°C, $p < 0.05$), and SPT at 5 Hz (1.3 and 1 mA, $p < 0.05$) across time. SPT at 2,000 Hz remained unaltered by all three conditions ($p > 0.05$). Age and gender also had no effect on all outcome measures ($p > 0.05$).

Conclusion

This study demonstrated minor reductions in skin blood flow, skin temperatures, and C fiber perception thresholds immediately after 3 MHz, and 1 MHz US. The responses observed may have been due to a thermo-cooling effect of the gel or due to the direct effect of US on C fibers of median and ulnar nerves. US had a negligible effect on A-beta fibres. This would suggest that future studies looking at physiological effects of US should move towards investigating larger dosages and study the effects in patient populations.

The effect of Mecobalamin on sensory nerve after flap transplantation

Tan Hongfeng

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Objective

To investigate the effect of Mecobalamin combined with nerve growth factor on the recovery of sensory nerve after flap transplantation for soft tissue injury of hand.

Methods

A total of 192 patients were randomly divided into 4 groups: control group (n=48); Group A (Mycobium group); Group B (neurotrophic factor group); and Group C (Mycobium + neurotrophic factor group). The current sensory threshold (CPT) was monitored at 1 month, 3 months, 6 months, and 1 year postoperatively.

Results

The C group showed a significant reduction in the current sensory threshold (CPT) at 3 months, with a statistically significant earlier therapeutic effect compared to groups A and B.

Conclusion

The combination of Mecobalamin and nerve growth factor can promote earlier recovery of sensory nerves after flap transplantation for hand soft tissue injuries; The application of Neurometer CPT tester provides quantitative measurement indicators for the restoration of cutaneous sensory function following flap transplantation for hand soft tissue defects after trauma.

Application of neuroselective sensory function assessment in rehabilitation medicine

Liu Haibin

Abstract

The sensory function assessment in rehabilitation medicine is an objective and quantitative method for effectively and accurately evaluating the types, nature, location, extent, severity, progression, prognosis, and outcome of sensory dysfunction in rehabilitation patients. Through the analysis of sensory examination results, it enables the identification of the causes of sensory changes, the impact of sensory dysfunction on daily life, functional activities, and the use of assistive devices, as well as the implementation of safety measures to prevent further injury due to sensory changes. Additionally, it allows for the prediction of future changes and the determination of when re-examination is necessary. Furthermore, it can assess disability, assist in the development of rehabilitation plans, and evaluate rehabilitation outcomes

Clinical sensory assessments, including superficial (tactile, pain, temperature), deep (position, vibration), and compound (two-point discrimination, proprioception) evaluations, are convenient yet subjective. While they provide basic normality assessments, their low reproducibility, specificity, and validity make quantitative analysis challenging. Although clinically valuable for sensory impairment diagnosis, these methods are inadequate for longitudinal studies tracking disease progression or treatment efficacy, failing to meet modern rehabilitation medicine standards. The Von Frey monofilament test, though capable of quantifying tactile sensation, remains subjective due to its sharp edges that may simultaneously trigger pain by stimulating both myelinated and unmyelinated afferent fibers

Change to Current Perception and Pain Tolerance Thresholds following Repetitive Transcranial Magnetic Stimulation

Min Kyun Sohn, M.D., Kang Hee Cho, M.D., Sung Ju Jee, M.D. and Tae Sung Lee, M.D.

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Objective

To investigate the effect of high-frequency repetitive transcranial magnetic stimulation (rTMS) over the primary motor cortex on sensory and pain perception.

Method

We measured the current perception threshold and the pain tolerance threshold with Neurometer® CPT/C in 14 healthy subjects (eleven males and three females, mean age: 25.0 years). Threshold testing was evaluated prior to, immediately after, 30 min after and 60 min after rTMS. The stimulation parameters were a frequency of 10 Hz and a field intensity of 100% of the active motor thresholds. Stimuli were provided in trains of 100 pulses, followed by a 50s rest period, 10 trains were applied in the session, resulting in 1,000 pulses in total.

Results

The current perception thresholds of 5, 250, 2,000Hz were significantly increased immediately, 30 min after rTMS ($p < 0.05$) and no effects at all were noticed after sham rTMS. The pain tolerance thresholds of 5, 250 Hz were significantly increased immediately, 30 min after rTMS and the pain tolerance threshold of 2,000 Hz were significantly increased immediately, 30 min, 60 min after rTMS ($p < 0.05$). No effects at all were noticed after sham rTMS.

Conclusion

After high frequency rTMS over the primary motor cortex, we found that the current perception thresholds and the pain tolerance thresholds of 5, 250, 2,000Hz were significantly increased. (J Korean Acad Rehab Med 2008; 32: 506-511)

Evaluation of polygenic risk scores for hormones and receptors levels in patients with vestibulodynia: a case-control study.

Filippo Murina, Cecilia Fochesato, Chiara Leo, Giuseppe E Condorelli, Anna Rocchi, Sara Amitrano, Valerio Napolioni, Valeria Savasi.

Background:

Vulvodynia is a multifactorial disease affecting 7%-16% of reproductive-aged women in general population; however, little is still known about the genetics underlying this complex disease.

Aim:

To compare polygenic risk scores for hormones and receptors levels in a case-control study to investigate their role in vulvodynia and their correlation with clinical phenotypes.

Methods:

Our case-control study included patients with vestibulodynia (VBD) and healthy women. All participants underwent a vestibular cotton swab test and the assessment of their: pelvic floor, vestibular trophism, ultrasound vestibular mucosa thickness, and current perception threshold levels (Neurometer CPT device). Shallow whole genome sequencing and polygenic risk score calculations were performed. Linear regression models were applied to predict whether genomic predisposition varied significantly between cases and controls, and to investigate the relationship of polygenic risk scores with clinical endophenotypes.

Results:

Thirty women with VBD and 30 controls were recruited. Significant differences between cases and controls were observed for body mass index, vestibular mucosa thickness, vestibular trophic health, pelvic floor hypertone and pain sensitivity ($P < .05$). Cases showed a genomic predisposition to higher levels of membrane-associated progesterone receptor component 1 compared to controls ($P < .05$). When considering the clinical endophenotypes, cases showed significant correlations between their polygenic risk scores with several clinical measures: predicted genomic levels of testosterone and estrogen receptor and the vestibular mucosa thickness values (estimates: $9.74\text{E-}09$ and $9.16\text{E-}08$, respectively; $P < .05$); predicted genomic levels of prolactin and Neurometer data at 250 Hz ($-2.15\text{E-}07$; $P < .05$); predicted genomic levels of prolactin, membrane-associated progesterone receptor component 2 and mineralocorticoid receptor and Neurometer data at 5 Hz ($-3.75\text{E-}07$, $-3.43\text{E-}07$ and $-3.06\text{E-}07$, respectively; $P < .05$).

Conclusion:

Cases showed significant differences compared to controls on both clinical and genetic data and specific endophenotypes necessary to classify disease development and treatment were identified.

Peripheral sensory nerve hyperaesthesia in women with polycystic ovary syndrome.

Sándor Magony, Szabolcs Nyiraty, Bettina Tóth, Fruzsina Pesei, Andrea Orosz, György Ábrahám, Peter Kempler, Csaba Lengyel, Tamás Várkonyi.

Background:

Dysfunction of the nervous system is well-known in diabetes and among patients with prediabetes, obesity, and hypertension. However, there is only a limited amount of data available on the changes in neuronal function in polycystic ovary syndrome (PCOs), even though this condition is also accompanied by metabolic and vascular abnormalities. The aim of our study was to assess the cardiovascular autonomic and peripheral sensory function in patients with PCOs.

Methods:

The study involved 27 women with PCOs, and 24 healthy women as control subjects. Autonomic neuropathy (AN) was assessed using the four standard cardiovascular reflex tests. Peripheral sensory function was determined using the Neurometer (Neurotron Incorporated, Baltimore, MD, USA). Electric stimulation was applied transcutaneously and the current perception threshold (CPT) values were determined on the median and peroneal nerves.

Results:

No significant differences were found between the PCOs patients and the control group regarding the cardiovascular autonomic reflex tests and the AN scores. The CPT values of PCOs patients in the median and peroneal nerves were lower at all frequencies in comparison to controls.

Conclusions:

The cardiovascular autonomic nerve function was normal in the patients with PCOs. The current perception thresholds were consequently lower in the PCOs patients both in the upper and lower extremities at all frequencies, which serves as an early sign of neuropathy. As a novel observation, our results suggest that early neuronal damage manifests in the form of sensory hyperesthesia in patients with PCOs.

Vulvar vestibular effects of ospemifene: a pilot study

Filippo Murina, Stefania Di Francesco & Silvia Oneda

Abstract

The study aimed to assess the effects of ospemifene on vulvar vestibule in postmenopausal women with vulvar pain and dyspareunia. Fifty-five postmenopausal women used oral ospemifene 60 mg/d for 60 d. Symptoms of dryness, burning, and dyspareunia were evaluated on a 10 cm visual analog scale. Visual examination of the vulvar vestibule was also conducted. Patients also underwent current perception threshold (CPT) testing obtained from the vulvar vestibule. Fifty-five patients (94.6%) completed the treatment. Hot flashes were the most frequent adverse effects, but this led to a discontinuation of therapy in three patients (5.4%). After therapy, there was a statistically significant decrease from the baseline in the mean scores for dryness, burning, and dyspareunia and reduction of vestibular trophic score (baseline value of 11.2–4.2 after the therapy, $p = .002$) and cotton swab test scores (2.81 compared with 1.25, $p = .001$). There was a difference in CPT values for all nerve fibers and more consistent for C fibers (38% of sensitivity). These results confirm the efficacy of ospemifene on postmenopausal vestibular symptoms and signs; moreover, the drug was effective in normalizing vestibular innervation sensitivity.

Vaginal diazepam plus transcutaneous electrical nerve stimulation to treat vestibulodynia: A randomized controlled trial.

Filippo Murina, Raffaele Felice, Stefania Di Francesco, Silvia Oneda

Objective

To assess the effectiveness of vaginal diazepam in addition to transcutaneous electrical nerve stimulation (TENS) in the treatment of vestibulodynia (VBD).

Study Design

This study was a randomized, double-blind, placebo-controlled trial. Forty-two patients with VBD were randomized, 21 underwent diazepam and TENS (diazepam group) and 21 received placebo and TENS (placebo group). Vulvar pain was assessed on a 10-cm visual analogue scale (VAS) and dyspareunia according to the Marinoff dyspareunia scale. Vaginal surface electromyography (EMG) and vestibular current perception threshold (CPT) testing were performed at baseline and 60 days after treatment. The primary endpoints included the change in pain and dyspareunia from baseline to 60 days of pain and dyspareunia. The secondary endpoints were the variation in objectivity of pelvic floor muscle (PFM) function and vestibular nerve fiber current perception threshold (CPT).

Results

The VAS scores for pain from basal values of 7.5 and 7.2 for the diazepam and placebo, respectively, showed significant ($p < 0.01$) decreases from 4.7 to 4.3, but this difference was not statistically significant. The Marinoff dyspareunia scores in the diazepam group showed a significant difference ($p < 0.05$) from values measured in the placebo group. The ability to relax the PFM after contraction (difference between maximal contraction and rest tone) was significantly greater for the diazepam group versus the placebo group (3.8 mv and 2.4 mv, respectively, $p < 0.01$). The CPT values for all of the nerve fibers increased after the treatment, but this increase was significant in the diazepam group only for the values at a 5-Hz stimulation (C fibers) with a change of 47.8% vs 26.9% ($p < 0.05$). Only two patients reported a mild drowsiness in the diazepam group.

Conclusions

The present study provided indications that vaginal diazepam plus TENS is useful to improve pain and PFM instability in women with VBD.

Variability of pudendal and median nerve sensory perception thresholds in healthy persons

Quaghebeur J, Wyndaele JJ.

Background

Normative current perception thresholds (CPTs) are used for the evaluation of sensory function in a variety of diseases.

Aims

To evaluate the reproducibility of CPT measurements with sinusoidal current in healthy volunteers.

Methods

Neuroselective CPT evaluations of the median and pudendal nerve in healthy volunteers were repeated with 1 week interval (T1 and T2).

Results

In the study group (N = 41) no difference between genders for age (MW-U: $P = 0.91$) and BMI (t-test: $P = 0.18$) were found. No significant difference between T1 and T2 was found (Paired t-test: all P -values > 0.05), although the intraclass correlation for each person was low. The variability of measures for the pudendal nerve was: ICC 2 kHz: 0.41; 250 Hz: 0.30; 5 Hz: 0.38, and for the median nerve respectively: 0.58; 0.46; 0.40. Normal CPTs were shown for the pudendal nerve: 2 kHz: 51%; 250 Hz: 76%; 5 Hz: 71%, and median nerve respectively: 78%; 98%; 80%. The pudendal nerve showed more deviating values compared to the median nerve.

Conclusion

Both nerves showed deviating values. CPT values with sinusoidal current assessed with 1 week interval, showed a weak intraclass correlation. This finding limits the use of CPT values with this current for longitudinal studies

Hyposensitivity of C-fiber afferents at the distal extremities as an indicator of early stages diabetic bladder dysfunction in type 2 diabetic women.

Lee WC, Wu HC, Huang KH, Wu HP4 Yu HJ, Wu CC.

Purpose

To investigate the relationship between distal symmetric peripheral neuropathy and early stages of autonomic bladder dysfunction in type 2 diabetic women.

Materials and Methods

A total of 137 diabetic women with minimal coexisting confounders of voiding dysfunction followed at a diabetes clinic were subject to the following evaluations: current perception threshold (CPT) tests on myelinated and unmyelinated nerves at the big toe for peroneal nerve and middle finger for median nerve, uroflowmetry, post-void residual urine volume, and overactive bladder (OAB) symptom score questionnaire. Patients presenting with voiding difficulty also underwent urodynamic studies and intravesical CPT tests.

Results

Based on the OAB symptom score and urodynamic studies, 19% of diabetic women had the OAB syndrome while 24.8% had unrecognized urodynamic bladder dysfunction (UBD). The OAB group had a significantly greater mean 5 Hz CPT test value at the big toe by comparison to those without OAB. When compared to diabetic women without UBD, those with UBD showed greater mean 5 Hz CPT test values at the middle finger and big toe. The diabetic women categorized as C-fiber hyposensitivity at the middle finger or big toe by using CPT test also had higher odds ratios of UBD. Among diabetic women with UBD, the 5 Hz CPT test values at the big toe and middle finger were significantly associated with intravesical 5 Hz CPT test values.

Conclusions

Using electrophysiological evidence, our study revealed that hyposensitivity of unmyelinated C fiber afferents at the distal extremities is an indicator of early stages diabetic bladder dysfunction in type 2 diabetic women. The C fiber dysfunction at the distal extremities seems concurrent with vesical C-fiber neuropathy and may be a sentinel for developing early diabetic bladder dysfunction among female patients.

Urethral sensation following reconstructive pelvic surgery.

Abernethy MG, Davis C, Lowenstein L, Mueller ER, Brubaker L, Kenton K.

Abstract

Introduction and hypothesis Most urethral neuromuscular function data focus on efferent rather than afferent innervation. We aimed to determine if changes exist in urethral afferent nerve function before and after reconstructive pelvic surgery (RPS). **Secondarily**, we compared afferent urethral innervation in women with and without stress urinary incontinence undergoing RPS.

Methods

Participants underwent current perception threshold (CPT) and urethral anal reflex (UAR) testing prior to surgery and again post-operatively. Wilcoxon signed ranked test and Spearman's correlations were used and all tests were twosided. $p=0.05$ was considered to indicate statistical significance.

Results

Urethral CPT thresholds increased significantly after RPS, consistent with decreased urethral afferent function. Preoperative urethral CPT thresholds at 5 and 250 Hz were lower in SUI women (10 [IQR 5–29], 40 [32–750]) compared with continent women (63 [14–99], 73 [51–109]; $p=0.45$, $p=0.020$), signifying increased urethral sensation or easier activation of urethral afferents in SUI women.

Conclusions

Reconstructive pelvic surgery is associated with a short-term deleterious impact on urethral afferent function, as demonstrated by the higher levels of stimuli required to activate urethral afferent nerves (decreased urethral sensation) immediately after RPS. Women with SUI required lower levels of stimuli to activate urethral afferent nerves prior to RPS, although UAR latencies were similar regardless of concomitant SUI.

Vestibulodynia: Synergy Between Palmitoylethanolamide + Transpolydatin and Transcutaneous Electrical Nerve Stimulation.

Filippo Murina, MD, Alessandra Graziottin, MD, Raffaele Felice, MD, Gianluigi Radici, MD, and Cinzia Tognocchi, Mrs

Objective

The study aimed to assess the effect of palmitoylethanolamide + transpolydatin combination in patients with vestibulodynia undergoing transcutaneous electrical nerve stimulation (TENS) therapy and to confirm the effectiveness of TENS also in a domiciliary protocol. The study is based on the premise that palmitoylethanolamide + transpolydatin combination may contribute to a down-regulation of mast cell hyperactivity, which is believed to be responsible for the proliferation and sprouting of vestibular pain fibers and the associated hyperalgesia and allodynia.

Materials and Methods

Twenty women with vestibulodynia were randomly assigned to receive oral palmitoylethanolamide (PEA) 400 mg and transpolydatin 40 mg or placebo, twice daily for 60 days. All patients underwent TENS therapy in a self-administered home protocol. Visual analogue scale (VAS), Marinoff score for dyspareunia, and current perception threshold obtained from the vulvar vestibule were assessed at baseline and at the end of treatment.

Results

The patients received a mean of 26.7 TENS sessions. All scores in the 2 groups improved significantly, although the level of improvement was similar between the groups (VAS, $p < .05$; dyspareunia, $p < .038$). Nevertheless, the analysis of regression of symptoms related to the duration of disease revealed the therapy to be more effective when PEA + transpolydatin is included in cases with more recent disease onset, as compared with the placebo group (PEA: VAS, $p < .01$; dyspareunia, $p < .01$) (placebo: VAS, $p =$ nonsignificant; dyspareunia, $p =$ nonsignificant).

Conclusions

This study confirms that TENS is of significant benefit in the management of vestibulodynia, also in a home environment. PEA + transpolydatin can be a value-added treatment adjunct when the onset of vestibulodynia is more recent or when the disease relapses

Sacral Neuromodulation Effects on Periurethral Sensation and Urethral Sphincter Activity

Jonathan L Gleason, MD, Kimberly Kenton, MD, W. Jerod Greer, MD, Olga Ramm, MD, Jeff M. Szychowski, PhD, Tracey Wilson, MD, and Holly E. Richter, PhD, MD

Aims

To characterize the effect of sacral neuromodulation (SNM) on urethral neuromuscular function.

Methods

Following IRB approval, women with refractory overactive bladder (OAB) underwent standardized urethral testing prior to and after stage 1 SNM implantation. Periurethral sensation was measured using current perception thresholds (CPT). Striated urethral sphincter activity was quantified using concentric needle electromyography (CNE) and Multi-Motor Unit Action Potential (MUP) analysis software. Nonparametric analyses were used to characterize pre/ post changes with intervention. Baseline CPT and CNE findings were compared between SNM responders and non-responders.

Results

27 women were enrolled in this pilot study with a mean age of 61 ± 13 years. Twenty of 26 women (76.9%) responded to SNM and went to stage 2 permanent implantation. Four (14.8%) withdrew after stage 1 implantation; 3 of the 4 withdrawals had not had therapeutic responses to SNM. CPT and CNE parameters did not significantly differ from baseline 2 weeks after SNM. Pre-SNM urethral sensation was not significantly different between responders and nonresponders. However, responders had larger amplitude, longer duration and more turns and phases at baseline approaching significance, reflecting more successful urethral reinnervation, than nonresponders.

Conclusions

SNM does not alter urethral neuromuscular function two weeks post Stage 1 implantation. Women with more successful urethral reinnervation may be more responsive to SNM.

Measuring Urinary Sensation with Current Perception Threshold: A Comparison between Method of Limits and Method of Levels.

Davis C, Lowenstein L, Mueller E, Brubaker L, Kenton K

Purpose.

To determine the association between the two methods of obtaining current perception thresholds (CPTs) in the lower urinary tract (LUT).

Materials and Methods

Twenty-one women undergoing pelvic surgery underwent CPT determinations of the urethra. CPTs were measured at 2,000, 250, and 5 Hz (corresponding to A- β , A- δ , and C fibers, resp.) both pre- and postoperatively. Threshold values were obtained in all patients by using the method of limits and the method of levels.

Results

CPT values obtained by using the method of levels and the methods of limits were highly correlated at all frequencies before and after surgery ($p = 0.93-0.99$, $P < 0.0001$). The mean threshold values obtained by the method of levels were significantly lower at all frequencies compared with those obtained by the method of limits.

Conclusions

Our findings suggest that the method of levels is more sensitive for the detection of CPTs compared to the method of limits.

Objective evaluation of the alleviating effects of Goshajinkigan on peripheral neuropathy induced by paclitaxel/carboplatin therapy: A multicenter collaborative study.

Kaku H, Kumagai S, Onoue H, Takada A, Shoji T, Miura F, Yoshizaki A, Sato S, Kigawa J, Arai T, Tsunoda S, Tominaga E, Aoki D, Sugiyama T

Abstract

Paclitaxel/carboplatin chemotherapy for cancer (TC therapy) exhibits neurotoxicity and causes peripheral neuropathy at a high frequency, which is difficult to cope with. In this study, we investigated the efficacy of Goshajinkigan, a traditional Japanese herbal medicine, for TC therapy-induced peripheral neuropathy. The subjects included in our study were patients with ovarian or endometrial cancer who underwent TC therapy and developed peripheral neuropathy. The patients were randomly divided into Group A, comprising of 14 patients (vitamin B12 treatment), and Group B, comprising of 15 patients (vitamin B12 + Goshajinkigan treatment). The observation period was 6 weeks following treatment initiation, and the evaluation items were as follows: i) the current perception threshold (CPT value) of the peripheral nerve, ii) visual analogue scale for numbness, iii) National Cancer Institute Common Terminology Criteria for Adverse Events v3.0 grade of neurotoxicity, and iv) a questionnaire on the subjective symptoms of peripheral neuropathy (functional assessment of cancer therapy-taxane). These were compared between the groups and no significant differences were noted in any item. However, CTCAE grade 3 neurotoxicity developed in 2 patients (14.3%) after 6 weeks of administration in Group A, whereas no neurotoxicity was observed in Group B. When the change in the frequency of abnormal CPT ratio at 6 weeks of administration from that before treatment was compared between the groups, the frequency of abnormal value was significantly lower in Group B than in Group A ($p < 0.05$). This suggests that Goshajinkigan inhibits the progression of peripheral neuropathy

Antimuscarinic effects on current perception threshold: a prospective placebo control study

Vijaya G, Digesu GA, Derpapas A, Hendricken C, Fernando R, Khullar V.

Aims

To evaluate the effect of Tolterodine on urethral and bladder afferent nerves in women with detrusor overactivity (DO) in comparison to placebo, by studying the changes in the current perception threshold (CPT).

Methods

Women with overactive bladder symptoms and idiopathic DO were recruited and randomized in a doubleblind manner between placebo and tolterodine extended release. All women underwent CPT testing of the bladder and urethra using a Neurometer constant current stimulator. CPT values were determined at three frequencies, including 2,000 Hz (corresponding to A β -fibers), 250 Hz (corresponding to A δ -fibers), and 5 Hz (corresponding to C fibers) before and 7 days on treatment. CPT values before and on treatment were compared using a Wilcoxon Signed Rank test.

Results

Twenty women (mean age 46 years) were studied. There was no statistical difference between the two groups in terms of age, ethnicity, severity of symptoms and pre-treatment CPT values. Only in the tolterodine group there was a significantly increased CPT value at 5 and 250 Hz upon both urethral and bladder stimulation after 1 week of treatment. When compared with placebo, women taking tolterodine had significantly increased Bladder CPT values at 5 Hz (P-value <0.05). The electrical stimulation with 5 Hz was described as urgency.

Conclusions

This is a randomized placebo control study evaluating the effect of antimuscarinics on sensory nerve function in women with DO. Our results support the animal studies that antimuscarinics have an effect on sensory function.

Neuroselective measure of the current perception threshold of A-delta and C-fiber afferents in the lower urinary tract.

Atsuko Fujihara, Osamu Ukimura, Tsuyoshi Iwata, Tsuneharu Miki,

Abstract

Sensory dysfunction could be involved in various pathogeneses in the lower urinary tract including neurogenic bladder, overactive bladder, painful bladder syndrome and neuropathy as a result of endocrine disorders. The ability to diagnose sensory function more objectively is of increasing interest to clinicians. Afferent innervations of the lower urinary tract involve myelinated (A-delta) and unmyelinated (C) fibers. The Neurometer (Neurotron, Baltimore, MD, USA) is the only reported commercially available device to evaluate afferent function by selectively depolarizing different subpopulations of afferent nerves, with 250 Hz activating A-delta fibers and 5 Hz activating C-fibers, to determine their current perception threshold (CPT) as a quantitative measure. Recently, increased evidence has suggested that measurement of CPT values of A-delta and C-fibers in the lower urinary tracts is feasible and shows significant correlation with clinical symptoms and conventional urodynamic variables, as well as the efficacy of various treatments. However, there are still controversial issues in the wider use of this technology in diagnosis and assessment of the therapeutic effectiveness of sensory dysfunction in the lower urinary tracts. In order to resolve the remaining challenges in the CPT test of the lower urinary tract, recent efforts include development of a new balloon-type electro-catheter with dual electrodes as an alternative sensory test for the bladder or urethra, which allows simultaneous performance of conventional urodynamic tests and urine collection, and future standardized techniques available for comparison with validated control values.

Sensory Perception Thresholds in Men With Chronic Pelvic Pain Syndrome

Ugur Yilmaz, Marcia A. Ciol, Richard E. Berger, and Claire C. Yan

Objectives

To compare sensory thresholds in different nerve-fiber types in men with chronic pelvic pain syndrome (CPPS) and healthy controls, using thermal sensory testing and measuring current perception thresholds (CPT).

Methods

We enrolled 22 men with CPPS and 20 healthy control participants. We determined the thermal sensory perception thresholds of C and A nerve fibers on the perineum and left posterior thigh. To test CPT, we used sine wave electrical stimulation at 5, 250, and 2000 Hz, resulting in the selective depolarization of small unmyelinated C fibers, small myelinated A δ , and large myelinated A fibers, respectively. We bilaterally tested the hypothenar surface of the palms, medial parts of soles, midshaft of penis, and 1 site in the midperineum, for a total of 7 sites.

Results

The mean age of men with CPPS was similar to that of controls [42.8 (standard deviation, 9.4) and 40.4 (standard deviation, 13.2) years, respectively, $P = .548$]. There was no significant difference between the 2 groups for thermal perception thresholds in both the perineum and left thigh ($P = .05$). There was also no difference between the 2 groups for CPT values of all 3 frequencies of stimuli in each area tested ($P = .05$ for all comparisons).

Conclusions

The absence of sensory threshold differences between men with CPPS and controls, with either thermal stimulation of C and A δ fiber afferents or electrical stimulation of C, A δ , and A β fiber afferents, discounts the existence of a peripheral neuropathy as a cause for pain in men with CPPS.

Electrodiagnostic Functional Sensory Evaluation of Patients With Generalized Vulvodynia: A Pilot Study.

Filippo Murina, MD, Vanda Bianco, MD, Gianluigi Radici, MD, Raffaele Felice, MD,
and Maria Signaroldi, MD

Objective

To objectively evaluate vulvodynia by the current perception threshold (CPT) neurometer.

Methods

Neuroselective CPT measures of the pudendal nerve were obtained at the perineum by a neurometer (Neurotron, Inc, Baltimore, MD), using constant alternating sinusoid waveform electrical stimulus at 2,000-, 250-, and 5-Hz frequencies, in 20 healthy volunteers and 38 women with vulvodynia. The mean T SD CPT values in vulvodynia and healthy (control) women were analyzed with the Student t test.

Results.

Women with vulvodynia showed lower mean CPT values ($p < .01$).

Conclusions.

Results of this study support a neuroselective sensory dysfunction in generalized vulvodynia. The field is opened for CPT measures in vulvodynia in selecting therapy strategy, monitoring response to treatment, and assessing vestibulodynia. Assessment of threshold values in a greater number of controls is needed to set a cutoff in CPT values for diagnosis and to grade the severity of the diseases.

Bladder Sensation Testing: Where Are We?

Firouz Daneshgari, MD, and Kimberly Kenton, MD, MS

Abstract

The pathogenesis of several diseases of the bladder is believed to lie in autonomic and sensory neuropathy, specifically in increased or altered afferent autonomic sensitivity. Nevertheless, no single standardized method has been devised to measure bladder sensation in these conditions. Here we first outline the physiology of the bladder, and then describe the four principal instruments and procedures that are currently used to measure bladder sensation. We conclude by assessing the clinical applicability of current perception threshold testing.

Overactive Bladder Is Not Only Overactive but Also Hypersensitive

Seung Ryeol Lee, Hyung Joon Kim, Ayoung Kim, and Jang Hwan Kim

Objectives

To evaluate differences in bladder filling sensations and current perception threshold (CPT) values between patients with and without overactive bladder (OAB), and to further investigate the correlation between CPT values and voiding patterns in OAB patients.

Methods

Detrusor overactivity and bladder volumes at first sensation of bladder filling, first desire to void, and strong desire to void during filling cystometry were compared between 55 female patients with OAB and 42 with non-OAB. CPT measurements from the bladder mucosa taken after neuroselective electrostimulation at frequencies of 2000, 250, and 5 Hz were compared between the 2 groups. In OAB patients, the correlations between CPT values and voiding variables based on 3-day bladder diaries were investigated.

Results

OAB patients showed significantly more detrusor overactivity than non-OAB patients ($P < 0.05$). Bladder volumes at first sensation of bladder filling, first desire to void, and strong desire to void were significantly lower in OAB patients than in non-OAB patients ($P < 0.05$). CPT values at all 3 frequencies were also significantly lower in OAB patients ($P < 0.05$). The total number of urgency episodes correlated with CPT values at 250 ($r = -0.274$, $P = 0.045$) and 5 Hz ($r = -0.293$, $P = 0.032$). The total number of urge incontinence episodes also correlated with CPT values at 250 ($r = -0.279$, $P = 0.041$) and 5 Hz ($r = -0.272$, $P = 0.046$).

Conclusions

Bladder sensory profiles displayed a more sensitive bladder in OAB patients compared with non-OAB subjects. OAB patients may have bladders that are not only overactive, but also hypersensitive.

Tolterodine causes measurable restoration of urethral sensation in women with urge urinary incontinence.

Kimberly Kenton *, Lior Lowenstein, Linda Brubaker

Department of Pelvic Medicine and Reconstructive Surgery, Obstetrics and Gynecology, and Urology, Loyola University Stritch School of Medicine

Abstract

Preface and Assumptions

To determine whether the use of tolterodine for treating urge incontinence can alter bladder and/or urethral sensation by means of current perception threshold (CPT) detection.

method

In a 7-day diary, women who experienced ≥ 1 episode of urinary incontinence were treated with 4 mg of long-acting tolterodine for 2 months. At baseline and 2 months, participants underwent CPT testing of the urethra and bladder at three frequencies: 2000 Hz, 250 Hz, and 5 Hz. Wilcoxon signed-rank test was used to compare baseline and post-treatment measurements.

Results

Seventeen female patients underwent baseline CPT testing. Four discontinued treatment due to adverse effects and were not re-evaluated. Post-treatment, the urethral CPT at 250 Hz was lower (median: 1.3 [interquartile range: 0.69–2.1] vs. 0.75 [0.45–1.2], $p = 0.003$), while the urethral CPT at 5 Hz showed a trend toward significant reduction (1.1 [1–1.9] vs. 0.84 [0.32–1.1], $p = 0.06$).

Conclusion

The improvement of urethral sensitivity after 2 months of treatment with tolterodine suggests that it may restore the sensory nerve function of the urethra in addition to the known motor effect.

Effects of concentrated growth factor combined with bio-oss bone powder on osteogenesis and sensory nerve action potential during dental implant restoration in the maxillary Molar Region.

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Objective

To investigate the effects of concentrated growth factor (CGF) combined with BioOss bone powder on osteogenic activity and sensory nerve action potential in maxillary molar implant restoration.

Methods

A total of 110 patients undergoing simultaneous implant placement with external maxillary sinus lift were randomly divided into two groups. The control group (n=55) received Bio-Oss bone powder alone, whereas the observation group (n=55) received Bio-Oss combined with autologous CGF. Postoperative bone augmentation, gingival health, osseointegration, sensory nerve action potential, and implant success rate were compared between groups.

Results

The observation group achieved a significantly higher implant success rate (100% vs. 92.73%) and greater alveolar bone gain (3.48 ± 0.82 mm vs. 2.73 ± 0.73 mm) than the control group ($P < 0.05$). At six months postoperatively, bone mineral density and alveolar ridge width were markedly higher in the observation group (1.73 ± 0.28 g/cm³; 6.62 ± 0.34 mm) than in the control group (1.47 ± 0.41 g/cm³; 6.11 ± 0.38 mm) ($P < 0.05$). The bone thickness in the observation group (2.97 ± 0.52) mm was significantly lower than that in the control group (2.79 ± 0.49) mm ($P < 0.05$). The observation group showed significantly higher PD levels (2.82 ± 0.42) mm, peri-implant bone tissue height (0.85 ± 0.21) mm, and ISQ values (72.53 ± 6.04) than the control group (2.34 ± 0.39) mm; (0.99 ± 0.28) mm; (65.91 ± 7.39) ($P < 0.05$). At six months after surgery, sensory nerve action potentials at different stimulus intensities increased in both groups compared with preoperative values, and the observation group showed higher potentials than the control group ($P < 0.05$).

Conclusion

CGF-guided bone regeneration in maxillary molar implant restoration not only enhances osteogenesis and oral soft-tissue regeneration, but also improves alveolar nerve function.

Functional detection and prognostic analysis of inferior alveolar nerve injury after mandibular third molar extraction.

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Objective·

To quantitatively evaluate the injury degree and prognosis of inferior alveolar nerve injury in patients with lower lip numbness caused by inferior alveolar nerve injury by using current perception threshold (CPT), electrical pulp test (EPT) and two-point discrimination (2PD), establish a diagnosis and detection scheme for inferior alveolar nerve injury and provide reference for prognosis evaluation.

Methods·

We selected patients with unilateral inferior alveolar nerve (IAN) injury for more than one month caused by mandibular third molar extraction who went to the outpatient department of oral surgery of the Ninth People's Hospital, Shanghai Jiao Tong University School of Medicine from July 2018 to January 2021. All patients were followed up regularly, and the visual analog scale (VAS) was used to determine the degree of numbness recovery. During the follow-up, if the patient's VAS<3, it was determined that the patients recovered from numbness and were included in the recovery group. The followup ended. If the follow-up time was more than 1 year, and the patients' VAS≥3, it was judged that the patients' numbness didn't recover and they were included in the unrecovered group. We performed current perception threshold (CPT), electrical pulp test (EPT) and two-point discrimination (2PD) on patients of different groups, and compared the values of the three tests on the healthy side and the correlation with prognosis.

Results·

A total of 60 patients were included in this study, including 14 males and 46 females. At the end of follow-up, 44 patients had VAS<3, and were setted as recovery group. The average recovery time was (4.1± 1.4) months. The remaining 16 patients did not have VAS<3, and were setted as the non-recovery group. The differences of two sides of all patients' CPT, EPT and 2PD were statistically significant (all P<0.05). For the data of affected side of patients with and without lower lip sensation recovery, only CPT 5 Hz and EPT were significantly different (both P=0.000). CPT (5 Hz) had high sensitivity (93.8%) and specificity (87.5%) in the evaluation of prognosis. Similarly, EPT also had high sensitivity (93.8%) and specificity (93.8%). The CPT (5 Hz) of the affected side was consistent with the value of EPT of the posterior teeth

Conclusion·

CPT, EPT and 2PD can evaluate the injury of inferior alveolar nerve. The value measured at CPT 5 Hz and posterior tooth EPT can evaluate the prognosis of nerve recovery

Detection of oropharyngeal sensory function in normal population

X L Liu, X Y Li, W Xu

Objective:

To study the oropharyngeal sensory function by Current Perception Threshold(CPT) detection, to explore the detection method of oropharyngeal sensory function in normal population, and to analyze the possible influencing factors.

Methods:

Fifty-eight normal subjects were included prospectively in this study. Age, gender, body mass index (BMI) were collected. The age of the subjects ranged from 20 to 76 (43.27 ± 13.52) years old. There were 34 females with 17 in childbearing period and 17 in menopause; and 24 males were included. In all the cases, 6 cases were in low BMI, 39 cases were in normal BMI, 10 cases were overweight and 3 cases were suffering from obesity. The CPT system of Neurometer was used to stimulate bilateral palatoglossal arch and tongue base. The current used was 2000 Hz, 250 Hz and 5 Hz respectively. The function of type $A\beta$, $A\delta$ and C sensory nerve fibers were tested and the CPT values were recorded. The values were inversely proportional to pharyngeal sensation function. To evaluate the oropharyngeal sensory function of the subjects, the CPT values of each frequency at each testing point were compared. SPSS 25.0 software was used for statistical analysis.

Results:

The CPT value of palatoglossal arch was significantly lower than that of tongue base ($t = -2.58, -2.65, -2.54, -2.47, -2.37, -2.77, P < 0.05$), 2 000 Hz > 250 Hz > 5 Hz, and there was no significant difference between left and right sides ($t = -0.03, -0.51, -0.49, 0.06, -0.16, 0.13, P > 0.05$). The CPT value of male was slightly higher than that of female ($t = 0.92, 1.55, 0.27, 0.78, 1.44, 1.26, 0.35, 0.77, 1.27, 0.24, 0.78, 0.96, P > 0.05$). The CPT values of women in childbearing period were significantly less than those in menopausal women ($t = -3.90, -3.64, -2.14, -4.20, -4.28, -3.52, -4.46, -3.41, -3.63, -4.66, -2.86, P < 0.05$). The CPT value increased with age, and the values of all frequency of 20 to 30 years old group was significantly lower than those of subjects over 40 years old at each point (The t values of bilateral palatoglossal arch at 2 000 Hz were -5.57, -6.22, -10.18, -11.00; the t values of bilateral palatoglossal arch at 250 Hz were -6.39, -8.79, -6.39, -15.61; the t values of bilateral palatoglossal arch at 5 Hz were -7.09, -5.57, -9.26, -15.23; the t values of tongue base at 2 000 Hz were -3.11, -3.88, -7.60, -8.55; the t values of tongue base at 250 Hz were -6.31, -10.59, -8.52, -10.60; the t values of tongue base at 5 Hz were -6.69, -5.09, -8.70, -7.07, $P < 0.05$). The values at all frequencies and testing points of 30-40 years old group were significantly lower than those of all subjects over 60 years old (The t values of bilateral palatoglossal arch at 2 000 Hz were -10.91, -12.42; the t values of bilateral palatoglossal arch at 250 Hz were -6.25, -10.87; the t values of bilateral palatoglossal arch at 5 Hz were -5.53, -11.01; the t values of tongue base at 2 000 Hz were -8.62, -10.12; the t values

of tongue base at 250 Hz were -6.89,-7.82;the t values of tongue base at 5 Hz were -6.13,-6.48, $P<0.05$).

Conclusions:

CPT can be used to evaluate oropharyngeal sensory function. The sensitivity of tongue base is lower than that of palatoglossal arch, there is no significant difference in oropharyngeal sensory function between male and female,between left and right sides. There are many factors influencing oropharyngeal sensory function. Age, hormone level changes may affect the sensitivity of oropharyngeal sensory function.

The effects of silicone-based resilient denture liners on pain: A randomized controlled trial

So Furokawa, Suguru Kimoto, Nobuhiko Furuse, Yoshiteru Furuya, Takahiro Ogawa, Yoshio Nakashima, Masakazu Okubo, Hidenori Yamaguchi, Yasuhiko Kawai

Purpose

This randomized controlled trial aimed to study the effects of lining mandibular complete dentures with silicone-based resilient denture liners, especially with respect to sensation.

Methods

The trial included completely edentulous patients who were willing to fabricate new set of complete denture. A random permuted block method (block size: 4) was used to assign participants to one of the following groups: mandibular conventional denture (CD) group or mandibular denture with resilient denture liner (RD) group. The outcomes were evaluated using both, objective measures (current perception threshold (CPT) and pain threshold (PT)) for external stimuli measured using the Neurometer CPT® and subjective measures (physical pain and psychological discomfort measured using the Japanese version of Oral Health Impact Profile for Edentulous patients — OHIP-EDENT-J). The outcomes were measured twice, at immediately after completion of denture adjustments (first measurement), and 3 months after the completion of denture adjustments (second measurement). All outcomes were analyzed using the Student t-test. A p-value of <0.05 was considered statistically significant.

Results

CPT was significantly higher with RD than CD only at second measurement with frequency level of 2000 Hz and 5 Hz. The pain thresholds were significantly higher in the RD group than the CD group. The physical pain and psychological discomfort scores were significantly lower in the RD group than in the CD group.

Conclusion

This study concludes that edentulous patients wearing mandibular complete dentures with silicone-based resilient denture liners dull perception mandibular ridge mucosa and felt less pain than those without the liners.

Verification of the reliability of current perception threshold and pain threshold testing by application of an electrical current stimulus to mandibular mucosa in young adults.

Nobuhiko Furuse, Suguru Kimoto, Yoshio Nakashima, Takahiro Ogawa, So Furokawa, Masakazu Okubo 2, Hidenori Yamaguchi, Yasuhiko Kawai

Background

There is little evidence regarding the reliability of CPT and PT measurement to gauge mandibular perception. Thus, this study aimed to evaluate the test-retest reliability of CPT and PT values obtained from the mandibular oral mucosa and to test the bilateral differences in CPT and PT values obtained from the mental foramen region and buccal shelf region by a single operator.

Methods

CPT and PT values were obtained from the mental foramen and buccal shelf regions of 20 volunteers (10 male, 10 female; average age: 26.4 ± 2.6 years) by using the Neurometer CPT/C® device to deliver electrical stimulation.

Results

Relative and absolute reliability was confirmed over two measurements of CPT and PT over a 7-10 day measurement interval. Intraclass correlation coefficient (ICC) for CPT and PT Table obtained from the mental foramen region were >0.8 , while most ICC for the buccal shelf region were <0.8 . Standard error of measurement, minimal detectable change, and Bland-Altman analyses showed that the CPT and PT measurements had no systematic error and could serve as useful methods. At all frequencies, the bilateral difference in CPT and PT values at the mental foramen and buccal shelf region was not significant.

Conclusion

CPT and PT measurements using a custom-made device that applied an electrical current to the mental foramen region have appropriate reliability to assess intraoral sensitivity to electrical stimulation in young adults.

Receptivity of the mandible versus the maxilla to external stimuli in patients with complete dentures.

Suguru Kimoto, Nobuhiko Furuse, Takahiro Ogawa, Yoshio Nakashima, So Furokawa, Masakazu Okubo, Hidenori Yamaguchi, Yasuhiko Kawai.

Purpose

This study aimed to investigate whether the mandible is more receptive to external stimuli than the maxilla in patients with complete dentures by comparing regional current perception thresholds (CPTs) and pain threshold (PTs).

Methods

A single operator obtained measurements from maxillae at the incisor foramen and the left side of the greater palatine foramen region and the mandible at the left side of the mental foramen region, using the Neurometer CPT/C device. CPT and PT values from the oral mucosa of 20 edentulous individuals wearing complete dentures were analyzed. Participant characteristics such as mucosal thickness, occlusal force, age, and sex. Mucosal thickness over target regions and occlusal force were measured by the same operator using Krupp SDM and Occlusal Force-Meter GM10s devices. Differences in CPT and PT among the three measurement regions were tested with an analysis of covariance, and post hoc t-tests with the Bonferroni correction.

Results

There were no significant differences between the mental foramen, incisor papilla, and greater palatine regions CPT values. PTs obtained at all current frequencies (2000 Hz, 250 Hz, and 5 Hz) were lowest in the mental foramen region and highest in the greater palatine region. Covariates including sex, mucosal thickness, and occlusal force had no significant influence on CPT or PT values at all frequencies.

Conclusions

The mandible exhibits higher receptivity to external pain stimuli than the maxilla

The quantitative sensory testing is an efficient objective method for assessment of nerve injury

Young-Kyun Kim , Pil-Young Yun , Jong-Hwa Kim, Ji-Young Lee and Won Lee

Background

This study evaluated Somatosensory evoked potentials (SEP), Quantitative sensory testing (QST), and thermography as diagnostic methods for nerve injury.

Methods

From 2006 through 2011, 17 patients (mean age: 50.1 years) from OOOO Hospital who sought care for altered sensation after dental implant treatment were identified. The mean time of objective assessment was 15.2 months after onset.

Results

SEP of Inferior alveolar nerve(IAN) was 15.87 ± 0.87 ms on the normal side and 16.18 ± 0.73 ms on the abnormal side. There was delayed N20 latency on the abnormal side, but the difference was not statistically significant. In QST, the abnormal side showed significantly higher scores of the current perception threshold at 2 KHz, 250 Hz, and 5 Hz. The absolute temperature difference was 0.55°C without statistically significance.

Conclusion

These results indicate that QST is valuable as an objective method for assessment of nerve injur

Reliability of pain tolerance threshold testing by applying an electrical current stimulus to the alveolar ridge

Nakashima Y, Kimoto S, Kawai Y.

Abstract

The purpose of this study was to assess the reliability of testing pain tolerance threshold (PTT) by applying an electrical current stimulus to the alveolar ridge. Twenty volunteers studying or working at the Nihon University School of

Dentistry at Matsudo participated in this study. Participants were seated comfortably on a dental chair in a quiet room during testing. A single operator obtained mucosal PTT measurements around the right greater palatine foramen using a Neurometer CPT/C device (Neurotron Inc., Baltimore, MD, USA) to deliver electrical stimulation at frequencies of 5, 250 and 2000 Hz. The participant released a button to automatically discontinue the stimulus when it could no longer be tolerated. Two types of factors were confirmed: the consistency of repeated measurements and a potential carry-over effect on PTTs. The

consistency and carry-over effects of pain with regard to PTT measurements were analysed via Cronbach's coefficient α . The Cronbach's coefficient α of PTTs calculated more than 6 days of PTT testing at 5, 250 and 2000 Hz was 0.97, 0.95 and 0.97, respectively, suggesting that the consistency of the measurements was excellent. The Cronbach's coefficient α calculated when the three frequencies of 5, 250 and 2000 Hz were applied in different orders was 0.91, 0.87 and 0.90,

respectively, suggesting no carry-over effect. In conclusion, the measurement of PTTs at the alveolar ridge as assessed by applying an electrical current stimulus with an electro-diagnostic device exhibited excellent reliability, and thus, it

constitutes a widely available option for PTT measurement in the clinical setting.

Does wearing dentures change sensory nerve responses under the denture base?

Ito N, Kimoto S, Kawai Y.

Background

The standard textbook on complete dentures suggests the necessity of relief for the incisive and posterior palatine foramina of denture wearers to prevent the impingement of the nerves and vessels passing through these foramina. However, concrete evidence of the effect of dentures on the sensory function of the nerves underlying dentures is lacking.

Objective

The study aim was to investigate the influence of denture-induced compression on sensory nerve responses to stimulations.

Materials and methods

Only partially edentulous patients of maxillary Kennedy class II who wear dentures (WD) or who never wear dentures (ND) were recruited as participants. The WD and ND groups had 15 participants with a mean age of 66.9 years and 22 participants with a mean age of 60.2 years, respectively. Current perception thresholds (CPTs) at 2000, 250 and 5 Hz, corresponding to A-beta, A-delta and C fibres, respectively, were measured by the Neurometer® NS3000 device and compared between groups. The data were analysed by the t-test, the paired t-test and analysis of covariance adjusted for age, sex and thickness of the mucosa.

Results

The CPTs showed large differences at 2000 Hz but no differences at the other frequencies when the WD and ND groups were compared. Only the CPT of the edentulous side at 2000 Hz was significantly different between groups.

Conclusion

Wearing removable partial dentures contributes to changes of responses to stimulations in the large fibre of the sensory nerve underlying the maxillary alveolar ridge.

Biopsychosocial aspects of atypical odontalgia.

Ciaramella A, Paroli M, Lonia L, Bosco M, Poli P.

Background.

A few studies have found somatosensory abnormalities in atypical odontalgia (AO) patients. The aim of the study is to explore the presence of specific abnormalities in facial pain patients that can be considered as psychophysical factors predisposing to AO.

Materials and Methods.

The AO subjects (= 18) have been compared to pain-free (= 14), trigeminal neuralgia (= 16), migraine (= 17), and temporomandibular disorder (= 14). The neurometer current perception threshold (CPT) was used to investigate somatosensory perception. Structured clinical interviews based on the DSM-IV axis I and DSM III-R axis II criteria for psychiatric disorders and self-assessment questionnaires were used to evaluate psychopathology and aggressive behavior among subjects.

Results.

Subjects with AO showed a lower A , A , and C trigeminal fiber pain perception threshold when compared to a pain-free control group. Resentment was determined to be inversely related to A (rho: 0.62, < 0.05), A (rho: 0.53, < 0.05) and C fibers (rho: 0.54, < 0.05), and depression was inversely related with C fiber (rho: 0.52, < 0.05) perception threshold only in AO subjects.

Conclusion.

High levels of depression and resentment can be considered predictive psychophysical factors for the development of AO after dental extraction.

Maxillary sensory nerve responses induced by different types of dentures

Kimoto S, Ito N, Nakashima Y, Ikeguchi N, Yamaguchi H, Kawai Y.

Purpose

The purpose of this study was to investigate whether different types of dentures induced different responses to stimulations in sensory nerve underlying the denture-supporting mucosa using current perception threshold (CPT).

Materials and methods

The study population comprised 45 complete denture wearers with a mean age of 69.7 years (CD), 30 partial denture wearers (PD) with a mean age of 67.1 years, and 40 dentulous participants with a mean age of 69.0 years (Dent). Current perception threshold (CPT) on the greater palatine nerve at 2000 Hz, 250 Hz, and 5 Hz, corresponding to A-beta, A-delta, and C fibers respectively, were measured by the Neurometer1 NS3000 device. The differences CPTs among CD, PD, and Dent groups were analyzed by Kruskal–Wallis test and Mann–Whitney U test with adjusting the multiple comparisons' inflation of type 1 error rate by a Bonferroni correction.

Results

CPTs of CD, PD, and Dent group at 2000 Hz were 61.5 45.8, 53.5 25.3, 33.0 11.4 (10 2 mA) respectively. CPTs of CD, PD, and Dent group at 250 Hz were 29.2 28.2, 20.1 13.2, 14.3 5.9 (10 2 mA) respectively. CPTs of CD, PD, and Dent group at 5 Hz were 28.9 23.4, 17.8 12.2, 12.2 5.6 (10 2 mA) respectively. The CPTs at all frequencies increased in the following order: Dent < PD < CD wearer. The statistical analyses showed that the different types of dentures significantly affected CPTs at 2000 Hz ($p < 0.0001$), 250 Hz ($p < 0.0001$), and 5 Hz ($p < 0.0001$).

Conclusion

The different types of dentures induce different responses to stimulations in the sensory nerve underlying the denture-supporting mucosa.

Comparison of Current Perception Threshold Electrical Testing to Clinical Sensory Testing for Lingual Nerve Injuries

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Purpose:

We performed a retrospective study of lingual nerve injury assessment comparing the techniques of current perception threshold testing versus clinical sensory testing.

Patients and Methods:

We designed and implemented a cross-sectional study and enrolled a patient sample with lingual nerve injuries presenting for treatment to the principal investigator. The predictor variables were clinical sensory testing modalities (ie, temperature, nociception, vibration, 2-point discrimination, brush stroke, and von Frey monofilament perception). The primary outcome variable was the electrical current perception thresholds of the tongue dorsum (neurometer measurements at 5, 250, and 2,000 Hz). Comparisons were established with the ipsilateral affected and contralateral unaffected lingual nerve distributions. The associations between the clinical sensory testing and current perception threshold measurements were assessed using correlation coefficients, with the level of statistical significance set at $P .05$.

Results:

A total of 40 patients (13 males and 27 females) were included in the present study. The average age of these patients was 34 years (range 13 to 66). Significant correlations were observed between the electrical stimulation thresholds at 2,000 Hz and the 2-point discrimination, reaction to brushing, reaction to vibration, and von Frey fiber thresholds, between the electrical stimulation thresholds at 250 Hz to the nociceptive and thermal thresholds, and between the electrical stimulation thresholds at 5 Hz to thermal stimuli.

Conclusions:

The significant correlations observed in the present study indicate that current perception threshold can be a complementary or alternative tool in the assessment and evaluation of lingual nerve injuries.

A comparison of neurosensory alteration and recovery pattern among different types of orthognathic surgeries using the current perception threshold

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Objective.

The objective of this study was to compare postsurgical neurosensory alteration and recovery patterns among different nerve fiber types and orthognathic surgeries by measuring current perception thresholds (CPT).

Study design.

CPTs of 186 patients who underwent various orthognathic surgeries (Le Fort I or II, bilateral sagittal split [BSSRO] or intraoral vertico-sagittal [IVSRO] ramus osteotomy with or without genioplasty) were measured at 2000, 250, and 5 Hz, assessing 3 different nerve fiber types before surgery and at 3, 6, and 12 months after surgery.

Results.

CPTs were highest at 3 months postsurgery and gradually returned to presurgical levels until 12 months postsurgery in most cases. CPT at 2000 Hz showed the largest amount of increase. Le Fort I and IVSRO caused less neurosensory alteration compared with Le Fort II and BSSRO, respectively.

Conclusion.

Our data provide nerve recovery patterns following various orthognathic surgeries that may be applied to evaluating the patient's severity and recovery of nerve damage.

Guidelines for somatosensory evaluation of temporomandibular dysfunction and orofacial pain patients

Priscila Brenner Hilgenberg Sydney, Paulo César Rodrigues Conti

Background And Objectives

Different stimulations are needed to evaluate the integrity of afferent fibers and to better understand the mechanisms involved in different pain conditions which may affect the orofacial region. This study aimed primarily at reviewing the literature to provide guidelines to the clinical practice.

Contents

PubMed database was searched from 1990 to 2011 using MeSH terms. Mechanical stimulation could be done with Von-Frey monofilaments to test A-beta and A-delta fibers. Pinprick test is a simple way to evaluate A-delta and C fibers. Pressure pain threshold (PPT) tests A-delta and C fibers. Among thermal test modalities one may use ice cubes or a freezing spray to measure the level of central sensitization involved. Electric stimulations applied by the Neurometer/Neurotron® device evaluated three major fibers (A-delta, A-beta and C), hyperesthesia and hypoesthesia. In addition, C fibers can also be evaluated by chemical stimulations with capsaicin and/or menthol.

Conclusion

Quantitative sensory tests are a reliable way to evaluate nervous fibers sensory function. Sensory deficit may be quantified and data may be used as diagnostic aid or to compare the effectiveness of different treatment approaches.

Bibliography of Selected Neurometer® CPT Related Publications Grouped by Topic and Specialty

This section presents bibliographies of selected scientific publications using Neurometer® technology grouped according to topic and speciality. Additional documents, including a comprehensive bibliography of more than 500 scientific publications utilizing Neurometer® technology as well as additional information about clinical applications, product literature and more is available upon request or on Neurotron’s website at: <http://www.neurotron.com/downloads.html>.

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Anesthesia and Pain Pharmacology and Physiology (see Laboratory Animal Research)

1. Sun Yunzhong, Guo Xiaoli, Zhao Lei, Wang Xiaochuan, Shen Qiming, Ma Jianyun, Zhang Ying (Department of Pain Medicine, Suzhou High-Tech Zone People's Hospital) Evaluation and prediction of efficacy of radiofrequency combined with platelet-rich plasma in the treatment of trigeminal nerve ophthalmic branch herpes zoster by current threshold measurement. Chinese Journal of Pain Medicine 30 (7) 2024
2. Jia Hongying, Yang Guangyu, Wang Lijun (Henan Provincial People's Hospital, Department of Pain Medicine, Department of Rehabilitation Medicine) Effect of ultra laser irradiation combined with suspension exercise on pain and surface electromyography of neck in patients with cervical spondylotic radiculopathy. Chin J Orthop Clin Basic Res, Oct 2024 Vol.14, No.5 2024.
3. Han Xuemei, Li Jiayi, Lu Menghan, Liu Wei, Sun Wei (Qingdao Traditional Chinese Medicine Hospital) Curative effect of Feijing Zouqi acupuncture at five points of lumbar process combined with Duhuo Jisheng Decoction in lumbar disc herniation. Liaoning Journal of Traditional Chinese Medicine August 2024.
4. Shi Guirong, Li Ting, Zhou Jie Effect of Shaoyang Meridian Acupuncture Combined with Tao Wu Tong Prescription on Painful Diabetic Peripheral Neuropathy and Its Influence on Neural Conduction Function. Global Traditional Chinese Medicine, June 2024, Vol. 17, No. 6 2024.
5. Zhu Chunyan, Ni Huadong, He Qiuli, Xie Keyue, Fei Yong, Zhou Xiyan, Huang Bing, Yao Ming. Prediction and evaluation of current perception threshold for epidural block in patients with herpes zoster neuralgia. Clinical Education of General Practice Dec, Vol.18, No.12. 2020.
6. Liang Shufen (Guangxi University of Chinese Medicine) The study of the evaluation of sensory nerves for the treatment of cervical headache from milli fire needle under the guidance of ingjin theory. Master's Thesis of Guangxi University of Chinese Medicine 2020.
7. Liu Qianying, Ni Huadong, Chen Yajing, Yao Ming, Zhou Xuyan, Huang Bing, Ankang, Zhu Chunyan, He Qiu Li. (Department of Anesthesiology and Pain Medical Center, the First Affiliated Hospital of Jiaying University, Bengbu Medical College Graduate Department, Bengbu) Application Of Current Perception Threshold In Ct-Guided Trigeminal Radiofrequency Coagulation Surgery. China Journal of Pain Medicine 25 (12) 2019.
8. Yi Chen , Cheng-Jie Mao , Si-Jiao Li , Fen Wang , Jing Chen , Hui-Jun Zhang , Ling Li , Sha-Sha Guo , Ya-Ping Yang , Chun-Feng Liu , Quantitative and fiber-selective evaluation of pain and sensory dysfunction in patients with Parkinson's disease. Parkinsonism and Related Disorders. 1-5 2015.
9. Zakir Uddin, MScPT, Joy C MacDermid, PhD, Victoria Galea, PhD, Anita R Gross, MSc, Michael R Pierrynowski, PhD, The Current Perception Threshold Test Differentiates Categories of Mechanical Neck Disorder. Journal of Orthopaedic & Sports Physical Therapy. 2014.
10. Halder SK, Yano R, Chun J, Ueda H. Involvement of LPA1 receptor signaling in cerebral ischemia-induced neuropathic pain. Neuroscience 235 (2013) 10–15 2013.
11. Cheung J, Kajaks T, Janice Cheung1 , Tara Kajaks2 and Joy C. MacDermid, The relationship between neck pain and physical activity.. The Open Orthopaedics Journal, 2013, 7, (Suppl 4: M11) 521-529 2013.
12. Wu S, Yamaguchi H, Shibutani K. Effect of acupuncture on perception threshold: a randomised controlled trial. Acupunct Med. 2012.
13. Miyazaki Takuro, Kage Tetsuya, Togaya Tomohisa, Yamazaki Naoya, Tagawa Nu, Mifune Mariko, Shibata Yoshinobu, Nagano Takeshi, Assessment and follow-up of intercostal nerve damage after video-assisted thoracic surgery. European Journal of Cardiothoracic Surgery 2011
14. Thomas Jochum , Michael K. Boettger , Christin Burkhardt a, Georg Juckel , Karl-Jürgen Bär Increased pain sensitivity in alcohol withdrawal syndrome. European Journal of Pain 2009
15. Lee, Y-S., Kho, H-S., Kim, Y-K., Chung, S-C. Influence of Topical Capsaicin on Facial Sensitivity in Response to Experimental Pain. Journal of Oral Rehabilitation.. Volume 34(1):9-14, 2007.

16. Sakai, T., Tomiyasu, S., Yamada, H., Sumikawa, K. Evaluation of Allodynia and Pain Associated with Postherpetic Neuralgia Using Current Perception Threshold Testing. Clinical Journal of Pain. Volume 22(4):359-362, 2006.
17. Passavanti, M.B., Pace, M.C., Barbarisi, A., D'Andrea, F., Grella, E., Nicoletti, G., Aurilio, C. Pain and Sensory Dysfunction After Breast Cancer Surgery: Neurometer CPT Evaluation. Anticancer Research. Volume 26(5):3839-3844, 2006.
18. Suzuki, A., Kanai A., Hokia, S. Comparison of Analgesic Effect of a Metered-Dose Lidocaine Spray with a Lidocaine Patch. Anesthesiology. Volume 105:A205, 2006.
19. Sakai, T., Hojo, M., Aoki, H., Higashijima, U., Sumikawa, K. Epiduroscopy Improves the Pain and the Sensory Nerve Function in the Patients with Lumbar Spinal Stenosis. Anesthesiology Volume 103:A1003, 2005.
20. Oda, M., Kitagawa, N., Yang, B-X., Totoki, T. Morimoto, M. Quantitative and fiber-selective evaluation of dose-dependent nerve blockade by intrathecal lidocaine in rats. The Journal of Pharmacology and Experimental Therapeutics, Volume 312(3):1132-1137, 2005.
21. Liem EB, Joiner TV, Tsueda K, Sessler DI. Increased Thermal Sensitivity and Reduced Subcutaneous Lidocaine Efficacy in Redheads. Anesthesiology. Volume 102(3):509-514, 2005.
22. Daschbach, P., Houle, T., Newman, D., Ranjbaran, Z., Hyun, P., Harden, R. Is Etiology of Amputation Correlated with Psychophysiological and Psychosocial Aspects of Pain? American Pain Society. Poster #662, 2005.
23. Sakai, T., Use, T., Miura, K., Tomiyasu, S., Sumikawa, K. Quantitative and Selective Assessment of Sensory Nerve Block with Transdermal Amitriptyline. Anesthesiology. Volume 101:A901, 2004.
24. Alkire, M.T., White, N.S., Hsieh, R., Haier, R.J. Dissociable Brain Activation Responses to 5 Hz Electrical Pain Stimulation: A High-field Functional Magnetic Resonance Imaging Study. Anesthesiology. Volume 100:939-46, 2004.
25. Angst, S. M., Ramaswamy, B., Davies, M.F. Comparative Analgesic and Mental Effects of Increasing Plasma Concentrations of Dexmedetomidine and Alfentanil in Humans. Anesthesiology. Vol.101:744-52, 2004.
26. Voller, B., Sycha, T., Gustorff, B., Schmetterer, L., Lehr, S., Sichler, H.G., Auff, E., Schnider, P. A randomized, double-blind, placebo controlled study on analgesic effects of botulinum toxin A. Neurology. Volume 61:940-944, 2003.
27. 13. Falci, S.P., Best, L.G., Bayles, R., Cown, C. Dorsal Root Entry Zone (DREZ) microcoagulation for central pain of spinal cord injury: operative intramedullary electrophysiological guidance and clinical outcome. Journal of Neurosurgery (Spine 2). Volume 97:193-200, 2002.
28. Finkel, J.C., Yang, C.I. Yarvitz, J.L. Patel, K.M. Neuroselective sensory electrodiagnostic evaluation of 4% liposomal lidocaine. Anesthesia Analgesia. Volume 94:1259-62, 2002.
29. Gustorff, B., Hoerauf, K.H., Lierz, P., Kress, H.G. Comparison of different quantitative sensory testing methods during remifentanyl infusion in volunteers. British Journal of Anaesthesia. Volume 91(2) 2003 Aug;91(2):203-8.
30. Toda, K., Muneshige, H., Asou, T., Kimura, H. Comparison of Current Perception Threshold between Each Side in Unilateral Complex Regional Pain Syndrome Patients does not Measure the Patient's Pain. Hiroshima Journal of Medical Sciences. Volume 53, 2004.
31. Kudoh, A., Katagai, H. Takezawa, T. Current Perception Thresholds with Long-term Administration of Meprobitaline. Pharmacopsychiatry Volume 36:57-60, 2003.
32. Healey, M., Rice G., Western R. Does Endometriosis Pain Alter Sensation Perception?, Australian Gynaecologic Endoscopy Society (AGES) Free Communications. (A) 1130-1340, 2003. http://www.ages.com.au/melb03/AGES_03_Melb_freecomonly.pdf
33. Matsunaga, A.; Sanuki, M.; Kinoshita, H. Optimal application time of lidocaine adhesive tape examined using current perception threshold measurement Masui. Volume 52:946-52, 2003.

34. Kudoh, A., Matsuki, A. Current perception thresholds of epileptic patients treated with valproate. Seizure, Volume 9; Part 7:498-501, 2000.
35. Kudoh, A., Ishihara, H., Matsuki, A., Current Perception Threshold and Postoperative Pain in Schizophrenic Patients, Regional Anesthesia and Pain Medicine, Volume 25(5):475-479, 2000.
36. Alo', K.M., Chado, H.N. Effect of Spinal Cord Stimulation on Sensory Nerve Conduction Threshold Functional Measures. Neuromodulation, Volume 3(3):145-154, 2000.
37. Skarke, C., Darimont, J., Geisslinger, G., Lötsch, J., Schmidt, H. Analgesic effects of morphine and morphine-6-glucuronide in a transcutaneous electrical pain model in healthy volunteers. Clinical Pharmacology and Therapeutics, Volume 73(1):107-121, 2003.
38. Lötsch J, Angst MS. The mu-opioid agonist remifentanyl attenuates hyperalgesia evoked by blunt and punctuated stimuli with different potency: a pharmacological evaluation of the freeze lesion in humans. Pain Volume 102:151 - 161, 2003.
39. Tegeder I, Meier S, Burian M, Schmidt H, Geisslinger G, and Lötsch J. Peripheral opioid analgesia in experimental human pain models. Brain, Volume 126(5), 1092-102, 2003.
40. Raj, P.P., et al. Painless Electrodiagnostic Current Perception Threshold and Pain Tolerance Threshold Values in CRPS Subjects and Healthy Controls: A Multi-Center Study. Pain Practice, Volume 1(1):53-60, 2001.
41. Radwan, I.A., Saito, S. Goto, F. High-concentration tetracaine for the management of trigeminal neuralgia: quantitative assessment of sensory function after peripheral nerve block. Clinical Journal of Pain. Volume 17:323-326, 2001.
42. Gustorff, B., Nahlik, G., Klaus, Hoerauf, K.H., Kress, H.G. The Absence of Acute Tolerance During Remifentanyl Infusion in Volunteers. Anesthesia & Analgesia, Volume 94: 1223-8, 2002.
43. Okada, T., et al. Long-term efficacy of topical 0.05% capsaicin in post herpetic neuralgia. Pain Clinic, Volume 22(2):219-222, 2001.
44. Sakai, T., Tomiyasu, C., Ono, T., Yamada, Y., Sumikawa, K. The Evaluation of Dynamic Allodynia and Pain Associated with Postherpetic Neuralgia Using Current Perception Threshold Testing Device. American Society of Anesthesiology, Abstract A-800, 2001.
45. Egi, A.; Sanuki, M.; Kinoshita, H.; Fujii, K. Evaluation of adhesive tape containing lidocaine using current perception threshold measurement. Ma sui, Volume 50(7):731-735, 2001.
46. Angst, M.S., Drover, D.R., Lötsch, J., Ramaswamy, B., Naidu, S., Wada, D.R., Stanski, D.R. The pharmacodynamics of orally administered sustained release hydromorphone in humans. Anesthesiology, Volume 94:63-73, 2001.
47. Oshima, M., Ogawa, R., Menkes, D.L. Current perception threshold increases during pregnancy but does not change during the menstrual cycle. Journal of Nippon Medical School, Volume 69(1):19-23, 2002.
48. Watanabe, S., Otsubo, Y., Araki, T. The current perception thresholds in normal pregnancy. Journal of the Nippon Medical School, Volume 69:342-346, 2002.
49. Horiguchi, I. and Otake, T., Obata, H., Saito, S. Abnormal current perception threshold observed with post-herpetic neuralgia. The Pain Clinic, Volume 12(1):57-60, 2000.
50. Mironer, Y., Somerville, J.J. Pain Tolerance Threshold: A pilot study of an objective measurement of spinal cord stimulator trial results. Pain Medicine, Volume 1(2):110-115, 2000.
51. Angst, M.S., Ramaswamy, B., Reily, E.T. Stansky, D.R. Lumbar Epidural Morphine in Humans and Supraspinal Analgesia to Experimental Heat Pain. Anesthesiology, Volume 92(2):312-324, 2000.
52. Miyake, M., Hitosugi, N., Ikegami, K., Inoue, H., Sato, Y., Sato, I. Alteration of current perception threshold in severely injured patients. Critical Care Vol 4 Suppl 1 20th International Symposium on Intensive Care and Emergency Medicine. P187, page 107, 2000. <http://ccforum.com/content/4/S1/P187>

53. Sakura, S., Sumi, M., Morimoto, N., Saito, Y. The Addition of Epinephrine Increases Intensity of Sensory Block During Epidural Anesthesia with Lidocaine, Regional Anesthesia and Pain Medicine, Volume 24(6): 541-546, 1999.
54. Sakura S, Sumi M, Yamada Y, Saito, Y., Kosaka, Y. Quantitative and Selective Assessment of Sensory Block During Lumbar Epidural Anaesthesia with 1% or 2% lidocaine. British Journal of Anaesthesia, Volume 81:718-22, 1998.
55. Sakura, S., Sumi, M., Kushizaki, H., Saito, Y., Kosaka, Y. Concentration of Lidocaine Affects Intensity of Sensory Block During Lumbar Epidural Anesthesia. Anesthesia and Analgesia, Volume 88(1):123-7, 1998.
56. Sakura, S., Sumi, M., Yamada, Y., Saito, Y., Kosaka, Y. Quantitative Assessment of Differential Nerve Block During Lumbar Epidural Anesthesia, Masui, Japan Volume 47(7):824-30, 1998.
57. Tay, B., Wallace, M.S., Irving, G. Quantitative Assessment of Differential Sensory Blockade after Lumbar Epidural Lidocaine. Anesthesia and Analgesia, Volume 84:1071-1075, 1997.
58. Maeda, M., Sakura, S., Saito, Y., Uchida, H., Tanaka, A., Kosaka, Y. Quantitative and selective assessment of peripheral nerve function in Patients with Chronic Pain: The value of the Neurometer CPT®. The Journal of the Japan Society of Pain Clinicians, Volume 4(2):113-119, 1997.
59. Suzuki, K., Goto, Y. Evaluation of Mexiletine Hydrochloride on Nerve Conduction in Patients with Painful Diabetic Neuropathy. Japanese Journal of Medicine and Pharmaceutical Science, Volume 36(10):713-726, 1997.
60. Liu, S.S., Gerancher, J.C., Bainton, B.G., Kopacz, D.J., Carpenter, R.L: Effects of Electrical Stimulation at Different Frequencies on Perception and Pain in Human Volunteers: Epidural Versus Intravenous Administration of Fentanyl. Anesthesia & Analgesia, Volume 82:98-102, 1996.
61. Wallace, M.S., Dyck, J.B., Rossi, S.S., Yaksh, T.L. Computer Controlled Lidocaine Infusion for the Evaluation of Neuropathic Pain after Peripheral Nerve Injury. Pain, Volume 66:69-77, 1996.
62. Liu, S., Kopacz, K.J., Carpenter, R.L: Quantitative Assessment of Differential Sensory Nerve Block after Lidocaine Spinal Anesthesia. Department of Anesthesiology, Virginia Mason Medical Center, Seattle, WA. Anesthesiology, Volume 82(1):60-63, 1995.
63. Mekhail, N.A, Daoud, E, Maruna, N. Effect of sympathetic blockade on pain tolerance and current perception in sympathetic-maintained pain state. Dolor, Volume 13: 43, 1998.
64. Okada, T., et al. Long-term efficacy of topical 0.05% capsaicin in post herpetic neuralgia. Pain Clinic, Volume 22(2):219-222, 2001.
65. Imamachi, N., Sakura, S., Sato, N., Kanata, K., Saito, Y., et al. Ambient Temperature Affects Current Perception Thresholds in Patients with Neuropathic Pain. Anesthesiology, 95:A-837, 2001.
66. Sakura, S., Imamachi, N., Kushizaki, H., Hashimoto, T., Saito, Y., et al. Effect of Ambient Temperature on Current Perception Thresholds in Healthy Volunteers. Anesthesiology, 95:A-838, 2001.
67. Oshima, M., Ogawa, R., Menkes, D.L. Current perception threshold increases during pregnancy but does not change during the menstrual cycle. Journal of Nippon Medical School Volume 69(1):19-23, 2002.
68. Tomiyasu, S., Sakai, T., Ono, T., Yamada, H., Sumikawa, K. Analysis of Intercostal Nerve Damage Associated with Chronic Post-Thoracotomy Pain. Anesthesiology, 95:A-964, 2001.
69. Goto, F. Trigeminal nerve block using high concentration local anesthetics. Pain Clinic .Volume 22(8):1066-1069, 2001.
70. Tankano, K., Muramori, S, Masao mi, T., Iseki, M., Suzuki, T., Tomono, K., Goto, H., Miyazaki, T, Nishitani, A., Watanabe, J. Quantitative Investigation of the Effect of Sensory Nerve Anesthesia with 9% Lidocaine Ointment on Healthy Subjects by use of the Neuro selective Current Perception Threshold. J. Pharm. Sci. Technol., Jpn., Volume 62(3):105-112, 2002.

Dentistry

71. Jin Haishan, Zheng Dongdong, Fu Xin(Department of Orthodontics, Department of Implantology, Handan Stomatological Hospital;Department of Stomatology, Handan First Hospital, Handan)Effects of concentrated growth factor combined with bio-oss bone powder on osteogenesis and sensory nerve action potential during dental implant restoration in the maxillary Molar Region.Chin J Dent Mater Dev.Volume 34, Issue 4, 2025
72. Dong Yabing, Hao Yunbo, Zhang Wenhao, Wang Yiwen, Chen Minjie (Department of Oral Surgery, The Ninth People's Hospital Affiliated to Shanghai Jiao Tong University School of Medicine, Shanghai Jiao Tong University School of Stomatology, National Center for Oral Medicine, National Clinical Research Center for Oral Diseases, Shanghai Key Laboratory of Stomatology) Functional detection and prognostic analysis of inferior alveolar nerve injury after mandibular third molar extraction.Journal of Shanghai Jiao Tong University (Medical Edition)Vol.42 No.6 Jun. 2022.
73. So Furokawa, Suguru Kimoto, Nobuhiko Furuse, Yoshiteru Furuya, Takahiro Ogawa, Yoshio Nakashima, Masakazu Okubo, Hidenori Yamaguchi, Yasuhiko Kawai. The effects of silicone-based resilient denture liners on pain: A randomized controlled trial. J Prosthodont Res 2020 Oct;64(4) 2020.
74. Suguru Kimoto, Nobuhiko Furuse, Takahiro Ogawa, Yoshio Nakashima, So Furokawa, Masakazu Okubo, Hidenori Yamaguchi, Yasuhiko Kawai. Receptivity of the mandible versus the maxilla to external stimuli in patients with complete dentures. J Prosthodont Res 2019 Jul;63(3):299-302 2019.
75. Nakashima Y, Kimoto S, Kawai Y. Reliability of pain tolerance threshold testing by applying an electrical current stimulus to the alveolar ridge.Oral Rehabilitation Journal of Oral Rehabilitation 2014.
76. Ito N, Kimoto S, Kawai Y. Does wearing dentures change sensory nerve responses under the denture base? Gerodontology. 31: 63–67.2014
77. Ciaramella A, Paroli M, Lonia L, Bosco M, Poli P. Biopsychosocial aspects of atypical odontalgia. ISRN Neuroscience 2013.
78. Kimoto S, Ito N, Nakashima Y, Ikeguchi N, Yamaguchi H, Kawai Y.Maxillary sensory nerve responses induced by different types of dentures.J Prosthodont Res. 2013 Jan;57(1):42-5 2013.
79. Ogura, K., Kim oto, S., Kobayashi, K., Yam aguchi, H., Sairo, T. [Reliability of the Measurement of Current Perception Thresholds in the Palatal Mucosa]. Nihon Hotetsu Shika Ga akkai Zasshi Volume 50(3):432-40, 2006.
80. Seo, K., Tanaka, Y., Terum itsu, M., S, G. Characterization of different paresthesias following orthognathic surgery of the mandible. J Oral Maxillofac Surg. Vol. 63(3): 298-303, 2005.
81. Kim, H-S, Kho, H-S, Kim, Y-K., Lee, S-W, Chung, S-C Reliability and Characteristics of Current Perception Thresholds in the Territory of the Infraorbital and Inferior Alveolar Nerves, Journal of Orofacial Pain, Volume 14:286-292, 2000.
82. Lerner, T.H., Goldstein, G.R., Hittelman, E. Quantitative sensory Nerve Conduction Threshold (sNCT) evaluation of the trigem inal nerve at the mental foramen area. The Journal of Prosthetic Dentistry. Volume 84(1):103-107, 2000.
83. Lee, Y-S., Kho, H-S, Kim, Y-K, Lee, S.W., Chung, S-C. Quantitative Evaluation of Differential Sensory Changes after Topical Capsaicin in Mental Area. Journal of Orofacial Pain, 333, 2002.

Dermatology

84. Wang Xue, Pan Yongtao, Yang Yang, Xu Changfen, Ye Li (Department of Dermatology, Shanghai Ninth People's Hospital, Shanghai Jiao Tong University School of Medicine, ; Xiamen ZAOWOO Cosmetics Co., Ltd., ; SGS-CSTC Standards Technical Services (Shanghai) Co., Ltd., ; SGS-CSTC Standards Technical Services Co., Ltd., Xiamen Branch,China; Dermatology Hospital of Southern Medical University Cosmetic Testing Center) .Clinical study on the improvement of facial redness in sensitive skin with soft mask. Detergent & Cosmetics.Vol.49 No.4 Apr. 2026
85. Yang Yang, Chen Tian, Wei Zefeng, Zhang Rongxue, Wang Dongyu, Yu Qionghua, Research Progress on Cosmetics Suitable for Sensitive Skin and Its Efficacy Evaluation Methods. SHANGHAI LIGHT INDUSTRY. 2025 .
86. Qiu Simin, Zhao Chunxia, Zhang Dawei, Evaluation Methods for the Human Efficacy of Soothing Cosmetics. FLAVOUR FRAGRANCE COSMETICS, February 2025, Issue 1
87. Feng Faqing, Li Jing. Scientific evaluation methods for soothing cosmetics efficacy.China Surfactant Detergent & Cosmetics Vol.53 No.7 July 2023.

88. JaeIn Lee, DongHyek Jang, JooYoon Bae, HyeJung Jung, MiYoun Park, JiYoung Ahn . Efficacy of pregabalin for the treatment of chronic pruritus of unknown origin, assessed based on electric current perception threshold. Scientific Reports2020 Jan 23;10(1)
89. Manuel P Pereira, Konstantin Agelopoulos, Johannes Köllner, Gitta Neufang, Martin Schmelz, Sonja Ständer. Selective Nerve Fibre Activation in Patients with Generalized Chronic Pruritus: Hint for Central Sensitization? Acta Derm Venereol .2019 Oct 1;99(11) 2019.
90. Ma Li, Tan Yimei, Cheng Ying, Lu Nan, Hua Weiguang (Shanghai Dermatology Hospital, Department of Dermatology and Cosmetics Research, Shanghai Jahwa United Co., Ltd.) Evaluation Methods for the Applicability of Facial Sensitive Skin Cosmetics. Chin J Dermatol Venerol Integ Trad W Med 2018, Vol. 17 No. 1 2018.
91. H.Ham,S.M.An,E.J.Lee,E.Lee,H.O.Kim and J.S.Koh,Itching sensation and neuronal sensitivity of the skin.Skin Research and Technology 2016;22:104-107 2016
92. Li Shuyuan, Wang Xuemin, Gao Yanrui, Chen Shuangyu, Liu Xiaoping, Dong Yaqi, Fan Guobiao(Skin & STD Department, Tongji Hospital of Tongji University)Clinical value of CPT in the diagnosis of neural sensitive skin.J Clin Dermatol.January2014, Vol 43, No.1
93. Li Shuyuan, Wang Xuemin(Skin & STD Department, Tongji Hospital of Tongji University,Shanghai Dermatology Hospital, Department of Dermatology and Cosmetics Research),Pathogenesis and evaluation of self-perceived sensitive skin .Journal of Practical Dermatology, Dec. 2013,Vol.6 No.6 2013.
94. Christina M. Reinisch , Erwin Tschachler,The dimensions and characteristics of the subepidermal nerve plexus in human skin – Terminal Schwann cells constitute a substantial cell population within the superficial dermis.Journal of Dermatological Science 65 (2012) 162–169 2012.
95. Ozawa A, M., Tsuchiyama, K., Gomi, R., Kurosaki, F., Kawamoto, Y., Aiba, S. Neuroselective Transcutaneous Electric Stimulation Reveals Body Area-Specific Differences in Itch Perception . Journal of the American Academy of Dermatology. Volume 55:996-1002, 2006.
96. Kobayashi H, Kikuchi K, Tsubono Y, Tagami H. Measurement of electrical current perception threshold of sensory nerves for pruritus in atopic dermatitis patients and normal individuals with various degrees of mild damage to the stratum corneum. Dermatology. Volum e 206(3):204-11, 2003.
97. Yokota, T., Matsumoto, M., Sakamaki, T., Hikima, R., Hayashi, S., Yanagisawa, M., Kuwahara, H., Yamazaki, S., Ogawa, T., Hayase Classification of Sensitive Skin and Development of a Treatment System Appropriate for Each Group. (International Federation of the Societies of Cosmetic Chemists) IFSCC Magazine, Volum e 6(4):303-307,2003.

Endocrinology & Diabetes

98. Zhang Bilin, Han Pingping, Zhang Yu, Xiang Shiqiang, Xiang Guangda.Correlation between peripheral neuropathic hyperesthesia and body fat composition and thyroid function in patients with type 2 diabetes mellitus.Joint Logistics Military Medicine 2025, July 28, Volume 39, Issue 7. 2025.
99. Bordács B, Várkonyi Á, Valkusz Z, Nyiraty S, Pósa A, Menyhárt A, Lengyel C, Kempler P, Kupai K, Várkonyi T.Comprehensive Assessment of Neuropathy and Metabolic Parameters in Type 1 Diabetic Patients with or Without Using Continuous Glucose Sensors. Int J Mol Sci. 2025 Feb 26;26(5):2062. doi: 10.3390/ijms26052062
100. Zhang Yang, Qu Junsheng, Cheng Xuebing, Wang Hongsheng, Huang Na (Department of Endocrinology and Metabolism, Affiliated Hospital of Fang Medical College) Establishment of a risk regression equation for type 2 diabetes mellitus peripheral neuropathy based on multivariate regression analysis. Diabetes New World January 2025.
101. Esze R, Barna S, Fülöp P, Kempler P, Mikó M, Páll D, Paragh G, Somodi S, Emri M, Képes Z, Garai I, Káplár M.C-peptide: an essential ally in microvascular complications of type 2 diabetes mellitus and obesity. Diabetol Metab Syndr. 2024 Aug 29;16(1):211. doi: 10.1186/s13098-024-01454-1. 2024.
102. Sun Xiaoming, Wang Dan, Duan Binhong, Zhao Lingfei, Li Na (Department of Endocrinology, Heilongjiang Provincial Hospital)Efficacy of Semaglutide Combination with Metformin in the Treatment of Diabetic Peripheral Neuropathy and Its Impact on Body Weight. Journal of Clinical and Experimental Medicine November 2024, Volume 23, Issue 21. 2024
103. Yuan Fang Yuan, Hui Li Wang, Yuan Yuan Yue, Li Mo, Wei Sun. Study on mechanism of nerve fiber injury in diabetic neuropathy. J Medical Forum Vol 45, NO. 13, July 2024.
104. Wang Yulong, Pan Deng(West Electric Group Hospital) Effect of modified Huangqi Guizhi Wuwu decoction combined with traditional Chinese medicine foot bath on diabetic peripheral neuropathy and its influence on current perception threshold.Clinical Medical Research and Practice Volume 9, Issue 13, May 2024.
105. Wu Yanlin, Ma Jun, Du Yanfen, Wang Yuezhen, Duan Jianying, Li Dan (Department of Endocrinology, Zhangjiakou First Hospital) Plantar pressure changes in diabetic peripheral neuropathy and its relationship with nerve conduction, sensory current thresholds and inflammatory factors. Medical Science Journal of Central South China, Vol 52,No 3,2024.
106. Anna E Körei, Magdolna Békeffy, Adrienn Menyhárt, Karola Osgyán, Ildikó Istenes, Viktor J Horváth, Péter Kempler. No clear evidence of neuropathy among patients with high risk for the development of prediabetes/diabetes: a pilot study . Front Endocrinol 2024.
107. Dóra Zsuzsanna Tordai, Noémi Hajdú, Ramóna Rác, Ildikó Istenes, Magdolna Békeffy, Orsolya Erzsébet Vági, Miklós Kempler, Anna Erzsébet Körei, Bálint Tóbiás, Anett Illés, Henriett Pikó, János Pál Kósa , Kristóf Árvai, Márton Papp, Péter András Lakatos, Péter Kempler, Zsuzsanna Putz. Genetic Factors Associated with the Development of Neuropathy in Type 2 Diabetes. International Journal of Molecular Sciences .2024.

108. Lu Liang, Xu Hua, Zhao Lu (Zhengzhou Hospital of Traditional Chinese Medicine; The Third Affiliated Hospital of Henan University of Chinese Medicine) Clinical efficacy of oral administration of modified Saposhnikovia miltiorrhiza decoction combined with transcutaneous electrical stimulation on diabetic peripheral neuropathy with yin deficiency and fire hyperactivity and its effects on nerve function and oxidative stress index. Traditional Chinese Medicine Research Volume 35, Issue 4, 2022.
109. Huang Zhengguo, Shen Sheng'ai, Tai Hongmei, Lu Changri, Zhang Chunzi (Yanji City Hospital) Clinical Application of Sensory Nerve Conduction Threshold Assessment in the Diagnosis of Diabetic Peripheral Neuropathy. Diabetes New World February 2022.
110. Anna Vágvolgyi, Ágnes Maróti, Mónika Szűcs, Csongor Póczik, Dóra Urbán-Pap, István Baczkó, Attila Nemes, Éva Csajbók, Krisztián Sepp, Péter Kempler, Andrea Orosz, Tamás Várkonyi, Csaba Lengyel. Peripheral and Autonomic Neuropathy Status of Young Patients With Type 1 Diabetes Mellitus at the Time of Transition From Pediatric Care to Adult-Oriented Diabetes Care. Front Endocrinol 2021
111. Wang Yun, Lu Mengxi, Gao Lijuan, Hu Shuguo (The Second Hospital of Shijiazhuang City, Hebei Province; School of Basic Medical Sciences, North China University of Science and Technology) Correlation between lower extremity arterial disease in patients with type 2 diabetes mellitus and current perception Threshold. Hebei Medical Journal, Vol 40 Mar No. 5 2018.
112. Wang Yun, Gao Lijuan, Hu Shuguo, Huang Jiehua, Wang Xianwei (Department of Endocrinology, The Second Hospital of Shijiazhuang City, Shijiazhuang). Clinical significance of evaluation of current perception threshold in early diagnosis and intervention of type 2 diabetic peripheral neuropathy. Hebei Medical Journal, 2018, Vol 40 Feb No. 3
113. Wang Yun, Gao Lijuan, Hu Shuguo, Huang Jiehua (The Second Hospital of Shijiazhuang City, Hebei Province) Therapeutic effects of compound Danshen dripping pills on early peripheral neuropathy in patients with type 2 diabetes mellitus. Hebei Medical Journal, Vol 40 Apr No. 7, 2018
114. Yue Zongxiang, Zhuo Wenxiu, Huang Rongli, Li Xiaoyan, Zhang Peihai (Nanjing University of TCM, Affiliated Integrated Traditional and Western Medicine Hospital of Nanjing University of TCM, Nanjing) Rules of TCM in Treating Tumor-Related Sleep Disorders. Henan Traditional Chinese Medicine Vol 39, No. 7, 2017.
115. Su Guanming, Hu Shuguo, Wang Lihui, Yang Yang, Liu Qiong (Department of Endocrinology, the Second People's Hospital Shijiazhuang) Correlation between glycated hemoglobin and damage of different sensory nerve subsets in diabetes patients. Chin J Clin Healthc, December 2017, Vol. 20, NO.6 2017
116. Wang Tianlu, Zhao Tingyang, Zhao Chengxuan, Wang Xinyan, Xu Limei (General Hospital of the People's Liberation Army Air Force) Clinical research on quantitative sensory testing instrument for early diabetic nerve injury of the lower limbs. Chin J Clinicians (Electronic Edition), August 1, 2015, Vol. 9, No. 15
117. Xu Xiuhua, Han Ruolin, Zhang Kun (Department of Diabetes, The First Affiliated Hospital of Kunming Medical University) Exploration of the significance of quantitative detection instrument of sensory nerve in the diagnosis of diabetic peripheral neuropathy. Integrated Medicine September 2015.
118. Zhao Renhua, Niu Ben, Su Heng, Xue Yuanming, Tang Qingli (Department of Endocrinology, Yunnan Provincial First People's Hospital) Application of sensory current threshold in the assessment of nerve fiber damage in type 2 diabetes mellitus. China Diabetes Journal Volume 23, Issue 7, July 2015.
119. Wang Qiong, Zeng Rong, Guo Jing (Union Hospital Affiliated to Tongji Medical College, Huazhong University of Science and Technology) Application of sensory nerve in the quantitative detection of diabetes patients. Modern Clinical Nursing, 2013. 12 (10)
120. Han D. Retrogression of Nervous Fibers According to the Age of Patients with Diabetes Mellitus (DM). J. Phys. Ther. Sci. 25: 1063-1066 2013
121. Tang Fengyan (Suzhou University, Department of Internal Medicine, Endocrinology and Metabolic Diseases) Study on the Changes and Significance of Hypoxia Inducible Factor-1 α in Type 2 Diabetes and its Peripheral Neuropathy. Master's Professional Degree Thesis of Soochow University May 2013.
122. Tang Fengyan, Li Quanmin, Gao Qing, Zhang Yi (Department of Endocrinology, General Hospital of the Second Artillery Force of the People's Liberation Army) Application of electrical current threshold measurement in early diagnosis of diabetic peripheral neuropathy. Beijing Medicine Volume 35, Issue 2, 2013.
123. Legrady P, Bajcsi D, Lengyel C, Varkonyi TT, Fejes I, Kempler P, Abraham G. Investigation of cardiac autonomic and peripheral sensory neuropathy in diabetic and nondiabetic patients with hypertension. ClinExpHypertens, 2013.
124. Nawfar SA, Yacob NB. Effects of monochromatic infrared energy therapy on diabetic feet with peripheral sensory neuropathy: a randomised controlled trial. Singapore Med J, 2011.
125. Kim ES, Moon SD, Kim HS, Lim DJ, Cho JH, Kwon HS, Ahn KH, Kang MI, Cha BY, Son HY. Diabetic peripheral neuropathy is associated with increased arterial stiffness without changes in carotid intima-media thickness in type 2 diabetes. Diabetes Care, 2011 Jun;34(6) 2011.
126. Li Dongying, Yang Jinkui (Department of Endocrinology, Beijing Tongren Hospital, Capital Medical University) Detection and Risk Factor Analysis of Peripheral Neuropathy in Type 2 Diabetes Mellitus. Annual Academic Conference of Endocrinology and Diabetes of Beijing Medical Association, October 2009
127. Givi Kurashvili, Ramaz Kurashvili, Liana Tsutskiridze, Elena Shelestova, Mzia Dundua. Georgian Diabetes Center, Tbilisi, Georgia ANTI-OXIDANT TREATMENT IN DIABETIC PERIPHERAL NEUROPATHY ISDN-Neurodiab 2009 Final Booklet & Book of Abstracts page 108 .2009
128. T.T. Várkonyi, A. Szabolcs, V. Szidor, A. Szász, É. Börcsök, C. Lengyel, T. Takács, P. Kempler, T. Wittmann; Evaluation of exocrine pancreatic function in patients with type 1 and type 2 diabetes. European Association for the Study of Diabetes. 2009.
129. Aziz Nather⁴, Shu Hui Neo, Siok Bee Chionh, Stanley C.F. Liew, Eileen Y. Sim, Jocelyn L.L. Chew, Assessment of sensory neuropathy in patients with diabetic foot problems. Journal of Diabetes and Its Complications 22 (2008) 126 – 131 2008

130. Kurashvili, G., Kurashvili, R., Tutsiskiridze, L., Shelestova, E. Efficacy of α -Lipoic acid in Newly Diagnosed Type 2 Diabetes. Diabetic Medicine Journal of Diabetes UK. Cape Town, South Africa. Volume 23 (Suppl.4):P 221, 2006.
131. Hermányi, Z., Putz, Z., Tóth, N., Berta, B., Keresztes, K., Istenes, I., Kempler, P. The Separate and Combined Effects of Benfotiamin and Alpha-Lipoic Acid on the Progression of Diabetic Neuropathy. Diabetologia. 2006.
132. Keresztes, K., Istenes, I., Vargha, P., Kempler, P. Higher Fasting Glucose Levels Within the Normal Range Associated with Sensory Nerve Dysfunction in Patients with Essential Hypertension. Diabetologia. Volume 49 (Suppl. 1):1034, 2006.
133. Kempler, P., Keresztes, K., Istenes, I., Hermányi, Z., Vargha, P. Complete Restoration of Sensory Nerve Dysfunction in Newly diagnosed Type 1 Diabetic Patients Following Long Term Benfotiamine Treatment (Two Cases). 7th International Symposium on Diabetic Neuropathy Somerset West, South Africa. P. 2, 2006.
134. Barla, L., Váradi, G., Kempler, P., Mazsaroff, C., Vámosi, I. Beta-Fibrinogen Gene G/A -455 Polymorphism in Relation to Subclinical Diabetes Complications in Children and Adolescents with Type 1 Diabetes. Diabetes. Volume 54 (1881-P; Suppl. 1):A 452, 2005.
135. Yang, G., Yuan, S., Du, Y., et al. Clinical Analysis of Diabetic Sensory Neuropathy with Neurometer. Chinese Journal of Coal Industry Medicine, Volume 8(1): 62- 63, 2005.
136. Hermányi, Zs., Putz, Zs., Berta, B., Tóth, N., Istenes, I., Keresztes, K., Kempler, P. Comparison of Case IV, Medoc, Neurometer, Neurometer Rapid, Calibrated Tuning Fork, Neuropathy Impairment Score (NIS), MTHF Gene Polymorphism Methods to Nerve Conduction Velocity in the Diagnosis of Diabetic Polyneuropathy. 40th Annual Meeting of the European Diabetes Epidemiology Group of the European Association for the Study of Diabetes (EASD), Siófok, Hungary, 2005.
137. Lengyel, C., Török, T., Várkonyi, T., Kempler, P., Rudas, L. Baroreflex Sensitivity and Heart-Rate Variability in Insulin-Dependent Diabetics with Polyneuropathy. The Lancet Volume 351(1823):1436-1437, 1998.
138. Nather, A., Lin, B. C., Feng, M. C. B., Ong, H. J. C., Aziz, Z. Diabetic Foot Problem: An Epidemiology Study - Preliminary Results. Malaysian Orthopedic Society, 35th Annual General Meeting & Annual Scientific Meeting, presentation, 2005.
139. Nather, A., Ong, H. J. C., Feng, M. C. B., Lin, B. C., Aziz, Z. Assessment for Neuropathy in patients with Diabetic Foot Problem s. Malaysian Orthopedic Society, 35th Annual General Meeting & Annual Scientific Meeting, presentation, 2005.
140. Nather, A., Liew, S., Feng, M. C. B., Ong, H. J. C., Lin, B. C., Aziz, Z. Assessment for Neuropathy in patients with Diabetes Mellitus. Malaysian Orthopedic Society, 35th Annual General Meeting & Annual Scientific Meeting, presentation, 2005.
141. Matsutomo, R., Suetsugu, M., Yamamoto, R., Matsumoto, S., Wakabayashi, S., Takebayashi, K., Aso, Y., Take mura, Y., Inukai, T. Measurement of Current Perception Threshold Determined by Neurometer® Accurately Reflects the Progression of Peripheral Neuropathy in Patients with Type 2 Diabetes Mellitus. 64th Scientific Session, American Diabetes Association, poster presentation, 2004.
142. Prendergast, J.J., Miranda, G., Sanches, M. Improvement of sensory impairment in patients with peripheral neuropathy. Endocrine Practice, Volume 10(1):21-30, 2004.
143. Yang, G., Yuan, S., Li, H., et al. Clinical investigation of sensory nerve function in 100 diabetic patients. Basic Medical Sciences and Clinics, Volume 24(3): 352-353, 2004.
144. Yang G., Li H., Yuan S., et al. Sensory nerve function in diabetic patients and the relationship with lower extremity arterial disease. Chinese Journal of Diabetes, Volume 13(1):11-13, 2003.
145. Du, Y., Yang G., Yuan S., et al. Experience of Neurometer Assessing Sensory Nerve Function in Diabetic Patients. Chinese Academy of Clinical Medicine. Volume 3(23): 14-16, 2002.
146. Weintraub, M.I., Wolfe, G.I., Barohn, R.A., Cole, S.P., Parry, G.J., Hayat, G., Cohen, J.A., Page, J.C., Bromberg, M.B., Schwartz, S.L., and Magnetic Research Group. Static Magnetic Field Therapy for Symptomatic Diabetic Neuropathy: A randomized, Double-Blind, Placebo-Controlled Trial. Arch Phys Med Rehabil. Volume 84:736-46, 2003.
147. Domisen, U., Schwegler, B., Spinaz, G.A., Lehmann, R. The Prevalence of Peripheral and Autonomic Neuropathy in Patients With Type 2 Diabetes Mellitus in a Diabetes Clinic. American Diabetes Association Annual Meeting, Abstract 2139, 2002.
148. Barkai, L., Kempler, P. Puberty as a risk factor of Diabetic Neuropathy. Diabetes Care, Volume 23(7):1044 - 1045, 2000.
149. Barkai, L., Kempler, P., Vámosi, I., Lukács, K., Marton, A., Keresztes, K. Peripheral Sensory Nerve Dysfunction in Children and Adolescents with Type 1 Diabetes Mellitus. Diabetic Medicine, Volume 15:228-233, 1998.
150. Cheng, W.-Y., Jiang, Y.-D., Chuang, L.-M., Huang, C.-N., Heng, L.-T., Wu, H.-P., Tai, T.-Y., Lin, B.J. Quantitative sensory testing and risk factors of diabetic sensory neuropathy. Journal of Neurology, Volume 246: 394-398, 1999.
151. Cozzarelli J. How sensory Nerve Conduction Threshold Evaluations Can Facilitate Early Detections and Improved Outcomes. Podiatry Today:58-61, 2000.
152. Farkas, G., R., Degi, Varkoni, T., Vörös P., Lengyel, Cs. Fetal Islet Grafting Prevents Secondary Diabetic Complications. Diabetologia. Volume 43 (Suppl 1):A 28, 2000.

153. Guthrie, D.W., Kingery, D., Schulz, T., Childs, B., Guthrie, R.A., Parks, L. Screening for hype in children who have diabetes mellitus. International Study Group of Diabetes in Children, International Diabetes Federation, Australia, 1988.
154. Jiang, Y-D, Hsieh, S-T, Wu, H-P, Tai, T-Y, Katims, J.J., Chuang, L-M. Characterization of hyperesthetic stage of diabetic neuropathy with current perception threshold, a method for diabetic neuropathy staging. XI Meeting, Diabetic Neuropathy Study Group of the European Association for the Study Diabetes(EA SD) NEURODIAB. 2001.
155. Rice, B. Mind-Body Interventions. (From Research to Practice/Complementary & Integrative Medicine) Diabetes Spectrum, September 22, 2001.
156. Kempler, P., Keresztes, K., Marton, A., Hermányi, Zs., Vargha, P., Gyula, T. Comprehensive evaluation of peripheral sensory nerve dysfunction by Neurometer® CPT evaluation in non-insulin dependent diabetes mellitus and in newly diagnosed non-insulin dependent diabetes mellitus. Magyar Belorvosi Archivum (Hungary). Volume 3:163-167, 1995.
157. Keresztes, K., Istenes, I., Hermányi, Z., Vargha, P., Barna, I., Kempler, P. Risk Factors of Autonomic and Sensory Nerve Dysfunction in Patients With Newly Diagnosed Type 1 Diabetes. Diabetes Care, Volume 26:2213-2214, 2003.
158. Oishi, M., Mochizuki, Y., Suzuki, Y., Ogawa, K., Naganuma, T., Nishijo, Y., Mizutani, T. Current perception threshold and sympathetic skin response in diabetic and alcoholic polyneuropathies. Internal Medicine, Volume 41(10):819-822, 2002.
159. Fielding, R. Aerobic exercise capacity remains normal despite impaired endothelial function in the micro- and macrocirculation of physically active IDDM patients. (insulin-dependent diabetes mellitus). Diabetes, Volume 46:1846-1852, 1997.
160. Lee, Y., Robinson, M., Wong, N., Chan, E., Charles, M. A. The effect of pentoxifylline on current perception thresholds in patients with diabetic sensory neuropathy. Journal of Diabetes Complications, Volume 11(5):274-278, 1997.
161. Masson, E.A., Boulton, A.J.M. The Neurometer: Validation and Comparison with Conventional Tests for Diabetic Neuropathy. Diabetic Medicine, Volume 8:S63-S66, 1991.
162. Masson, E.A., Veves, A., Fernando, D., Boulton, A.J.M. Current perception thresholds: a new, quick, and reproducible method for the assessment of peripheral neuropathy in diabetes mellitus. Diabetologia, Volume 32:724-728, 1989.
163. Pittei, D.L., Watkins, P.J., Stevens, M.J., Edmonds, M.E. The Value of the Neurometer® CPT in Assessing Diabetic Neuropathy by Measurement of the Current Perception Threshold. Diabetic Medicine, Volume e11:872-876, 1994.
164. Rendell, M., Bamisekun, O. Skin Blood Flow and Current Perception in Pentoxifylline-Treated Diabetic Neuropathy. Angiology, Volume 43(10):843-851, 1992.
165. Rendell, M.S., Dovgan, D.J., Bergman, T.F., O'Donnell, G.P., Drobny, E.P., Katims, J.J. Mapping Diabetic Sensory Neuropathy by Current Perception Threshold Testing. Diabetes Care, Volume 12(9):636-640, 1989.
166. Rendell, M.S., Katims, J.J., Richter, R., Rowland, F. A comparison of nerve conduction velocities and current perception thresholds as correlates of clinical severity of diabetic sensory neuropathy. Journal of Neurology, Neurosurgery and Psychiatry, Volume 52:502-511, 1989.
167. Rice, B.I., Schindler, J.V. Increased Sensory Nerve Function of the Peroneal Nerve in Response to Biofeedback Assisted Relaxation Training in a Population with Diabetes. Diabetes, Volume 41, (suppl):33A, 1992.
168. Suzuki, K-I., Chung, Y., Yuka, Kobayashi, Goto, Y. Current Perception Thresholds: A New Method for the Assessment of Peripheral Sensory Neuropathy in Diabetes Mellitus. Peripheral Nerve 6(1):59-63, 1995.
169. Takekuma, K.; Ando, F.; Niino, N.; Shimokata, H. Prevalence of hyperesthesia detected by current perception threshold test in subjects with glucose metabolic impairments in a community. Internal Medicine. Volume 41(12):124-9, 2002.
170. Várkonyi, T.T., Lengyel, C., Madácsy, L., Velösy, B., Kempler, P., Fazekas, T., Pávics, L., Csernay, L., Lonovics, J. Gallbladder Hypomotility in diabetic neuropathy. Clinical Autonomic Research, Volume e11:377-381, 2001.
171. Várkonyi, T.T., Farkas, G., Fülöp, Z., Vörös, P., Lengyel, Cs., Kempler, P., Lonovics, J. Beneficial Effect of Fetal Islet Grafting on Development of Late Diabetic Complications. Transplantation Proceedings, Volume 30:330-331, 1998.
172. Umezawa, S., Kanamori, A., Yajima, Y., Aoki, C. Current Perception Threshold in evaluating diabetic neuropathy. Diabetes Volume 8(1):711-719, 1997.
173. Várkonyi, T.T., Pető, T., Dégi, R., Keresztes, K., Lengyel, C., Janáky, M., Kempler, P., Lonovics, J. Impairment of Visual Evoked Potentials: An early central manifestation of diabetic neuropathy? DiabetesCare, Volume 25:1661-1662, 2002.
174. Varkonyi T, Roka, R., Legrady, P., Lazar, M., Lengyel, Cs, Madacsy, L., Velösy, B., Kempler, P., Pavics, L., Lonovics, J., Characterization of gastrointestinal motor dysfunction in patients with long- standing diabetes mellitus, Z Gastroenterol, Volume 37:455, 1999.

175. Várkonyi, T.T., Tóth, F., Róvo, L., Lengyel, with., Kiss, J.G., Kempler, P., Lonovics, J. Impairment of the auditory brainstem function in diabetic neuropathy. Diabetes Care, Volume 25(3):631-632, 2002.
176. Veves, A., Malik, R., Townsend, C., Thompson, S., Boulton, A.J.M. Unmyelinated Fibre Pathology in Diabetic Patients with Mild Neuropathy. Diabetologia, Volume 35, (suppl1):16A, 1992.
177. Winkler, G., Pal, B., Nagybeganyi, E., Ory, I., Porochanavec, M., Kempler, P. Effectiveness of different benfotiamine dosage regimens in the treatment of painful diabetic neuropathy. Arzneim.-Forsch./Drug Research, Volume 49:220-224, 1999.

Laboratory & Animal Research

178. WANG Ji-yuan, CHEN Ying, CHEN Qing-guang, YAN Zi-hui, and LU Hao (Department of Endocrinology, Shuguang Hospital Affiliated to Shanghai University of Traditional Chinese Medicine) Shenxie Zhitong Capsule Alleviates Diabetic Peripheral Neuropathy by Regulating Wnt/ β -catenin/Inflammatory Pathway. China Journal of Integrated Traditional Chinese and Western Medicine, 2026
179. Kana Hyakkoku, Nanae Umeda, Shinji Shimada, Takahiko Imai, Yasuhide Morioka, Gaku Sakaguchi, Hideaki Hara Post-stroke pain caused by peripheral sensory hypersensitization after transient focal cerebral ischemia in rats. Brain Res, 15:1715:35-40, 2019 Jul
180. Bicer F, Kim JY, Horowitz A, Daneshgari F, Liu G. Assessment of Bladder Sensation in Mice With a Novel Device. Urology. 2014.
181. Ohsawa M, Miyabe Y, Katsu H, Yamamoto S, Ono H. Identification of the sensory nerve fiber responsible for lysophosphatidic acid-induced allodynia in mice. Neuroscience 247 (2013) 65–74 2013.
182. Kyung Ae Lee1, Kyung Taek Park2, Hea Min Yu3, Heung Yong Jin1, Hong Sun Baek1, Tae Sun Park. Effect of Granulocyte Colony-Stimulating Factor on the Peripheral Nerves in Streptozotocin-Induced. Diabetic Rat Diabetes Metab J 2013;37:286-290 2013
183. SADAYOSm FURUTA, KENJIRO MATSUMOTO, SYUNJI HORIE/ TSUTOMU SUZUKI AND MINORUNARITA, Subdiaphragmatic Vagotomy Induces a Functional Change in Visceral Ab Primary Afferent Fibers in Rats. SYNAPSE 66:369-371 2012.
184. Julia Finkel ,Virginia Guptill , Alfia Khaibullina , Nicholas Spornick , Olavo Vasconcelos , David J. Liewehr , Seth M. Steinberg , Zenaide M.N. Quezado The three isoforms of nitric oxide synthase distinctively affect mouse nociceptive behavior. Nitric Oxide 26 (2012) 81-88 2012
185. Takami K, Fujita-Hamabe W, Harada S, Tokuyama S. A β and A δ but not C-fibers are involved in stroke related pain and allodynia: an experimental study in mice. Journal of Pharmacy and Pharmacology 63: 452–456 2011
186. Himeno T, Kamiya H, Naruse K, Harada N, Ozaki N, Seino Y, Shibata T, Kondo M, Kato J, Okawa T, Fukami A, Hamada Y, Inagaki N, Seino Y, Drucker DJ, Oiso Y, Nakamura J. Beneficial effects of exendin-4 on experimental polyneuropathy in diabetic mice. Diabetes. 2011.
187. Liu WJ, Jin HY, Lee KA, Xie SH, Baek HS, Park TS. Neuroprotective effect of the glucagon-like peptide-1 receptor agonist, synthetic exendin-4, in streptozotocin-induced diabetic rats. Br J Pharmacol. 2011.
188. Blais, M. Grenier, M., Berthod, F. Enrichment of tissue-engineered skin with Schwann cells improves cutaneous nerve regeneration. 69th Annual Meeting of the Society of Investigative Dermatology, Université Laval, Quebec, QC, Canada, 2009
189. Weijiao Xie, Misaki Matsumoto, Jerold Chun and Hiroshi Ueda, Involvement of LPA1 receptor signaling in the reorganization of spinal input through Abeta-fibers in mice with partial sciatic nerve injury. Molecular Pain 2008
190. Misaki Matsumoto, Weijiao Xie, Lin Ma and Hiroshi Ueda, Pharmacological switch in A β -fiber stimulation-induced spinal transmission in mice with partial sciatic nerve injury. Molecular Pain 2008.
191. Finkel, J., Besch, V., Hergen, A., Kakareka, J., Pohida, T., Melzer, J., Koziol, D., Wesley, R., Quezado, Z. Effects of Aging on Current Vocalization Threshold in Mice Measured by a Novel Nociception Assay. Anesthesiology, Volume 105:360-9, 2006.
192. Cais sie, R., Gin gras, M., Champigny, M., Berthod, F. In Vivo Enhancement of Sensory Perception Recovery in a Tissue-Engineered Skin Enriched with Laminin. Biomaterials. Volume 27(15):2988-2993, 2006.
193. Melzer, J., Besch, V., Finkel, J., Quezado, Z. Neuronal Nitric Oxide Synthase Does Not Impact on Sex Differences in Nociception. Anesthesiology. Volume 105:A 708, 2006.
194. Akada, Y.; Mori, R.; Kato, Y.; Yamasaki, F.; Mochizuki, H. Analgesic properties of the novel compound M 43068 in rat models of acute and neuropathic pain. European Journal of Pharmacology, Volume 523:46-2005.
195. Melzer, J., Besch, V., Finkel, J., Quezado, Z. Neuronal Nitric Oxide Synthase Does Not Impact on Sex Differences in Nociception. Anesthesiology, Volume 105:A 708, 2006.
196. Finkel, J., Besch, V., Melzer, J., Kakareka, J., Quezado, Z. Role of NOS1 in Nociception. Anesthesiology, Volume 105:A 702, 2006.
197. Koga, K., Furue, H., Rashid, M., Takaki, A., Katafuchi, T., Yoshimura, M. Selective activation of primary afferent fibers evaluated by sine-wave electrical stimulation. Molecular Pain, Volume 1:13, 2005. <http://www.molecularpain.com/content/1/1/13>
198. Huang, X., Abouassaly, R., Liu, G., Ukimura, O., Daneshgari, F. Neurometer Measurement of Current Perception Threshold (CPT) in Rats Bladder. International Continence Society, 515, Montreal, 2005.

199. Oda, M., Kitagawa, N., Yang, B.-X., Totoki, T., Morimoto, M. Quantitative and fiber-selective evaluation of dose-dependent nerve blockade by intrathecal lidocaine in rats. The Journal of Pharmacology and Experimental Therapeutics, Volume 312(3):1132-1137, 2005.
200. Finkel, J.C., Hergen, A., Kakareka, J., Pohida, T., Quezado, Z.M.N. Development of a Non-injurious Neuro-specific Nociceptive Assay in Mice. American Society of Anesthesiology. Abstract Accepted for presentation. Annual Meeting 2005.
201. Besch, V., Hergen, A., Melzer, J., Koziol, D., Quezado, Z. M.N. The Effect of Aging on Nociception in Mice. American Society of Anesthesiology. Abstract Accepted for presentation. Annual Meeting 2005.
202. Quezado, Z. et al. Development of a Noninjurious Neuro-Specific Nociceptive Assay in Mice. Annual Report of Clinical Research Activities: Oct. 1, 2003 to Sept. 30, 2003. Department of Health and Human Services, National Institutes of Health (USA), page 3, 2003.
203. Alkire, M.T., White, N.S., Hsieh, R., Haier, R.J. Dissociable Brain Activation Responses to 5 Hz Electrical Pain Stimulation: A High-field Functional Magnetic Resonance Imaging Study. Anesthesiology, Volume 100:939-46, 2004.
204. Yamaguchi, T., Toya, T., Tamura, S., Takemoto, Y., Nagakura, Y., Kohara, A., Kiso, T., Kakimoto, S., Iwai, A., Akuzawa, S., Effects of NMDA receptor antagonists on the current stimulus threshold with the neurometer in rats. Japanese Journal of Pharmacology. Volume 88(Sup 1.):230P, 2002.
205. Oda, M., Kitagawa, N., Miyabe, T., Miyazaki, A., Totoki, T., Morimoto, M. Quantitative Evaluation of Lidocaine Neurotoxicity by Current Perception Threshold. American Society of Regional Anesthesia. PD 2002. http://www.asra.com/Abstracts/Archives/Spring_2002/2002S_A33.pdf
206. Kiso, T., Nagakura, Y., Toya, T., Matsumoto, N., Tamura, S., Ito, H., Okada, M., Yamaguchi, T. Neurometer measurement of current stimulus threshold in rats. The Journal of Pharmacology and Experimental Therapeutics, Volume 297(1):352-356, 2001.
207. Song, E.B., Yang, J.H., Kang, Y.K., Kim, S.J. Usefulness of Current Withdrawal Threshold on Evaluation of the Neuropathic Pain on Animal Model. Journal of the Korean Academy of Rehabilitation Medicine, Volume 25(1):117-121, 2001.
208. Mamiya, K., Yokohama, H., Mamiya, N., Takahata, O., Iwasaki, H. Pregnancy Increases Cutaneous Pain Thresholds to Electrical and Chemical Stimuli in the Rats. Anesthesiology, 95:A-748, 2001.
209. Mamiya, K., Okaoda, H., Yokohama, K., Sengoku, K., Takahata, without., Iwazi, H. The effects of pregnancy-induced analgesia on sensory processing of the peripheral nerves in rats. Japanese Society of Anesthesiology. Annual Meeting, Poster Pd2N01, 2001.
210. Miyabe, T., Kitagawa, N., Oda, Y., Sakurata, T., Morimoto, T. Quantitative evaluation of lidocaine neurotoxicity by current perception threshold in rat. Japanese Society of Anesthesiology. Annual Meeting, Poster P2A05, 2001.
211. Huang, M.-C., Lee, I.-H., Hsieh, K.-C., Chen, W.-C., Chang, Lee, L.S., Cheng, H. Sensory recovery in the repaired cervical roots. Society for Neuroscience Abstracts Volume 26(1-2): 797.11, 2000.
212. Katims, J.J., Ng, L.K.Y. Transcutaneous Electrical Stimulation (TENS) Frequency Dependent Regional Increases in Rat Brain Metabolic Activity. International Journal of Acupuncture & Electrotherapeutics Research, Volume 10(3): 223-224, 1985.

Nephrology

213. Nan-Nan Zhang, Zhi-Yong Wang, Jian-Min Chen, Zhi-Peng Yan, Guo-Xin Ni, Jun Ni. Evaluation of Quantitative and Selective Sensory Fiber Dysfunction in Patients with Cirrhosis. Curr Neurovasc Res 2024
214. Yi-Tong Xiong, Man-Hua Liu, Han-Ying Gu, Kai Li, Jin-Ru Zhang, Xiao-Yu Cheng, Hong Jin, Jing Chen, Cheng-Jie Mao, Chun-Feng Liu. Fiber selectivity of peripheral neuropathy in patients with Parkinson's disease. Acta Neurol Scand Jul;146(1):75-81 2022.
215. Gao Xin, Yang Jianrong, Wang Cheng, Lian Zhanxiong, Liang Bin, Liu Chaofeng, Deng Xiangqiang, Luo Yang, Huang Woning, Deng Lisheng. Application value of sensory nerve quantitative detector in evaluating the degree of nerve root injuries of two methods in treatment of cervical spondylotic radiculopathy. Chinese Journal of New Clinical Medicine. Volume 15.Number 5.May 2022.
216. Hao Yuyan, Yang Qian, Xiao Zheman (Department of Neurology, People's Hospital of Wuhan University) The Study on the pathogenesis of migraine. J Apoplexy and Nervous Diseases, Volume 39, Issue 3, March 2022.
217. Yang Chenhui, Zhang Jie (Department of Neurology, Aviation General Hospital) Application of Current Threshold Measurement in Clinical Practice. Journal of Brain and Neurological Diseases Vol 25, No. 7, 2017.
218. Song Jianghua, Yuan Xiaodong, Lü Shujuan, Zhou Lifu, Zhang Yingjie, Li Gang, Lei Jun, Wang Shujuan, The Analyses Of Correlation And Influencing Factors Betw Een Som Atensory Evoked Potential Current Threshold And Current Perception Threshold. Journal of Modern Electrophysiology, Vol. 23, No.4, 2016.

219. Yin Yixiang (Department of Neurology, School of Clinical Medicine, Peking Union Medical College, Tutor: Cui Liying) Study on Normal Value of Current Sensory Threshold in 166 Healthy People. Graduation Thesis of Clinical Medicine 2016.
220. Yang Zhiying, Xue Bo, Jing Li, Li Linwei, He Hengxia, Chen Xiangli, Lu Yuqun, Wang Qin, Fang Xuzhong (Shengli Hospital, Shengli Petroleum Administration Bureau, Dongying City, Shandong Province) Study on sensory nerve conduction in children with sensory integration dysfunction. Chinese Journal of Child Health Care. Vol 24, No. 6, June 2016.
221. Stefan Brodoehl, Carsten Klingner, Otto W Witte, Katharina Stieglitz, Age-related changes in the somatosensory processing of tactile stimulation-An fMRI study. Behavioural Brain Research 238 259-264 2013.
222. Ban C. H. Tsui, MD • Timothy J. Shakespeare, MBBS • Danika H. Leung • Jeremy H. Tsui • Gareth N. Corry, PhD, Reproducibility of current perception threshold with the Neurometer vs the Stimpod NMS450 peripheral nerve stimulator in healthy volunteers: an observational study Reproductibilite' du seuil de perception du courant avec les stimulateurs des nerfs pe'ripher'iques Neurometer vs. Stimpod NMS450 chez des volontaires sains: une e'tude observationnelle. Can J Anesth/J Can Anesth . 60:753-760 2013.
223. Zheng W, He Y, Chen L. Correlation of current perception threshold and somatosensory evoked potential in diabetes. NeurophysiolClin. 2012 Jun;42(4):241-7 2012.
224. Ming Feng Liao • Meng Lee • Mei Jen Hsieh • Mei Yun Cheng • Jiann Der Lee • Hsu Huei Weng • Long Sun Ro, Evaluation of the pathophysiology of classical trigeminal neuralgia by blink reflex study and current perception threshold testing. J Headache Pain (2010) 11:241-246 2010
225. Y. Suzuki, K. Ogawa, H. Shiota, M. Oishi, T. Mizutani. Division of Neurology, Department of Medicine, Nihon University School of Medicine, Tokyo, Japan. Current perception threshold in subacute Myelo-Optico-Neuropathy. 19th World Congress of Neurology. Poster Abstracts / Journal of the Neurological Sciences 285 S1.S155-S339.2009.
226. Andy Chien , Eli Eliav , Michele Sterling, Hypoaesthesia occurs with sensory hypersensitivity in chronic whiplash e Further evidence of a neuropathic condition. Manual Therapy 14 138-146.2009
227. Joseph A. Cione, DPM, and John Cozzarelli, DPM. Neurometer Diagnostic Sensory Evaluationm . UNIV OF NORTHERN COLORADO on July 30, 2009 <http://fas.sagepub.com>
228. Avram, M.W. Severe Neuropathy in Urban Dialysis Patients: Neurological Complications in Chronic Uremic Management . Contemporary Dialysis and Nephrology, Volume 15(4):22-23,34, 1994.
229. Avram, M.M. Neurological Complications in Chronic Uremia Management . Morbidity and Mortality of Dialysis NIH Consensus Development Conference, pp. 123-128, National Institute of Health (USA), Bethesda, MD, 1993.
230. Mittman, N., Avram, M.M. Management of Uremic Peripheral Neuropathy. Dialysis Therapy, 2nd edition, edited by Nissenson, A.R. & Fine, R.N., pp. 277-279, 1993.
231. Weseley, S.A., Liebowitz, B., Katims, J.J. Neuropathy of Uremia: Evaluation by Nerve Conduction Velocity versus Neurospecific Current Perception Threshold. Nephron, Volume 52:317-322, 1989.
232. Weseley, S.A., Sadler, B., Katims, J.J. Current Perception: Preferred Test for Evaluation of Peripheral Nerve Integrity. Transactions of the American Society of Artificial Internal Organs, Volume 34(3):188-193, 1988.

Neurologic, Orthopedic, Vascular and Reconstructive Surgery

Spinal Nerve/Cord Publications

233. Chen Haiping, Li Xuan, Huang Lefen, Zhang Wei (Department of Rehabilitation Medicine, China Resources Wugang General Hospital) Application of Current Threshold Measurement in Lumbar Radiculopathy Chin J Rehabil Theory Pract. Vol. 24, No.5, May, 2018,
234. Chen Haiping, Cheng Shu, Li Xuan, Huang Lefen, Zhang Wei (Department of Rehabilitation Medicine, China Resources Wugang General Hospital) Comparative Study of CPT and H Reflex in Lumbar Radiculopathy. Stroke and Neurological Disorders Volume 25, Issue 1. February 2018,
235. Su Guanming, Hu Shuguo, Wang Lihui, Yang Yang, Liu Qiong (Department of Endocrinology, the Second People's Hospital Shijiazhuang) Correlation between glycated hemoglobin and damage of different sensory nerve subsets in diabetes patients. Chin J Clin Healthcare. Vol.20, No.6 December 2017.
236. Takuro Miyazaki, Tetsuya Sakai, Naoya Yamasaki, Tomoshi Tsuchiya, Keitaro Matsumoto, Tsutomu Tagawa, Go Hatachi, Koichi Tomoshige, Mariko Mine, Takeshi Nagayasu Chest tube insertion is one important factor leading to intercostal nerve impairment in thoracic surgery. Gen Thorac Cardiovasc Surg (2014) 62:58-63 2014.
237. Imoto, K., Takebayashi, T., Kanaya, K., Kawaguchi, S., Katahira, G., Yamashita, T. Quantitative Analysis of Sensory Functions After Lumbar Discectomy Using Current Perception Threshold Testing. Eur. Spine Journal. 2007.
238. Akagi, D., Arita, H., Komiya, T., Ishii, S., Shigematsu, K., Nagawa, H., Miyata, T. Objective Assessment of Nerve Injury after Greater Saphenous Vein Stripping. Eur J Vasc Endovasc Surg. January 2007.

239. Nakatani, T., Hashimoto, T., Hashimoto, A., Kushizaki, H., Saito, Y. Does Pulsed Radiofrequency Treatment Affect Sensory Function in Lumbar Radiculopathy? Anesthesiology, Volume 105:A 330, 2006.
240. Sakai, T., Aoki, H., Takada, M., Hojo, M., Sumikawa, K. Relationship Between Sensory Nerve Function and Disability Score in the Patients with Sciatica. American Society of Anesthesiology, A-349, 2006.
241. Sakai, T., Hojo, M., Aoki, H., Higashijima, U., Sumikawa, K. Epiduroscopy Improves the Pain and the Sensory Nerve Function in the Patients with Lumbar Spinal Stenosis. Anesthesiology Volume 103:A 1003, 2005.
242. Cui, L., Zhu, P., Fu, H., Starr, A. Current Perception Threshold (CPT) in Syringomyelia. Journal of Chinese Neurology, Volume 36(6):447-44, 2003.
243. Rao Jilun, Zhang Quanwei, Liao Shicheng, Pain Threshold in Patients with Chronic Lumbar Radiculopathy. Report on the Results of the Supplementary Special Project of the National Science Council of the Executive Yuan 2002.
244. Yamashita, T., Kanaya, K., Sekine, M., Takebayashi, T., Kawaguchi, S., Katahira, G. A quantitative analysis of sensory function in lumbar radiculopathy using current perception threshold testing. Spine, Volume 27(14):1567-70; 2002.
245. Falci, S.P., Best, L.G., Bayles, R., Cown, C. Dorsal Root Entry Zone (DREZ) microcoagulation for central pain of spinal cord injury: operative intramedullary electrophysiological guidance and clinical outcome. Journal of Neurosurgery (Spine 2), Volume 97:193-200, 2002.
246. Alo', K.M., Chado, H.N. Effect of Spinal Cord Stimulation on Sensory Nerve Conduction Threshold Functional Measures. Neuromodulation, Volume 3(3):145-154, 2000.
247. Tilaro, F., Miskovich, D. The Effects of Vertebral Axial Decompression on Sensory Nerve Dysfunction - In Patients with Low Back Pain and Radiculopathy. Canadian Journal of Clinical Medicine, Volume 6(1) 2-7, 1999.
248. Sakura, S., Sumi, M., Morimoto, N., Saito, Y. The Addition of Epinephrine Increases Intensity of Sensory Block During Epidural Anesthesia with Lidocaine, Regional Anesthesia and Pain Medicine, Volume 24(6): 541-546, 1999.
249. Miraner YE, Somerville JJ: The Current Perception Threshold Evaluation in Radiculopathy Efficacy in Diagnosis and Assessment of Treatment Results Pain Digest, Volume 8: 37-38, 1998.
250. Sakura, S., Sumi, M., Kushizaki, H., Saito, Y., Kosaka, Y. Concentration of Lidocaine Affects Intensity of Sensory Block During Lumbar Epidural Anesthesia. Anesthesia and Analgesia, Volume 88(1):123-7, 1998.
251. Tay, B., Wallace, M.S., Irving, G. Quantitative Assessment of Differential Sensory Blockade after Lumbar Epidural Lidocaine. Anesthesia and Analgesia, Volume 84:1071-1075, 1997.
252. Liu, S., Kopacz, K.J., Carpenter, R.L.: Quantitative Assessment of Differential Sensory Nerve Block after Lidocaine Spinal Anesthesia. Department of Anesthesiology, Virginia Mason Medical Center, Seattle, WA. Anesthesiology, Volume 82(1):60-63, 1995. Zhu, P.Y., Fu, H., Starr, A. Neuroselective Current Perception Threshold (CPT) Evaluation in Syringomyelia. Presented at the Annual Meeting of the North American Spine Society, Washington, D.C., 1995.
253. Zhu, P.Y., Cui, Y.L., Weber, R.J. Neuroselective Current Perception Threshold Evaluation in Syringomyelia. American Academy of Physical Medicine and Rehabilitation, Annual Meeting, Poster 63, 1998.
254. Zhu, P.Y., Fu, H., Starr, A. Neuroselective Current Perception Threshold (CPT) Evaluation in Syringomyelia. Presented at the Annual Meeting of the North American Spine Society, Washington, D.C., 1995.
255. Ben Eliyahu, D.J., Tartaglia, S.V., Spinelle, R. Current Perception Threshold/Quantitative Sensory Testing and MRI Findings In Patients with Signs and Symptoms of Cervical or Lumbar Disc Herniation: A Correlative Study of the Neurosensory Diagnosis of Discogenic Pain, American Journal of Pain Management, Volume 10(2):60-65, 2000.

Evaluation of Nerve Regeneration and Recovery of Function

256. Sakai, T., Hojo, M., Aoki, H., Higashijima, U., Sumikawa, K. Epiduroscopy Improves the Pain and the Sensory Nerve Function in the Patients with Lumbar Spinal Stenosis. Anesthesiology Volume 103:A 1003, 2005.
257. Berthod, F. Tissue-Engineering Approaches to Enhance Nerve Regeneration During Wound Healing. FASEB Journal, Volume 20(5):Part 2:A 871, 2006.
258. Nishimura A, Ogura T, Hase H, Makinodan A, Hojo T, Katsumi Y, Yagi K, Mikami Y, Kubo T. A Correlative electrophysiologic study of nerve fiber involvement in carpal tunnel syndrome using current perception thresholds. Clinical Neurophysiology Vol. 115(8):1921-4, 2004.
259. Inada, Y., Morimoto, S., Takakura, Y., Nakamura, T. Regeneration of Peripheral Nerve Gaps with a Polyglycolic Acid-Collagen Tube. Neurosurgery Volume 55(03):640-648, 2004.
260. Prendergast, J.J., Miranda, G., Sanches, M. Improvement of sensory impairment in patients with peripheral neuropathy. Endocrine Practice, Volume 10(1):21-30, 2004.

261. Várkonyi, T.T., Farkas, G., Fülöp, Z., Vörös, P., Lengyel, C.s., Kempler, P., Lonovics, J. Beneficial Effect of Fetal Islet Grafting on Development of Late Diabetic Complications. Transplantation Proceedings, Volume 30:330-331, 1998.
262. Chu, N.S. Current Perception Thresholds in Toe-To-Digit Transplantation and Digit-To-Digit Replantation. Muscle & Nerve, Volume 19(2):183-186, 1996.
263. Huang, M.-C., Lee, I.-H., Hsieh, K.-C., Chen, W.-C., Chang, Lee, L.S., Cheng, H. Sensory recovery in the repaired cervical roots. Society for Neuroscience Abstracts Volume 26(1-2): 797.11, 2000.

Carpal Tunnel Syndrome (CTS)/Hand (See Occupational Medicine section)

264. Aird, J., Cady, R., Nagi, H., Kullar, S., MacDermid, J. The Impact of Wrist Extension Provocation on Current Perception Thresholds in Patients with Carpal Tunnel Syndrome: A Pilot Study. Journal of Hand Therapy. Volume 19(3):299-306, 2006.
265. Nishimura A., Ogura T., Hase H., Makinodan A., Hojo T., Katsumi Y., Yagi K., Mikami Y., Kubo T. A Correlative electrophysiologic study of nerve fiber involvement in carpal tunnel syndrome using current perception thresholds. Clinical Neurophysiology Vol. 115(8):1921-4, 2004.
266. Nishimura, A., Ogura, T., Hase, H., Makinodan, A., Hojo, T., Katsumi, Y., Yagi, K., Mikami, Y., Kubo, T. Objective evaluation of sensory function in patients with carpal tunnel syndrome using the current perception threshold. Journal of Orthopedic Science Vol. 8:625-628, 2003.
267. Nishimura, A., Ogura, T., Hase, H., Makinodan, A., Hojo, T., Katsumi, Y., Yagi, K., Kubo, T. Evaluation of sensory function after median nerve decompression in carpal tunnel syndrome using the current perception threshold test. Journal of Orthopedic Science Vol. 8:500-504, 2003.
268. Nonomura, H. Some Early Stage Carpal Tunnel Syndrome Patients Show Sensory Disturbance as Hyperesthesia in Quantitative Sensory Evaluation Using Current Perception Threshold Testing. Journal of the Japanese Society for Surgery of the Hand. Volume 19(6):752-754, 2002.
269. Nonomura, H. Early stages of carpal tunnel syndrome patients show sensory disturbance as not only hyperesthesia but also hyperesthesia by quantitative sensory evaluation using current perception threshold testing. Japanese Society for Surgery of the Hand. Volume 18 (Part 4):S44, 2001.
270. Nonomura, R., Shimizu, K., Ohno, Y., Yokoi, T., Suzuki, Y. Quantitative assessment for entrapment neuropathy by Current Perception Threshold testing. 7th Congress of the International Federation of Societies for Surgery of the Hand IFSSH 1998, 0-M OF 1-7, Vancouver, 1998.
271. Nonomura, H. et al. Clinical study of quantitative assessment for entrapment neuropathy and repaired peripheral nerves by current perception threshold testing. Journal of the Japanese Society for Surgery of the Hand, Volume 14, page 260, 1997.
272. Nonomura, H. et al. Clinical study of quantitative assessment for entrapment neuropathy and repaired peripheral nerves by current perception threshold testing. Journal of the Japanese Society for Surgery of the Hand, Volume 14, page 260, 1997. Nonomura, H. et al. Quantitative assessment for carpal tunnel syndrome by current perception threshold testing. Chubu Seisai (Central Japan Trauma Prevention Journal), Volume 40:877-878, 1997.

Neurology, Neurophysiology and Physiatry

General Publications

273. Alkire, M.T., White, N.S., Hsieh, R., Haier, R.J. Dissociable Brain Activation Responses to 5 Hz Electrical Pain Stimulation: A High-field Functional Magnetic Resonance Imaging Study. Anesthesiology, Volume 100:939-46, 2004.
274. Drury, D.G., Greenwood, K., Stuenkel, K.J., Koltyn, K.F. Changes in Pain Perception in Women During and Following an Exhaustive Incremental Cycling Exercise. Journal of Sports Science and Medicine, in press, September, 2005.
275. Voller, B., Sycha, T., Gustorff, B., Schmetterer, L., Lehr, S., Sichler, H.G., Auff, E., Schnider, P. A randomized, double-blind, placebo controlled study on analgetic effects of botulinum toxin A. Neurology, Volume 61:940-944, 2003.
276. Várkonyi, T.T., Pető, T., Dégi, R., Keresztes, K., Lengyel, C., Janáky, M., Kempler, P., Lonovics, J. Impairment of Visual Evoked Potentials: An early central manifestation of diabetic neuropathy? Diabetes Care, Volume 25:1661-1662, 2002.
277. Várkonyi, T.T., Tóth, F., Róvó, L., Lengyel, with., Kiss, J.G., Kempler, P., Lonovics, J. Impairment of the auditory brainstem function in diabetic neuropathy. Diabetes Care, Volume 25:631-632, 2002.
278. Tomioka, Toshiya, Sawamura, S., Meno, A., Hayashida, M., Arita, H., Hanaoka, K. Is the Current Perception threshold test affected by changes? The Pain Clinic, Volume 14(3):213-215, 2002.
279. Suzuki, Y., Oishi, M., Shiota, H., Tsuda, H., Mizutani, T. Current perception threshold in cerebrovascular disease. In Electrophysiology and Kinesiology (ed. Mano Y & Okada M) Monduzzi Editore, Bologna, 625-629, 2000.
280. Menkes, D.L., Swenson, M.L., Sander, H.W. Current Perception Threshold: An Adjunctive Test for Detection of Acquired Demyelinating Polyneuropathies. Electromyography and Clinical Neurophysiology, Volume 40; Part 4:195-204, 2000.

281. Kudoh, A., Matsuki, A. Current perception thresholds of epileptic patients treated with valproate. Seizure, Volume 9; Part 7:498-501, 2000.
282. Maeda, M., Tsuji, T., Sasaki, U., Yorizumi, K., Oofuchi, S., Nagasawa, H., Shiba, Y. Changes of Current Perception Threshold on Sensory Nerve Fiber in Thermo therapy. Japanese Association of Physical Medicine Balneology. Volume 63(3):143-150, 2000.
283. Im am achi, N., Sakura, S., Sato, N., Kanata, K., Saito, Y., et al. Ambient Temperature Affects Current Perception Thresholds in Patients with Neuropathic Pain. Anesthesiology, 95:A-837, 2001.
284. Sakura, S., Im am achi, N., Kushizaki, H., Hashimoto, T., Saito, Y., et al. Effect of Ambient Temperature on Current Perception Thresholds in Healthy Volunteers. Anesthesiology, 95:A-838, 2001.
285. Maeda, S., Sasaki, U., Nagasawa, H., Shimizu, S., Tanaka, K., Obuchi, S., Shiba, Y., Hoka, C. Changes in the Current Perception Threshold (CPT) Due to Artificial High Concentration CO₂ Water Warm Bathing. Journal of the Japanese Association of Physical Medicine Balneology and Climatology. Volume 64, Part 4:191-198, 2001.
286. Szalay, F., Marton, A., Keresztes, K., Hermányi, Z. S., Kempler, P. Neuropathy as an Extrahepatic Manifestation of Chronic Liver Diseases. Scandinavian Journal of Gastroenterology, Volume 228:130-2, 1998.
287. Berger JS, Brannagan TH, Latov N: Neuropathy with anti-myelin-associated glycoprotein antibodies: Quantitative sensory testing and response to intravenous immunoglobulin. Muscle & Nerve. Volume e20:1056-1057, 1997.
288. Bleecker, M.L., Ford, D.P., Tiburzi, J., Lindgren, K.N. The relationship between peripheral nerve function and markers of lead dose. Neurology, Volume 50(4), Suppl. 4, A53, 1998.
289. Katims, J.J., Parsons, S.L., Gamboa, J., Tapia, R., Vargas, M., Appenzeller, O. Quantitative Sensory Evaluation of High Altitude Andean Natives., Neurology, Volume 50(4), Suppl. 4, A172-173, 1998.
290. Menkes DL, Hood DC, Ballesteros RA, Bodnar P: Quantitative sensory testing distinguishes axonal from demyelinating polyneuropathies. Muscle & Nerve; 20:1056, 1997.
291. Suzuki, K-I., Chung, Y., Yuka, Kobayashi, Goto, Y. Current Perception Thresholds: A New Method for the Assessment of Peripheral Sensory Neuropathy in Diabetes Mellitus. Peripheral Nerve 6(1):59-63, 1995.
292. Rendell, M.S., Dovgan, D.J., Bergman, T.F., O'Donnell, G.P., Drobny, E.P., Katims, J.J. Mapping Diabetic Sensory Neuropathy by Current Perception Threshold Testing. Diabetes Care, Volume 12(9):636-640, 1989.
293. Rendell, M.S., Katims, J.J., Richter, R., Rowland, F. A comparison of nerve conduction velocities and current perception thresholds as correlates of clinical severity of diabetic sensory neuropathy. Journal of Neurology, Neurosurgery and Psychiatry, Volume 52:502-511, 1989.
294. Katims, J.J., Naviasky, E., Rendell, M.S., Ng, L.K.Y., Bleecker, M.L. Constant Current Sine Wave Transcutaneous Nerve Stimulation for the Evaluation of Peripheral Neuropathy. Archives of Physical Medicine and Rehabilitation, Volume 68:210-213, 1987.

Autonomic Nervous System

295. Legrady, P., Bajcsi, D., Várkonyi, T., Langyel, C., Kempler, P., Abraham, G. Investigation of Cardiac Autonomic and Peripheral Sensory Neuropathy in Long-Standing Hypertension With and Without Type 2 Diabetes Mellitus. Diabetologia Volume 49(Suppl. 1):1032, 2006.
296. Várkonyi, T., Börcsök, R., Lázár, M., Papos, M., Favics, L., Kempler, P., Lonovics, J. Severity of neuropathy rather than duration of diabetes seems to influence gastric emptying in patients with type-1 diabetes. NEURODIAB XVI. 16th Annual Meeting of the Diabetic Neuropathy Study Group of the EASD. P 17, 2006.
297. Kempler, P., Keresztes, K., Kádár, É., Abonyi, M., Hermányi, Z., Istenes, I., Balázs, B., Tóth, N., Putz, Z., Szalay, F. Mild to Moderate Autonomic Dysfunction and Impairment of Large Myelinated Sensory Nerve Fibre Function are the Characteristic Features of Neuropathy in Patients with Anti-HCV-Positive Chronic Liver Disease. Falk Symposium 157 Chronic Hepatitis: Metabolic, Cholestatic, Viral and Autoimmune. P. 93, 2006.
298. Kádár, É., Abonyi, M., Keresztes, K., Hermányi, Z., Istenes, I., Balázs, B., Tóth, N., Taylor, J., Szalay, F., Kemper, P. Severe Impairment of Autonomic and Peripheral Sensory Nerve Function in Alcohol-Related Cirrhosis. Falk Symposium 157 Chronic Hepatitis: Metabolic, Cholestatic, Viral and Autoimmune. P. 86, 2006.
299. Kempler, P., Keresztes, K., Hermányi, Z., Istenes, I., Vargha, P. Higher Fasting Glucose Levels Within the Normal Range are Associated with Sensory Nerve Dysfunction in Patients with Essential Hypertension. 7th International Symposium on Diabetic Neuropathy, Somerset West, South Africa. P. 4, 2006.
300. Sallai, L., Lakatos, P., Timar, C., Putz, Z., Istenes, I., Speer, G., Kempler, P. The Role of Cardiovascular risk Factors and Essential Thrombocythemia - The Case of an Amputation Prevented. 16th Meeting, Diabetic Neuropathy Study Group of the European Association for the Study of Diabetes(EASD) NEURODIAB.P 22, 2006.

301. Várkonyi, T., Börcsök, Ü., Takács, R., Róka, R., Lengyel, C., Lázár, M., Papós, M., Pávics, L., Kempler, P., Lonovics, J. Determination on Gastric Emptying and Neuropathy Status in Patients with Different Durations of Type 1 Diabetes. Diabetologia, Volume 49(Supp. 1):1114, 2006.
302. Keresztes, K., Istenes, I., Folhoffer, A., Lakatos, P.L., Horvath, A., Csak, T., Varga, P., Kempler, P., Szalay, F. Autonomic and sensory nerve dysfunction in primary biliary cirrhosis. World J Gastroenterol, Vol. 10(20):3039-43, 2004.
303. Legrady, P., Bajcsi, D., Lengyel, Cs., Várkonyi, T., Takacs, R., Sonkodi, S., Kempler, P., Abraham, Gy. Cardiac Autonomic and Peripheral Sensory Neuropathy in Long-Standing Hypertension With and Without Diabetes Mellitus. 10th Scientific Meeting of the European Association for the Study of Diabetes (EASD) "Hypertension in Diabetes" (HID) Study Group, Istanbul, Turkey, 2005
304. Yanai, F., Yamagami, H., Shiomi, Y., Fukushima, T., Irie, M. Current perception threshold measurement before and after application of lumbar sympathetic ganglion block to subjects with lumbar spinal disease. 11th International Pain Clinic World Society of Pain Clinicians (Tokyo). PP 6-01, page 164, July 2004.
305. Keresztes, K., Istenes, I., Hermányi, Z., Vargha, P., Barna, I., Kempler, P. Risk Factors of Autonomic and Sensory Nerve Dysfunction in Patients With Newly Diagnosed Type 1 Diabetes. Diabetes Care, Volume 26:2213-2214, 2003.
306. Oishi, M., Mochizuki, Y., Suzuki, Y., Ogawa, K., Naganuma, T., Nishijo, Y., Mizutani, T. Current perception threshold and sympathetic skin response in diabetic and alcoholic polyneuropathies. Internal Medicine, Volume 41(10):819-822, 2002.
307. Várkonyi, T.T., Lengyel, C., Madácsy, L., Velösy, B., Kempler, P., Fazekas, T., Pávics, L., Csernay, L., Lonovics, J. Gallbladder Hypomotility in diabetic neuropathy. Clinical Autonomic Research, Volume 11:377-381, 2001.
308. Mekhail, N.A., Daoud, E., Maruna, N. Effect of sympathetic blockade on pain tolerance and current perception in sympathetic-maintained pain state. Dolor, Volume 13: 43, 1998.
309. Kempler, P., Váradi, A., Kádár, É., Szalay, F. Autonomic and peripheral neuropathy in primary biliary cirrhosis: evidence of small sensory fibre damage and prolongation of the QT interval. Journal of Hepatology, Volume 21:1150-1151, 1994. Lengyel, C., Török, T., Várkonyi, T., Kempler, P., Rudas, L. Baroreflex Sensitivity and Heart-Rate Variability in Insulin-Dependent Diabetics with Polyneuropathy. The Lancet Volume 351(1823):1436-1437, 1998.
310. Lengyel, C., Török, T., Várkonyi, T., Kempler, P., Rudas, L. Baroreflex Sensitivity and Heart-Rate Variability in Insulin-Dependent Diabetics with Polyneuropathy. The Lancet Vol. 351(1823):1436-1437, 1998.
311. Kempler, P., Marton, A., Vargha, P., Hermányi, Zs., Márczy, V., Kádár, É., Pap, A., Keresztes, K., Váradi, A., Szalay, F. Autonomic and Peripheral Sensory Nerve Function in Alcoholic Cirrhosis. Zeitschrift für Gastroenterologie, Volume 32(5):291, May, 1994.

Neuroselectivity Studies and Neuroselective Neuropathies (also see Neuroselective Ischemia and Compression Publications below)

312. Frankel, M., Zimran, A., Elstein, D. Current Perception Threshold Testing for Peripheral Neuropathy in Type I Gaucher Disease. HAEMA, Volume 9(2):264-269, 2006.
313. Koga, K., Furue, H., Rashid, M., Takaki, A., Katafuchi, T., Yoshimura, M. Selective activation of primary afferent fibers evaluated by sine-wave electrical stimulation. Molecular Pain, Volume 1:13, 2005. <http://www.molecularpain.com/content/1/1/13>
314. Tseng, C.H. Abnormal current perception thresholds measured by neurometer among residents in blackfoot disease-hyperendemic villages in Taiwan. Toxicology Letters, Vol. 146(1):27-36, 2003.
315. Doi, D., Ota, Y., Konishi, H., Yoneyama, K., Araki, T., Evaluation in the Neurotoxicity of Paclitaxel and Carboplatin by Current Perception Threshold in Ovarian Cancer Patients. Journal of Nippon Medical School, Vol 70(2):129-134, 2003.
316. Kurozawa, Y., Nasu, Y. Current Perception Thresholds in Vibration-Induced Neuropathy. Archives of Environmental Health, Volume 56(3):254-256, 2001.
317. Pelmeier, P.L. and Kusiak, R. Clinical Assessment of Hand-Arm Vibration Syndrome. Nagoya Journal of Medical Science, Volume 57:27-41, 1994.
318. Husin, L.S., Uttaman, A., Hisham, H.J., Hussain, I.H.S. The Effect of Pesticide on the Activity of Serum Cholinesterase and Current Perception Threshold on the Paddy Farmers in Muda Agricultural Development Area, MADA, Kedah, Malaysia. Medical Journal of Malaysia, Volume 54(3):320-324, 1999.
319. Katim, S., J.J., Long, D.M., Ng, L.K.Y. Transcutaneous Nerve Stimulation (TNS): Frequency and Waveform Specificity in Humans. Applied Neurophysiology, Volume 49:86-91, 1986.
320. Veves, A., Malik, R., Townsend, C., Thompson, S., Boulton, A.J.M. Unmyelinated Fibre Pathology in Diabetic Patients with Mild Neuropathy. Diabetologia, Volume 35, (supp 1):16A, 1992.
321. Kempler, P., Keresztes, K., Marton, A., Vargha, P., Hermányi, Zs., Kádár, É., Petrik, J., Tamási, L., Szalay, F. Large Myelinated peripheral sensory nerve fiber dysfunction detected by the NEUROMETER® CPT in patients with anti-HCV -positive chronic liver disease. Zeitschrift für Gastroenterologie, Volume 33(5):294, 1995.
322. Ro, L.S., Chen, S.T., Tang, L.M., Hsu, W.C., Chang, H.S., Huang, C.C. Current Perception Threshold Testing in Fabry's Disease. Muscle & Nerve, Volume 22: 1531-1537, 1999.

323. Bocerra, L., Stojanovic, M., Chang, I., Breiter, H., Tracey, I., Fishman, S., Edwards, A., Gonzalez, R.G., Borsook, D. fMRI Mapping of CNS Activation Following Noxious Heat and Electrical Stimuli. Presented at the Fifth Scientific Meeting of the International Society for Magnetic Resonance in Medicine in Vancouver, 1997.
324. Stojanovic, M., Becerra, L.R., Breiter, H.C., Fishman, S.M., Edwards, A., Chang, I.W., Borsook, D., Gonzalez, G. fMRI Analysis of Human CNS Activation Following Noxious Electrical Stimulation at 5 Hz and 250 Hz. Poster presentation at the Annual Meeting of the American Pain Society, New Orleans, LA, 1997.

Studies of Hyperesthesia

325. Takekuma, K.; Ando, F.; Niino, N.; Shimokata, H. Prevalence of hyperesthesia detected by current perception threshold test in subjects with glucose metabolic impairments in a community. Internal Medicine. Volume 41(12):1124-9, 2002.
326. Jiang, Y-D., Hsieh, S-T, Wu, H-P, Tai, T-Y, Katims, J.J., Chuang, L-M. Characterization of hyperesthetic stage of diabetic neuropathy with current perception threshold, a method for diabetic neuropathy staging. XI Meeting, Diabetic Neuropathy Study Group of the European Association for the Study of Diabetes (EASD) NEURODIAB. 2001.
327. Umezawa, S., Kanamori, A., Yajima, Y., Aoki, C. Current Perception Threshold in evaluating diabetic neuropathy. Diabetes Volume 8(1):711-719, 1997.

Neuroselective Ischemia and Compression Publications

328. Akagi, D., Arita, H., Komiya, T., Ishii, S., Shigematsu, K., Nagawa, H., Miyata, T. Objective Assessment of Nerve Injury after Greater Saphenous Vein Stripping. Eur J. Vasc Endovasc Surg. January 2007.
329. Baron, G.C., Irving, G.A. Effects of Tourniquet Ischemia on Current Perception Thresholds in Healthy Volunteers. Pain Practice, Volume 2 (2):129-133, 2002.
330. Morell, R. C., Prielipp, R. C., Harwood, T. N., James, R. L.; Butterworth, J. F. Men are more susceptible than women to direct pressure on unmyelinated ulnar nerve fibers. Anesthesia & Analgesia, Volume 97:1183-8, 2003.
331. Oshima, M., Inagi, T., Yokoyama, K., Shimada, Y., Ogawa, R. Influence of ischemic conditions induced by a tourniquet on functions of nerves, depending on the type of nerve fibers, was examined by measurement of current perception threshold (CPT) values. Anesthesiology, Volume 96:A-722, 2002.
332. Savidge, M.J., Fahmy, B., Price, C.M., Rodgers, P.D. Quantitative changes in sensory nerve threshold potentials, induced by a tourniquet and measured by a Neurometer® device. The Pain Society. The British and Irish Chapter of the International Association for the Study of Pain. Abstract, 1999.

Occupational Medicine / Epidemiology

333. Ron House, Kristine Krajnak, Michael Mannol, and Lina Lander. Current perception threshold and the HAVS Stockholm sensorineural scale. Occupational Medicine;59:476-482 2009
334. Costantini, M., Tunks, K., Wyatt, C., Zettel, H., MacDermid, J. Age and Upper Limb Tension Testing Affects Current Perception Thresholds. Journal of Hand Therapy. Volume 19(3):307-317, 2006.
335. Westerman, R.; Hocking, B. Diseases of modern living: neurological changes associated with mobile phones and radiofrequency radiation in humans. Neuroscience Letters Volume 361:13-6, 2004.
336. Nishimura, A., Ogura, T., Hase, H., Makinodan, A., Hojo, T., Katsumi, Y., Yagi, K., Kubo, T. Evaluation of sensory function after median nerve decompression in carpal tunnel syndrome using the current perception threshold test. Journal of Orthopedic Science Vol. 8:500-504, 2003.
337. Nishimura, A., Ogura, T., Hase, H., Makinodan, A., Hojo, T., Katsumi, Y., Yagi, K., Mikamo, Y., Kubo, T. Objective evaluation of sensory function in patients with carpal tunnel syndrome using the current perception threshold. Journal of Orthopedic Science Vol. 8:625-628, 2003.
338. Mitchell, S., Reading, I., Walker-Bone, K., Palmer, K., Cooper, C., Coggon, D. Pain tolerance in upper limb disorders: findings from a community survey. Occupational & Environmental Medicine, Volume 60:217-221, 2003.
339. Hocking, B.; Westerman, R. Neurological effects of radiofrequency radiation. Occupational Medicine (Lond). Volume 53:123-127, 2003.
340. Kurozawa, Y., Nasu, Y. Current Perception Thresholds in Vibration-Induced Neuropathy. Archives of Environmental Health, Volume 56(3):254-256, 2001.
341. Takekuma, K., Ando, F., Niino, N., Shimokata, H. Age and gender differences in skin sensory threshold assessed by current perception in community-dwelling Japanese. Journal of Epidemiology. Volume e10(1):S33-S38, 2000.
342. Nonomura, H., Ohno, Y., Yokoi, T., Suzuld, Y. Quantitative Sensory Assessment for Carpal Tunnel Syndrome by using Current Perception Threshold Testing Presented at the annual meeting of the American Society for Surgery of the Hand, Poster #58, August 2002, San Diego, CA.

343. Nonomura, H. et al. Clinical study of quantitative assessment for entrapment neuropathy and repaired peripheral nerves by current perception threshold testing. Journal of the Japanese Society for Surgery of the Hand, Volume 14:260, 1997.
344. Nonomura, H. et al. Quantitative assessment for carpal tunnel syndrome by current perception threshold testing. Chubu Seisai (Central Japan Trauma Prevention Journal), Volume 40:877-878, 1997.
345. Bartol, A., Levin, L. Study of Nerve Function Related to Occupational Repetitive Motion Injury and Carpal Tunnel Syndrome. American Industrial Hygiene Conference & Exposition, Industrial Hygiene General Practice II Papers, No. 297, 1996.
346. Vale, J.R., Dreisinger, T.E. Case Management of the Individual Worker in the Poultry Processing Industry. Managing Ergonomics in the 90's, Cleveland, OH, 1995.
347. Vale, J.R., Dreisinger, T.E. Upper Extremity Cumulative Trauma Disorder (UECTD) Screening Protocol: A pilot study. Abstract. Prevention '94, Atlanta, GA, 1994.
348. Vale, J., Dreisinger, T. Upper Extremity Cumulative Trauma Disorders (UECTDs) Screening Protocol - A Different Perspective. Presented at the Arkansas Worker's Compensation Commission, Worker's Compensation Educational Conference, Hot Springs, Arkansas, 1994.
349. Pelmeier, P.L. and Kusiak, R. Clinical Assessment of Hand-Arm Vibration Syndrome. Nagoya Journal of Medical Science, Vol. 57:27-41, 1994.
350. Pelmeier, P.L. and Kusiak, R. Clinical Assessment of Hand-Arm Vibration Syndrome. Nagoya Journal of Medical Science, Volume 57:27-41, 1994. Pelmeier, P.L., Taylor, W. Hand-Arm Vibration Syndrome. The Journal of Family Practice, Volume 38(2):180-185, 1994.
351. Pelmeier, P.L., Taylor, W. Carpal Tunnel Syndrome and Hand-Arm Vibration Syndrome. Archives of Neurology, Volume 51:416-420, 1994.
352. Bilgi, C., Pelmeier, P.L. Hand-Arm Vibration Syndrome: A Guide to Medical Impairment Assessment. Journal of Occupational Medicine, Volume 35(9):936-942, September, 1993.
353. Katims, J.J., Patil, A.S., Rendell, M., Rouvelas, P., Sadler, B., Weseley, S.A., Bleecker, M.L. Current Perception Threshold Screening for Carpal Tunnel Syndrome. Archives of Environmental Health, Volume 46(4):207-212, 1991.
354. Katims, J.J., Rouvelas, P., Sadler, B.T., Weseley, S.A. Current Perception Threshold: Reproducibility and Comparison with Nerve Conduction in Evaluation of Carpal Tunnel Syndrome. Transactions of the American Society of Artificial Internal Organs, Volume 35(3):280-284, 1989.
355. Katims, J.J., Naviasky, E., Ng, L.K.Y., Bleecker, M.L., Rendell, M. New Screening Device for Assessment of Peripheral Neuropathy. Journal of Occupational Medicine, Volume 28(12):1219-1221, 1986.

Podiatry

356. Shandles, I.D., Pruchniewski, J., Reynolds, K.L. Heel Neuroma: the enigma of recalcitrant heel pain and an innovative approach highlighting sixty surgical cases and a review of two hundred and fifty seven symptomatic but non-surgical cases. The Foot, Volume 12:10-20, 2002.
357. Rice, B., Kalker, A.J., Schindler, J.V., Dixon, R.M. Effect of Biofeedback-Assisted Relaxation Training on Foot Ulcer Healing. Journal of the American Podiatric Medical Association, Volume 91(3):132-141, 2001.
358. Cozzarelli J. How sensory Nerve Conduction Threshold Evaluations Can Facilitate Early Detections and Improved Outcomes. Podiatry Today:58-61, 2000.
359. Hill, R.S., Lawrence, A. Current Perception Threshold in Evaluating Foot Pain. Journal of the American Podiatric Medical Association, Volume 81(3): 150-154, 1991.

Toxicology and Pharmacology

360. Griffith KA, Couture DJ, Zhu S, Pandya N, Johantgen ME, Cavaletti G, Davenport JM, Tanguay LJ, Choflet A, Milliron T, Glass E, Gambill N, Renn CL, Dorsey SG. Evaluation of chemotherapy-induced peripheral neuropathy using current perception threshold and clinical evaluations. Support Care Cancer. 2014 May;22(5): 2014.
361. Ishii Y, Fujimoto S, Okazaki K, Miyoshi M, Furihata T, Hase I, Takizawa H, Kikkawa Y, Yamada I, Fukuda T. Fractionated administration of carboplatin/paclitaxel reduces neurotoxicity in patients with advanced non-small cell lung cancer. Anticancer Drugs. 22:926-932 2011
362. Jonathan S Rutchik, Toxic Neuropathy. eMedicine Neurology Updated: Feb 24, 2009 <http://emedicine.medscape.com/article/1175276-print>
363. Bleecker, M.L., Ford, D.P., Vaughan, C.G., Lindgren, K.N., Tiburzi, M.J., Walsh, K.S. Effect of Lead Exposure and Ergonomic Stressors on Peripheral Nerve Function. Environmental Health Perspectives. doi:10.1289/ehp.8106 (<http://dx.doi.org/>) Volume 113(12):1730-1734, 2005.
364. Lubis, S. Biomonitoring of Organophosphate and Carbamate Pesticides Toxicity With Current Perception Threshold (CPT) Using Neurometer® CPT/Eagle Among Paddy Farmers and Fishermen. Epidemiology, Volume 15(4):S179, 2004.
365. Tseng, C.H. Abnormal current perception thresholds measured by neurometer among residents in blackfoot disease-hyperendemic villages in Taiwan. Toxicology Letters, Vol. 146(1):27-36, 2003.

366. Doi, D., Araki, T., Konishi, H., Ota, Y., Yoneyama, K. Evaluation in the Neurotoxicity of Paclitaxel and Carboplatin by Current Perception Threshold in Ovarian Cancer Patients. Journal of Nippon Medical School, Vol 70(2):129-134, 2003.
367. Hocking, B.; Westerman, R. Neurological effects of radiofrequency radiation. Occup Med (Lond). Volume 53:123-127, 2003.
368. Hirsch, A.R. Sensory Nerve Conduction Threshold Testing in Trichloroethylene (TCE) Exposure. American Academy of Clinical Neurophysiology Presentation at annual meeting Boston, MA, Feb., 2003.
369. Miyamoto, K., Wakamiya, J., Murao, K. Study on the effect of sex hormone on methyl mercury poisoning. Annual Report 2002 National Institute for Minamata Disease (Japan), page 9, 2002.
370. Hirsch, A.R., Kang, C. Effects of acute alcohol inebriation on Current Perception Threshold: A preliminary report. J. Neurol. Orthop. Med. Surg., Volume 19:10-13, 1999.
371. Husin, L.S., Uttaman, A., Hisham, H.J., Hussain, I.H.S. The Effect of Pesticide on the Activity of Serum Cholinesterase and Current Perception Threshold on the Paddy Farmers in Muda Agricultural Development Area, MADA, Kedah, Malaysia, Medical Journal of Malaysia, Volume 54(3):320-324, 1999.
372. Winkler, G., Pal, B., Nagybeganyi, E., Ory, I., Porochnavec, M., Kempler, P. Effectiveness of different benfotiamine dosage regimens in the treatment of painful diabetic neuropathy. Arzneim.-Forsch./Drug Research, Volume 49:220-224, 1999.
373. Bleeker, M.L., Ford, D.P., Tiburzi, J., Lindgren, K.N. The relationship between peripheral nerve function and markers of lead dose. Neurology, Volume 50(4), Suppl. 4, A53, 1998.
374. Katim, S., J.J., Parsons, S.L., Gamboa, J., Tapia, R., Vargas, M., Appenzeller, O. Quantitative Sensory Evaluation of High Altitude Andean Natives. Neurology, Volume 50(4), Suppl. 4, A172-173, 1998.
375. Lee, Y., Robinson, M., Wong, N., Chan, E., Charles, M. A. The effect of pentoxifylline on current perception thresholds in patients with diabetic sensory neuropathy. Journal of Diabetes Complications, Volume 11(5):274-278, 1997.
376. Green, J., Clewell, W., Hickey, S., Karstsonis, P. An Alternate Method of Objectively Assessing Subjective Sensory Complaints by Perceptual Threshold Testing in a Series of Silicone-Exposed Female Patients Complaining of Dysesthesias, Numbness, and/or Tingling of One or More Extremities. Pain Digest, Volume 7:13-15, 1997.
377. Suzuki, K., Goto, Y. Evaluation of Mexiletine Hydrochloride on Nerve Conduction in Patients with Painful Diabetic Neuropathy. Japanese Journal of Medicine and Pharmaceutical Science, Volume 36(10):713-726, 1997.
378. Hirsch, A.R. Neuropsychiatric Effects of Norplant Contraceptive: A Pilot Study. J. Neurol. Orthop. Med. Surg., Volume 16: 111-117, 1995.
379. Liu, S., Kopacz, D.J., Carpenter, R.L. Quantitative Assessment of Differential Sensory Nerve Block after Lidocaine Spinal Anesthesia. Anesthesiology, Volume 82(1):60-63, 1995.
380. Hirsch, A.R. Denham Springs, Louisiana: Neurotoxicity as a Result of Ambient Chemicals, International Congress on Hazardous Waste: Impact on Human and Ecological Health, U.S. Department of Health and Human Services, Public Health Agency for Toxic Substances and Disease Registry, p 229, Atlanta, Georgia, 1995.
381. Hirsch, A.R. Neurotoxicity as a Result of Acute Nitrogen Tetroxide Exposure, International Congress on Hazardous Waste: Impact on Human and Ecological Health, U.S. Department of Health and Human Services, Public Health Agency for Toxic Substances and Disease Registry, p 177, Atlanta, Georgia, 1995.
382. New, P. Neuro-selective Current Perception Threshold (CPT) quantitative sensory test: A re-evaluation. Neurology, Volume 49(5):1482, 1997.
383. New, P. Neurotoxicity of Taxotere. Neurology, Volume 43(4), (supp 2):A190, 1993.
384. National Research Council. Multiple Chemical Sensitivities. Heuser, G., Wohdani, A., Heuser, S. Diagnostic Markers of Multiple Chemical Sensitivity, pages 117-122. National Academy Press, Washington, D.C., 1992. <http://www.nap.edu/books/0309047366/html/index.html>
385. Wisner, R.M., Root, D., Shields, M., Beckmann, S.L. Neurotoxicity and Toxic Body Burdens: Relationship and Treatment Potentials. International Conference on Peripheral Nerve Toxicity, Proceedings Edited by K. Hashimoto, Kanazawa, pp. 49-50, June, 1993.
386. Bernad, P.G., Newell, S., Spyker, D.A. Neurotoxicity and behavior abnormalities in a cohort of clinically exposed to Trichloroethylene. Beh. Vet. Toxicol., Volume 29(6):475, 1987.
387. Shields, M., Beckmann, S.L., Cassidy-Brinn, G. Improvement in Perception of Transcutaneous Nerve Stimulation Following Detoxification in Firefighters Exposed to PCBs, PCDDs and PCDFs. Clinical Ecology, Volume 6(2):47-50, 1989.
388. Appenzeller, O., Wood, S.C., Appenzeller, T. Pentoxifylline, Altitude, and Peripheral Nerve Function. Annals of Sports Medicine, Volume 4(4):286-288, 1988.
389. Bleeker, M.L. Quantifying Sensory Loss in Peripheral Neuropathies. Neurobehavioral Toxicology and Teratology, Volume 7:305-308, 1985.

Urology & Gynecology

390. Filippo Murina, Cecilia Fochesato, Chiara Leo, Giuseppe E Condorelli, Anna Rocchi, Sara Amitrano, Valerio Napolioni, Valeria Savasi. Evaluation of polygenic risk scores for hormones and receptors levels in patients with vestibulodynia: a case-control study. The Journal of Sexual Medicine 2025 Apr 8;22(3)
391. Sándor Magony, Szabolcs Nyíraty, Bettina Tóth, Fruzsina Pesei, Andrea Orosz, György Ábrahám, Peter Kempler, Csaba Lengyel, Tamás Várkonyi. Peripheral sensory nerve hyperaesthesia in women with polycystic ovary syndrome. Minerva Endocrinol (Torino) 2021 Apr 21
392. Filippo Murina, Stefania Di Francesco & Silvia Oneda , Vulvar vestibular effects of ospemifene: a pilot study. Gynecological Endocrinology 2018
393. Filippo Murina, Raffaele Felice, Stefania Di Francesco, Silvia Oneda, Vaginal diazepam plus transcutaneous electrical nerve stimulation to treat vestibulodynia: A randomized controlled trial. Gynecological Endocrinology 2018.
394. Quaghebeur J, Wyndaele JJ. Variability of pudendal and median nerve sensory perception thresholds in healthy persons. Neurourology and Urodynamics 34:327–331 2015.
395. Lee WC, Wu HC, Huang KH, Wu HP4 Yu HJ, Wu CC. Hyposensitivity of C-fiber afferents at the distal extremities as an indicator of early stages diabetic bladder dysfunction in type 2 diabetic women. PLoS One. 2014.
396. Abernethy MG, Davis C, Lowenstein L, Mueller ER, Brubaker L, Kenton K. Urethral sensation following reconstructive pelvic surgery. IntUrogynecol J. 2014.
397. Filippo Murina, MD, Alessandra Graziottin, MD, Raffaele Felice, MD, Gianluigi Radici, MD, and Cinzia Tognocchi, Mrs. Vestibulodynia: Synergy Between Palmitoylethanolamide + Transpodylatin and Transcutaneous Electrical Nerve Stimulation. Journal of Lower Genital Tract Disease, Volume 17, Number 2, 111-116 .2013
398. Jonathan L Gleason, MD, Kimberly Kenton, MD, W. Jerod Greer, MD, Olga Ramm, MD, Jeff M. Szychowski, PhD, Tracey Wilson, MD, and Holly E. Richter, PhD, MD ,Sacral Neuromodulation Effects on Periurethral Sensation and Urethral Sphincter Activity. Neurourol Urodyn. 2013 June ; 32(5): 476–479. 2013
399. Davis C, Lowenstein L, Mueller E, Brubaker L, Kenton K. Measuring Urinary Sensation with Current Perception Threshold: A Comparison between Method of Limits and Method of Levels. ObstetGynecol Int. 2012.
400. Kaku H, Kumagai S, Onoue H, Takada A, Shoji T, Miura F, Yoshizaki A, Sato S, Kigawa J, Arai T, Tsunoda S, Tominaga E, Aoki D, Sugiyama T. Objective evaluation of the alleviating effects of Goshajinkigan on peripheral neuropathy induced by paclitaxel/carboplatin therapy: A multicenter collaborative study. ExpTher Med. 2012 Jan;3(1):60-65. 2012.
401. Vijaya G, Digesu GA, Derpapas A, Hendricken C, Fernando R, Khullar V. Antimuscarinic effects on current perception threshold: a prospective placebo control study. Neurourol Urodyn.31:75-79, 2012. 2012.
402. Atsuko Fujihara, Osamu Ukimura, Tsuyoshi Iwata, Tsuneharu Miki, Neuroselective measure of the current perception threshold of A-delta and C-fiber afferents in the lower urinary tract. International Journal of Urology 18(5):341-9 March 2011
403. Ugur Yilmaz, Marcia A. Ciol, Richard E. Berger, and Claire C. Yang, Sensory Perception Thresholds in Men With Chronic Pelvic Pain Syndrome. Ambulatory and Office Urology75: 34 –37, 2010.
404. Filippo Murina, MD, Vanda Bianco, MD, Gianluigi Radici, MD, Raffaele Felice, MD, and Maria Signaroldi, MD Electrodiagnostic Functional Sensory Evaluation of Patients With Generalized Vulvodynia: A Pilot Study. American Society for Colposcopy and Cervical Pathology Journal of Lower Genital Tract Disease 2010.
405. Firouz Daneshgari, MD, and Kimberly Kenton, MD, MS, Bladder Sensation Testing: Where Are We? Current Bladder Dysfunction Reports .4:65–70.2009
406. Seung Ryeol Lee, Hyung Joon Kim, Ayong Kim, Jang Hwan Kim. Overactive Bladder Is Not Only Overactive but Also Hypersensitive. Female Urology 2009
407. Kimberly Kenton , Lior Lowenstein, Linda Brubaker, Tolterodine causes measurable restoration of urethral sensation in women with urge urinary incontinence. Neurourology and Urodynamics Volume 29 Issue 4, Pages 555 - 557 2009
408. Yokoyama, T., Nozaki, K., Fujita, O., Nose, H., Inoue, M., Kumon, H. Role of C afferent fibers and m monitoring of intravesical resiniferatoxin therapy for patients with idiopathic detrusor overactivity. Journal of Urology, Volume 172(2):596-600, 2004. N 368 .
409. De Laet, K., De Wachter, S, Wyndaele, J. Current perception thresholds in the lower urinary tract: Sine- and square-wave currents studied in young healthy volunteers. Neurourology and Urodynamics. Volum e 24:261-266, 2005.
410. Ukimura, O., Ushijima, S., Honjo, H., Iwata, T., Suzuki, K., Mizutani, Y., Kawauchi, A., Miki, T. Neuro selective Current Perception Threshold Evaluation of Bladder Mucosal Sensory Function. European Urology, Volume 45(1):70-76, 2004.
411. Honjo, H., Ukimura, O., Ushijima, S., Iwata, T., Suzuki, K., Hirahara, N., Kitakoji, H., Nakao, M., Miki, T. Acupuncture for Treatment of Patients with Overactive Bladder Refractory to Conventional Pharmacotherapy. Neurourology and Urodynamics, Volume 23, Issue 5-6:510, 2004. <http://www.icsoffice.org/publications/2004/PDF/0510.PDF>
412. Hirahara, N., Ukimura, O., Honjo, H., Ushijima, S., Iwata, T., Suzuki, K., Matsubara, H., Miki, T. The quantitative bladder sensory test: Evaluation of the neuroselective current perception threshold of the bladder sensory to identify patients with overactive bladder associated with sensory dysfunction. Neurourology and Urodynamics, Volume 23, Issue 5-6:503, 2004 <http://www.icsoffice.org/publications/2004/PDF/0503.PDF>

413. Ushijima, S., Ukimura, O., Miki, T., Iwata, T., Inaba, M., Honjo, H. The Neurometer as an instrument for appropriate selection and monitoring of intravesical resiniferatoxin therapy for patients with detrusor hyperreflexia. Neurourology and Urodynamics, Volume 21(4):333-334, 2002.
414. Simmons, J., Kenton, K., Fitzgerald, M. P., Brubaker, L. Current Perception Threshold (CPT) Measurements of the Urethra and Bladder in Asymptomatic Women. Journal of Pelvic Medicine and Surgery. Volume 9(5):258, 2003.
415. Ushijima, S., Ukimura, O., Honjo, H., Miki, T. Observer Reproducibility in Quantitative Measurement of the Current Perception Threshold (CPT) on Bladder Sensory Function Using a Neurometer. International Continence Society, 476, 2003. <http://www.icsoffice.org/publications/2003/PDF/476.PDF>
416. Honjo, H., Ukimura, O., Ushijima, S., Suzuki, K., Inaba, M., Iwata, T., Kitakoji, H., Miki, T. Selection of Candidate for Acupuncture-treatment of Urinary Incontinence Determined by Neurometer to Measure Current Perception Threshold in the Bladder. International Continence Society. 460, 2003.
417. Ukimura, O., Iwata, T., Inaba, M., Honjo, H., Kawauchi, A., Kojima, M., Miki, T. Quantitative measurement of urinary sensory function assessed by current perception threshold in the bladder using a Neurometer. Neurourology and Urodynamics, Volume 20 (Part 4):121, 2001.
418. Ukimura, O., Miki, T., Kawauchi, A., Iwata, T., Iwata, M., Honjo, H. Preliminary results of quantitative measurement of urinary sensory function assessed by current perception threshold in the bladder. Journal of Urology, Volume 165(5 Suppl.):299, 2001.
419. Neal, G.W. Neuromodulation of Genital Sensory Thresholds in Normal Women. Annual meeting of the International Society for the Study of Women's Sexual Health, Vancouver, 2002.
420. Neal, G.W. Effects of Clitoral Application of Alprostadil and Dinoprostone on Quantitative Sensory Testing. Annual meeting of the International Society for the Study of Women's Sexual Health, Vancouver, 2002.
421. Kenton, K., Fuller, E., Benson, J.T. Current perception threshold evaluation of the female urethra. Int Urogynecol J Pelvic Floor Dysfunct. Volume 14(2):133-5, 2003.
422. Kenton, K., Fuller, E. M., Benson, J.T. Current Perception Threshold Evaluation of the Female Lower Urinary Tract. Muscle & Nerve, Volume 23(10): 1628-1629, 2000.
423. Katims, J.J., Engel, R.M.E., Hendler, H., Scally, A., Widdifield, J.F., Widdifield, G.E. Electrodiagnostic Evaluation of Penile Pudendal Nerve Sensory Function. Clinical Neurophysiology, Volume 110, Supplement 1:PS-2.15:S99, 1999.

physiatry department

424. YU Tong, AN Guanghui, CHEN Wei, LUO Dingyuan, LIANG Xiuyan, JIANG Shan, YIN Tao (The Affiliated Tai'an City Central Hospital of Qingdao University, College of Acupuncture and Massage, Shanghai University of Traditional Chinese Medicine, Wuxi County People's Hospital) The Effect of Vibration Training on Hemisensory Dysfunction in Stroke Patients. Traditional Chinese Medicine Rehabilitation, 3(3):33-38, 2026
425. Peng Rucheng, Huang Lefen, Chen Haiping (School of Medicine, Wuhan University of Science and Technology; Department of Rehabilitation Medicine, China Resources Wuhan Iron and Steel General Hospital, Wuhan University of Science and Technology) Application of Current Perception Threshold in the diagnosis of cervical spondylotic radiculopathy. China experimental diagnostics Volume 27, Issue 4, April 2023.
426. Yan Tao, Luo Bin, Gao Qiang, Wang Yan, Zhang Jiefeng, (Department of Rehabilitation Medicine, Taian City Central Hospital, Department of Rehabilitation Medicine, Wuxi County People's Hospital,) Effects of Suspension Exercise Therapy Combined with Soft Tissue Manipulation on Upper Limb Sensory Function in Patients with Radicular Cervical Spondylosis. Journal of Medical Biomechanics, February 2022, Volume 37, Issue 1.
427. Chen Qingfa, Huang Huayao, Chen Zhenqiang (Department of Rehabilitation Medicine, Union Hospital Affiliated to Fujian Medical University) Clinical observation of α -lipoic acid combined with Mecobalamin in the treatment of diabetic peripheral neuropathy. Strait Pharmaceutical Journal Vol 30 No. 6 2018,
428. Chen Haiping, Li Xuan, Sun Jinwen, Zhang Wei. (China Resources Wugang General Hospital) Research Progress of Quantitative Sensory Examination in Diabetic Foot. Chinese Journal of Rehabilitation, Vol31, No. 4, August 2016.
429. Shaik SS, MacDermid JC, Birmingham T, Grewal R, Farooq B. Short-term sensory and cutaneous vascular responses to therapeutic ultrasound in the forearms of healthy volunteers. Journal of Therapeutic Ultrasound 2014
430. Tan Hongfeng (Department of Hand Surgery, Yuhong District Hospital, Shenyang City, Liaoning Province) The effect of Mecobalamin on sensory nerve after flap transplantation. China folk medicine 2011.
431. Liu Haibin Application of neuroselective sensory function assessment in rehabilitation medicine.. Beijing International Rehabilitation Forum 2010
432. Min Kyun Sohn, M.D., Kang Hee Cho, M.D., Sung Ju Jee, M.D. and Tae Sung Lee, M.D. Change to Current Perception and Pain Tolerance Thresholds following Repetitive Transcranial Magnetic Stimulation. Journal of the Korean Society of Rehabilitation Medicine, Vol. 32, No.5 2008

Review Publications and Editorials

433. Katims, J.J. Evaluation of Pain. 11th International Pain Clinic, World Congress of Pain Clinics (Tokyo), Me dimond, S.r.l. Italy, 55-58, 2004.
434. Rutchik, J. Toxic Neuropathy. emedicine.com, July 28, 2005.<http://www.emedicine.com/neuro/topic378.htm>
435. Hoitsma, E., Reulen, J.P., de Baets, M., Drent, M., Spaans, F., Faber, C.G. Small fiber neuropathy: a common and important clinical disorder. J Neurol Sci. Volume 227:119-130, 2004.
436. Fukuuchi, A. Current Perception Threshold. Pain Clinic (Japan). Volume 24(3):354-360, 2003.
437. National Guideline Clearinghouse, Intermetatarsal neuroma. Academy of Ambulatory Foot and Ankle Surgery - Medical Specialty Society. 2000 (revised 2003 Sep). 7NGC:003243, 2003.http://www.guideline.gov/sum mary/summary.aspx?doc_id=4243&nbr=3243&string=Intermetatarsal+A ND +neuroma
438. National Guideline Clearinghouse, Vertebral subluxation in chiropractic practice. Council on Chiropractic Practice - Private Nonprofit Organization.1998 (revised 2003). NGC:003438, 2003.http://www.guideline.gov/sum mary/summary.aspx?doc_id=4746&m ode=full&ss=1
439. Baba, M. Hyperesthesia: An Early Manifestation of Diabetic Polyneuropathy. Internal Medicine. Volume 41(12), 1079-80, 2002.
440. Medical Services Advisory Committee (MSAC). Vertebral Axial Decompression Therapy for Chronic Low Back Pain, June 2001. Application 1012, Assessment Report, Dept. of Health and Aged Care, Commonwealth of Australia, page 11, 2001.
441. Santiago, S., Ferrer, T., Espinosa, M.L. Neurophysiological studies of thin myelinated (A delta) and unmyelinated (C) fibers: application to peripheral neuropathies. Neurophysiol Clin. Volume 30:27-40, 2000.
442. Salihovic, M. Nevrodiagno stika v ambulanti za zdravljenje bolecin (Neurodiagnostics in Analgesic Practice). Medicinski razgledi Volume 39:S 11:125-132, 2000.
443. Arita, H. Current Perception Threshold (CPT): A review of utilization in the pain clinic. Pain Clinic, Volume 20(7):1035-1044, 1999.
444. Texas Workers' Compensation Commission Rules including Preambles, page 7, Adopted Amendments to Chapter 134.1001 Spine Treatment Guidelines published in the Dec. 17, 1999 issue of the Texas Register, 1999.
445. Katims, J.J. Electrodiagnostic Functional Sensory Evaluation of the Patient with Pain: A Review of the Neuroselective Current Perception Threshold (CPT) and Pain Tolerance Threshold (PTT). Pain Digest Volume 8(5), 219-230, 1998.
446. Council on Chiropractic Practice. Clinical Practice Guideline Number 1: Vertebral Subluxation in Chiropractic Practice. Page 21 and chapter 3 page 90, 1998.
447. Katims, J.J., Mitsuhashi, H., Miyazaki, T. Electrodiagnostic evaluation of sensory nerve function in the patient with pain: Neuroselective Current Perception Threshold (CPT) and Pain Tolerance Threshold (PTT). Pain Clinic, Volume 19(4):535-549, 1998.
448. Root, D.E. Statement Before The Presidential Special Oversight Board For Department of Defense Investigations Of Gulf War Chemical & Biological Incidents. United States Senator Warren P. Rudman, Chairman, page 3, Nov. 20, 1998.
449. Nelson, B., Carpenter, D., Dreisinger, T., Redesigning the American Workplace, RehabManagement, pp 30-32, October/November, 1998.
450. Dotson, R.M. Clinical Neurophysiology Laboratory Tests to Assess the Nociceptive System in Humans. Journal of Clinical Neurophysiology, Volume 14(1):32-45, 1997.
451. Pelmar, P.L., Wills, M. Impact Vibration and Hand-Arm Vibration Syndrome. Journal of Occupational and Environmental Medicine, Volume 39 (11):1092-1097, 1997.
452. Kempler, P., (editor). Neuropathies - 2nd Edition, 74-77, Springer, New York, 2002.
453. Freeman, R., Stewart, J.D. Quantitative Sensory Testing: An AAEM Workshop. American Association of Electrodiagnostic Medicine, Rochester, MN: pgs. 1-5, 1996.
454. Chado, H.N., The Current Perception Threshold Evaluation of Sensory Nerve Impairments. Disability, Volume 5(1):23-25, 1996.
455. Technology and Equipment Review: Quantitative Sensory Testing Systems, Burgess, R.C., ed. Journal of Clinical Neurophysiology, Volume 12(2):192-202, 1995.
456. Kuhn, B. Device for Assessing Integrity of Sensory Nerve Fibers Promoted for Pain Management. Anesthesiology News, Volume 21(5):2, May, 1995.
457. Chado, H.N. The Current Perception Threshold Evaluation of Sensory Nerve Function in Pain Management. Pain Digest, Volume 5:127-134, 1995.

458. Katims, J.J., Kornhauser, S.H. Quantitative Sensory Nerve Evaluation by Neuro-Selective Current Perception Threshold (CPT) Determination. Medical Electronics, pp. 80-82, February, 1994.
459. Voiss, D.V. Reflex Sympathetic Dystrophy Syndrome (RSDS) A Psychogenic Disorder (Syllabus). Neurology, Volume 43(4.2):A 120, Seminar No. 215, pp 1-36, 1993.
460. Dent, M.T., Ward, J.D., Ryder, R.E.J. Testing for diabetic neuropathy: part I, somatic nerve function. Practical Diabetes, Volume 9(1):24-28, January/ February, 1992.
461. Pelmeur, P.L., Taylor, W., Wasserman, D.E. Hand Arm Vibration: A Comprehensive Guide for Occupational Health Professionals. Hand Arm Vibration: A Comprehensive Guide for Occupational Health Professionals, Van Nostrand Reinhold, New York, 1992.
462. Ryder, R.E.J., Dent, M.T., Ward, J.D. Testing for diabetic neuropathy, part two: autonomic neuropathy. Practical Diabetes, Volume 9(2):56-60, March/April, 1992.
463. Blecker, M.L. Quantitative Sensory Testing Comparison with Standard Electromyography. Occupational and Environmental Neurology, Course No. 108, American Academy of Neurology. Neurology, Volume 36(4.1):42, 1986.
464. Blecker, M.L. Neurometer: A Screening Device for the Detection of Peripheral Neuropathy. Occupational Neurology. Course No. 102, American Academy of Neurology. Neurology, Volume 35(4.1):37, 1985.

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