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Quantitative Measurement and Evaluation of Pain

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Pain is a person's subjective perception of an uncomfortable response to harmful stimulation to the body. Even when the diagnosis of the cause of the pain is identical, the perception of pain among different subjects can be quite different in terms of intensity and type of feeling. Pain is, therefore, an individual and subjective phenomenon. We have developed a system that makes possible the quantitative measurement of human clinical pain. In this system, measured values are obtained making use of the subject's reporting of their own sensations. The concept of pain quantification is to compare the magnitude of the subject's pain to the magnitude of a non-painful electric stimulus and measure it. A pulse current is applied to the subject's forearm, and the subject compares the magnitude of this sensation to the magnitude of pain. The electric current (pain equivalency current) is recorded and compared against a minimum perception current, Quantification is obtained by deriving a pain ratio, the value of which is obtained by dividing the pain equivalency current by the minimum perception current.

The device is operated by a conventional personal computer system using a graphical user interface. All measurement sequences, data filling, printing and other functions for the pain evaluation are designed as a single application software system. Using this system, we have successfully measured the magnitude of pain both for subjects in controlled experiments and patients undergoing physical therapy. Through the experiments, followings phenomena were confirmed. 1) There were no differences in the sensitivity to electrical perception current between the right and left arms, 2) the minimum perception current was not affected by the magnitude of pain, 3) a larger magnitude of pain showed a larger pain ratio, and 4) the subjects were able to differentiate pains for the quantitative determination of each pain.

The values of the pain ratio determined from actual patients were clearly decreased after treatment. These quantitative values were compared with a conventional visual analog scale (pain scale) to clinically evaluate the usefulness of this method. The values of both our system's pain ratio and the pain scale indicated the improvement of pain, but a clear correlation between them was not observed. This result is due mainly to the subjective meaning of the quantification in the visual analog scale. We can conclude that both of the subjective and quantitative measurement of pain should be important to evaluate the actual pain.
Pain is a person's subjective perception of an uncomfortable response to harmful stimulation to the body. Even when the diagnosis of the cause of the pain is identical, the perception of pain among different subjects can be quite different in terms of intensity and type of feeling. Pain is, therefore, an individual and subjective phenomena.

We have developed a system, which makes possible the quantitative measurement of human clinical pain. The concept of pain quantification is to compare the magnitude of the subject's pain to the magnitude of a non-painful electric stimulus and measures it. A pulse current is applied to the subject's forearm, and subject compares the magnitude of this sensation to the magnitude of pain. The electric current (pain equivalency current) is recorded and compared against the minimum perception current. Quantification is obtained by deriving a pain ratio, the value of which is obtained by dividing the pain equivalency current by the minimum perception current. In this system, measured values are obtained making use of the subject's reporting of their own sensations.

We have successfully measured the magnitude of pain both for subjects in the controlled experiment and patients treated by several methods. The values of pain ratio determined from actual patients were clearly decreased after the treatment. These quantitative values were compared with conventional visual analog scale (pain scale) to clinically evaluate the usefulness of this method. Both values of pain ratio and pain scale indicated the improvement of pain, but the clear correlation between them was not observed. This result will mainly due to the subjective meaning for the quantification in the visual analog scale. We can conclude that the subjective and quantitative measurement of pain should also be important to evaluate the actual pain.
Quantitative Analysis of the Degree of Pain Using Pain-Less Electrical Stimuli

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We have devised a method of quantitatively evaluating degree of pain that does not rely on subjective criteria. In this method, degree of pain is measured by replacing it with sensation of painless electrical stimuli that can be compared to actual pain. The degree of pain is quantified as the Pain Ratio, the ratio between the level of painless stimulatory electrical current that corresponds perceptually to a degree of actual pain (pain equivalent current) and the minimum perceived current. In the basic study, the Pain Ratio and the Visual Analog Scale (Pain Scale) were compared for the experimental pain. The changes in the Pain Ratio correspond to those in the Pain Scale, but the variations in Pain Scale showed the typical difference in the two methods for the production of experimental pain.

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We have developed a method and a system to quantitatively evaluate human pain without relying on subjective criteria. The concept of pain quantification is to compare the magnitude of the subject’s pain to the magnitude of a painless electric stimulus that is comparable to actual pain. We quantified degree of pain as the pain ratio, based on the ratio between pain equivalent current and minimum perceived current. In the system developed as the objective of this study, a gradually increasing pulsed current (frequency was 50Hz, and the pulse width was 0.3ms) was applied to the subject’s medial forearms, and the subjects compared the magnitude of this sensation to electrical stimulation produced by an electrical current. Using test equipment, we conducted basic evaluations of measurement principles. We induced two types of experimental pain, by applying weight load to the upper arm and the lower leg, and by pinching the skin using clips. We examined whether changes in the degree of sensation with respect to electrical stimulation used in this method could be accurately observed, and whether or not it was possible to accurately and with high reproducibility measure minimum perceived current and pain equivalent current. As a result, we were able to make a clear comparison between pain and the degree of stimulation by electrical current, which was a sensation differing from pain. Although there were individual differences in the measured values, the reproducibility of the pain equivalent current as measured was favorable, and the measured values for pain ratio were also reproducible. We confirmed in the present study that the degree of experimental pain can be expressed as quantitative numerical values using an index defined as pain ratio.
Acupuncture Attenuates the Pain Sensation Induced by an Experimental Weight-Loaded Pain

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Objectives: To clarify the effectiveness and mechanisms of acupuncture for intractable or chronic pain, we evaluated effects on changes of threshold for painless electrical stimulation during acupuncture.

Method: 17 of healthy adult male volunteers were randomly divided to acupoint group (n=10) and non-acupoint group (n=7). In acupoint group, volunteers had acupuncture procedures at bilateral zusanri acupoint for 10 minutes. In non-acupoint group, they had acupuncture procedures at non-acupoints 2-3 cm lateral to the zusanri acupoint for 10 minutes. A volunteers was applied a 200g weight-loaded stumped aluminum rod (diameter 3mm) at his one forearm. Two different types of the current perception (CPT) threshold were measured by a commercially available microprocessor-controlled electrical neurostimulator (Pain visionTM, Nipro Japan) which delivers a sinusoidal constant alternating current (frequency 50 Hz, pulse width 0.3 ms, intensities 0-250 micro A). One CPT is the minimum perception threshold (MPT) which a volunteers starts to perceive the current applied non weight-loaded forearm. The other CPT (pain equivalent threshold PET) is the current threshold which the volunteer starts to perceive the equivalent strength as pain stimulus by the weight-loaded rod. These measures were performed 5 minutes before the acupuncture and 5 minutes after the acupuncture. Pain degree was calculated: (PET-MPT)/MPT.

Results: There were no significant changes of mean MPT and mean PET in non-acupoint group between pre-acupuncture and post-acupuncture. In acupoint group, mean MPT was significantly elevated and decreased Pain degree after acupuncture procedures (fig1, fig2).

Conclusion: These results suggest that Acupuncture attenuates the pain sensation induced by an experimental weight-loaded pain.
Three Cases of Lower back and/or Limbs Pains as Evaluated with VAS, RDQ and PainVision

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As the intensity of lower back and/or limb pain associated with lumbar spine disease widely changes depending on the posture and/or movements of the patient, it is not always feasible to accurately evaluate the pain. For this reason, Visual Analog Scale (VAS) and Roland-Morris Disability Questionnaire (RDQ), both of which have been commonly used in the evaluation of pain, may not be able to satisfactorily evaluate pain of such type. As an alternative, we used Painvision®/PS-2100 NIPRO, which is an analyzer of perception/pain capable of quantifying pain, to measure PainVision (PV) scores over time in three patients in postures so that they felt the strongest pains and compared the PV scores with their corresponding VAS and RDQ scores. The comparisons were made on scores taken at the initial treatments, two weeks after starting the treatments and four weeks after starting the treatments. The first patient who was a 84 yr female received epidural blocks for her lower back pain due to lumbar spondylosis. Her Vas-PV-RDQ score sets changed from 14-463-11 to 80-66-9 after two weeks and then to 82-67-15 after four weeks. The second patient was a 34 yr old male who received successive epidural blocks for his neuralgia sciatica on the left side due to a herniated lumbar disk. His scores changed from 90-33-10 to 38-61-9 after two weeks and to 3-23-2 after four weeks. The third patient was a 33 yr old female who received successive epidural blocks for her neuralgia sciatica on the left side due to a herniated lumbar disk. Her scores changed from 6-34-17 to 0-57-9 after two weeks and to 5-100-10 after four weeks. With each of these patients, no clear correlations were found between PV, VAS and RDQ.
Effect of Hip Traction Therapy on the Non-Operated Side after Unilateral Total Hip Arthroplasty for Bilateral Osteoarthritis of the Hip

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**Purpose:** We report the outcome of hip traction therapy for pain on the non-operated side for a case with bilateral osteoarthritis of the hip who received unilateral total hip arthroplasty.

**Subjects:** The subject was a female in her fifties who had late stage bilateral hip osteoarthritis, and who could walk about 500m using a T-shaped cane prior to surgery.

**Method:** The assessment items were pain assessed by a pain meter and 10m walking speed.

**Results:** The patient commenced walking with a T-shaped cane 1 week after surgery, was discharged after 3 weeks, and resumed work after 4 weeks. Pain on the non-operated side and 10m walking speed were both improved by hip traction therapy.

**Conclusion:** In cases of unilateral total hip arthroplasty for bilateral hip osteoarthritis, we anticipate that discharge will be facilitated by the inclusion in the clinical program of hip traction therapy on the non-operated side.
The Type of the Sense Against Stimuli Was Different in Gender

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Introduction: Males are reported to have higher pain thresholds and therefore show higher tolerance to noxious stimulation than females. Pain Vision® PS-2100 (Nipro Co., Osaka, Japan) is a device that measures a magnitude of pain objectively by painless electrical stimulation; minimum perceived current (MPC), pain threshold (PT) and pain degree (PD). It evaluates human pain without relying on subjective criteria, like numerical rating scale (NRS). In this study, to confirm whether males complain less pain than females, we quantify the magnitude of pain when rods weighing on the right dorsal surface of the hand.

Methods: After obtaining IRB approval, 68 healthy volunteers (20-50yrs old, M: F =35: 33) were enrolled in this study. MPC is defined as the minimum perceived current required to first sense a gradually increasing pulsed current (frequency is 50 Hz, and the pulse width is 0.3ms) applied to the left medial forearm. PT is defined as the compatible electrical current with which he/she feels the intensity of ongoing pain. PD is calculated as (PT - MPC) / MPC× 100. MPC, PT, and PD were evaluated when rods weighing 0, 200, 400, 200, and 0 g were placed (in those order) on the right dorsal surface of the hand. He/she was also asked to assess his/her pain subjectively as NRS when each rod was placed.

Results: The males' MPCs were higher than females' MPC at each rod weighing on the right dorsal surface of the hand; MPCs were unchanged regardless of any rods weighing. PTs, PDs, and NRSs were generally increased and decreased alone during the changes of rods; there were individual varieties, not gender differences in changes of PT and PD.

Conclusion: Multiple factors such as age, social factors, psychological reasons, culture influences, and previous memories were involved in pain. Moreover, we would like to indicate that the type of stimuli should be added to the factors of gender differences against pain because the only sense against MPC was blunt in males, not PT or PD.
Pain is a subjective sensation that is difficult to measure and/or assess. Methods of pain intensity measurement that have been presented in the past, including the visual analogue scale (VAS), are all subjective. A device for quantitative analysis of perception and pain sensation has now been devised which quantitatively assesses a patient’s pain by replacing it with another sensation that does not accompany pain. This device will enable a more objective measurement of pain intensity as well as a comparison and evaluation of pain intensities among different patients or that of a patient over a long period of time. Presented is a part of our clinical data in comparison with VAS.
Quantification of Acute Pain Caused by Capsaicin and Mustard Oil by Current Perception Threshold

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Introduction: A method for quantitative measurement of magnitude of pain using a microprocessor-controlled electrical neurostimulator (PainVision®: PV, Nipro Co., Osaka, Japan) has recently been developed. Although the magnitude of pain has been analyzed in patients with chronic pain by using this technique, it has not been determined whether this technique can be used for quantification of the degree of acute pain. In the present study, we investigated the degree of pain in acute pain states caused by application of capsaicin and mustard oil (allyl isothiocyanate).

Materials and Methods: After approval of the institutional ethical committee, 10 healthy adult volunteers (aged 27-49 y.o.) were enrolled in this study. Ten μl of capsaicin (1%) was intradermally injected in the skin of the anterior aspect of the left forearm. A compress (1 x 1 cm) soaked with mustard oil was applied to the skin of the left forearm for 5 min. After application of capsaicin and mustard oil, a sinusoidal constant alternating current (frequency of 50 Hz, pulse width of 0.3 ms, intensities of 0-250 μA) was applied to the anterior aspect of the right forearm by PV. One current perception threshold (CPT) is the minimum perception threshold (MPT) at which a volunteer starts to perceive the current. The other CPT is the current threshold at which the volunteer starts to perceive the equivalent strength as pain stimulus (pain equivalent threshold: PET). Pain degree (PD) was calculated as (PET-MPT)/MPT. The two types of CPT and visual analog pain scale (VAS, 0-100 mm) were determined by each volunteer before and after application of capsaicin and mustard oil.

Results: The time courses of VAS and PD were correlated well with each other. There were strong correlations between VAS scores and PV after injection of capsaicin and mustard oil.

Discussion and Conclusion: capsaicin activates TRPV1 receptors that are located only in C-fibers, while mustard oil stimulates TRPA1 receptors that are located both in C-fibers and A-delta fibers. The results of this study suggest that PD of acute pain caused by different mechanisms can be quantified by PV.
Acupuncture Attenuates Chronic Pain Subjectively and Objectively

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Objectives: We reported previously “Acupuncture attenuates the pain sensation induced by an experimental weight-loaded pain” at the ASA annual meeting in Chicago, 2007. This study was to clarify the effectiveness and mechanisms of acupuncture for patients with chronic pain by evaluating effects on chronic pain subjectively and objectively.

Method: The study was approved by the ethical committee of Jichi Medical University. Twenty three of adult patients (32-84 y.o.) suffering from chronic pain were candidates for this study. All patients had acupuncture procedures for 40-60 minutes by needling acupuncture points according to the concept of “meridian” and the vital energy “Qi”. We evaluated the effects of acupuncture on chronic pain subjectively and objectively at pre-acupuncture and at post-acupuncture. Subjective evaluation of pain was visual analogue scale (VAS) of pain. Objective evaluations of pain were measured by a commercially available microprocessor-controlled electrical neurostimulator (Pain vision™, Nipro Japan). It delivers a sinusoidal constant alternating current (frequency 50 Hz, pulse width 0.3ms, intensities 0-250 micro A) and measures different types of the current perception (CPT) threshold. One CPT is the minimum perception threshold (MPT) which a patient starts to perceive the current applied on a normal forearm. The other CPT (pain equivalent threshold PET) is the current threshold which the patient starts to perceive the equivalent strength as the chronic pain worrying the patient. Pain degree was calculated: (PET-MPT)/MPT.

Results: There were significant changes of VAS (45.4±19.3 vs. 26.4±18.5 mm, mean±SD, p=0.000000009), MPT (10.4±8.3 vs. 11.9±7.8, p=0.0059) and pain degree (241.7±278.8 vs. 111.3±173.7, p=0.00089) between pre-acupuncture and post-acupuncture (fig1:VAS, fig2:Pain Degree).

Conclusion: These results suggest that acupuncture attenuates chronic pain subjectively and objectively. But, whether needling at acupuncture points, or at any site, reduces pain independently of the psychological impact of the treatment ritual is unclear.
Evaluation of the treatment outcome by an objective assessment with quantitative measurement of the magnitude of pain using electrical stimulation in fibromyalgia patients

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Fibromyalgia (FM) is a condition characterized by chronic and disabling pain. Since pain is commonly evaluated by a subjective assessment, it is difficult to evaluate the treatment effect objectively. In this report, the treatment outcome was evaluated by an objective assessment of pain in FM patients.

Eight FM patients who fulfilled the American College of Rheumatology criteria for the classification of fibromyalgia participated. The severity of FM was assessed with the Japanese version of the Fibromyalgia Impact Questionnaire (JFIQ). The pain level was evaluated by pain degree, i.e., the magnitude of pain which was quantitatively measured with Pain Vision PS-2100™, and by visual analog scale (VAS). The treatment procedure involved the injection of a local anesthetic into bilateral lateral pterygoid muscles followed by the insertion of an oral device which restricted horizontal mandibular movements. In three cases, the treatment procedure was repeated and a clinical course was observed for 3-6 months.

Pain degree and VAS were significantly reduced after the monotherapy. There was a significant correlation between pain degree and VAS. Pain degree, VAS and JFIQ were reduced in three cases in the follow-up period, although some fluctuations were observed.

The pain relief procedure for lateral pterygoid muscles exhibited a significant effect on the reduction of systemic pain for temporomandibular disorder patients who fulfilled the classification criteria of FM, and could be considered as a treatment option for FM. It was also suggested that a quantitative measurement method for the magnitude of pain could be valuable for the evaluation of treatments for FM.
Correlation between Current Perception Thresholds Obtained by the PainVision™ and the Neurometer™

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**Introduction:** It is very difficult to quantify pain. Recently, a method for quantitative measurement for the magnitude of pain using a microprocessor-controlled electrical neurostimulator (PainVision™ (PV) PS-2100; Nipro Co, Osaka, Japan) has been developed. The Neurometer™ (NM) (Neurotron Inc, Baltimore, USA) is a computerized automated neurodiagnostic device that can measure peripheral sensory function quantitatively. The device can stimulate three different types of sensory peripheral nerve fibers (Aβ, Aδ, and C fibers) selectively. This method is particularly appropriate for quantitative estimation of peripheral sensory nerve function. The purpose of this study was to evaluate the relationship between CPT measured by PV and CPT measured by NM.

**Materials and Methods:** All procedures were approved by the institutional ethics committee, and informed consent was obtained from 30 healthy volunteers (aged 21-62 yr). CPT testing with the NM was performed with the subject seated. The stimulus site was located on the left forearm. CPT values at frequencies of 2000, 250 and 5 Hz were measured. A 100-g weight-loaded stumped aluminum rod (diameter of 3 mm) was applied to the forearm of each subject. Pain caused by mechanical stimuli was rated on a visual analogue scale. Then two different types of current perception threshold (CPT) were measured by PV, which delivers a sinusoidal constant alternating current (frequency of 50 Hz, pulse width of 0.3 ms, intensities of 0-250 micro A). One CPT is the minimum perception threshold (MPT) at which the subject starts to perceive the current applied to the non-weight-loaded forearm, and the other CPT (pain equivalent threshold (PET)) is the current threshold at which the subject starts to perceive the equivalent strength as pain stimulus by the weight-loaded rod. Then the weights applied were increased by additional weights to the rod (1, 2 and 3) and measurements were performed in the same way. Pain degree (PD) was calculated as (PET-MPT)/MPT.

**Results:** The gain in weight (on the forearm) increased not only VAS but also PD within individual. Correlation coefficients between CPT measured by NM and MPT values (measured by PV) were as follows: 2000 Hz: r=0.52; 250 Hz: r=0.56 (Fig. 1). The correlation between CPT of 5 Hz measured by NM and PD measured by PV measured at relatively weak pain (100g weight-loaded) was strong (r=0.52) (Fig. 2).

**Discussion and conclusion:** There were strong correlations between MPT values and CPT of high frequencies (2000 Hz and 250 Hz). On the other hand, there was a strong correlation between PD at relatively weak pain and low-frequencies CPT (5 Hz).
Fig. 1: Correlation between minimum perception threshold and CPT value for 1000 Hz and 500 Hz stimulation.

- Slope: 0.75
- Intercept: 1.5
- R²: 0.45

Fig. 2: Pain degree at relatively weak pain and CPT to 3 Hz stimulation.
Greater Reduction of the Affected Skin Temperature Predicts Persistent Pain Following Herpes Zoster

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**Background:** The pain of herpes zoster (HZ) gradually resolves with time, but may persist after the acute disease as post-herpetic neuralgia (PHN) for months or even years. Several studies on the natural history of HZ have indicated that severity of the nerve injury at the time of presentation may predict PHN occurrence. However, there is no standardized method to assess the nerve injury in HZ. Here, we evaluated the predictive value of skin temperature and current perception threshold (CPT) in patients with HZ.

**Methods:** Consecutive 15 outpatients (mean age, 69 years; range, 58 to 83 years) with HZ were enrolled into this study. Inclusion criteria for the selection of HZ were that age ≥ 20 years, time from rash onset ≤ 40 days, and the cutaneous lesions resolved with antiviral agents prior to enrollment. At the time of enrollment, the surface temperature was measured at the affected skin and the contralateral healthy skin using a digital thermometer ST-717 (SCALA K.K., U.S.A.). Also, CPT was measured with the PainVision PS-2100 (Nipro Corporation, Japan) as a maximum current of 260 µA at the same skins. A 10-cm visual analog scale (VAS) was used for the assessment of the worst, the average, and the least pain on the day of rash onset, and in 1, 2 and 3 months after the onset. Patients were treated with opioids, anticonvulsants, antidepressants, and/or antiarrhythmics throughout the 3-months observation.

**Results:** The CPT in the affected skin was 189 [98-1610] (median [range]) % of that in the contralateral healthy skin, resulting in the significant difference in the CPT between the two skins. However, the CPT did not correlate with the VAS scores. Although no significant difference was found in the surface temperature between the affected and the healthy skins, comparative temperature of the affected skin with the healthy skin (value (°C) in subtraction of the healthy skin temperature from the affected skin temperature) was inversely related to all VAS scores in the worst, the average, and the least pain in 1, 2 and 3 months after rash onset, but not on the day of rash onset. While the complete recovery rate of pain in patients with higher temperature of the affected skin was 71 %, that of pain in patients with lower temperature was 25 %.

**Discussion:** In the present study, the CPT provided quantitative evaluation of sensory loss in HZ skin, but did not predict persistent pain following HZ. On the other hand, greater decrease of temperature in HZ skin was significantly associated with the persistence of pain beyond 3 months. Therefore, the difference between the affected and the healthy skin temperatures may predict PHN occurrence. Epidural, intrathecal, and sympathetic blocks are used for the treatment of pain caused by HZ, and may increase the affected skin temperature. Available evidence shows that these treatments reduce the...
incidence of PHN. The results of this study may help physicians to identify patients with a higher risk of developing PHN and undertaking preventative strategies.
**Purpose and methods:** Recently in Japan, PainVision®/PS-2100 (Nipro Co., Osaka, Japan) has been used to objectively measure degrees of pain (Pain Degrees (PD)). PainVision® quantifies the PD based on the Minimum Perception Threshold (MPT) which is the minimum electrical stimulus that the patient feels pain as well as the Pain Equivalent Threshold (PET) which is the electric current that corresponds to the patient’s perceived magnitudes of pain. In this study, which is a part of a collaboration among 29 institutes to measure PD scores on 1,052 patients with the aim of identifying factors that may affect the magnitudes of pain, correlation between the Short-Form McGill Pain Questionnaire (SF-MPQ) results that characterize neuropathic and nociceptive pains and PD scores was evaluated.

**Results:** SFMPQ results were obtained from 900 patients composed of 582 with neuropathic and 318 with nociceptive pains. An average PD score was calculated for each of the 15 verbal expressions of pain contained in the SF-MPQ. Among the words, fearful (PD = 422.27), sickening (347.59), splitting (330.79) and sharp (327.17) were associated with higher PD scores. Between the types of pain, neuropathic pain patients with higher PD scores more often chose punishing-cruel, fearful, sickening, tiring-exhausting and shooting, while nociceptive pain patients with higher PD scores chose fearful, splitting, shooting and tender more often. In both groups, some but not all of the words that indicate the characteristics of the pain (none at all, somewhat, considerably, strongly present) showed correlations with the PD scores. Lastly, the patients with neuropathic pain chose shooting and tender significantly more often than other SFMPQ expressions while those with nociceptive pain chose gnawing, heavy, sickening and punishing -cruel.

**Conclusions:** Many emotional words were associated with higher PD scores in patients with neuropathic or nociceptive pains, suggesting various factors were involved in such pains.
A NEW METHOD FOR QUANTITATIVE MEASUREMENT OF ITCH SENSATION BY PAINVISION®

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It is very difficult to assess itch sensation as well as pain, because itch is a subjective nature. Simple and effective methods for measurement of itch sensation will contribute substantially to treatment of pruritus. Recently a method for quantitative measurement of pain intensity using a painless electrical stimulation (PainVision®: Nipro Co., Osaka, Japan) has been developed in Japan. However, there is little data available on the quantitative measurement of itch sensation. In this study, we present the new method for quantitative measurement of magnitude of itch sensation using PainVision®.

Methods: A total of 14 patients (mean age, 74 years; range, 51 to 88 years) with neuropathic itch after herpes zoster were enrolled into this study. A visual analogue scale (VAS) was used to subjectively measure the severity of itching. Two different types of current perception threshold (CPT) were measured by PainVision®. One CPT was the minimum perception threshold (MPT) defined by the lowest electrical current detected; the other CPT was itch equivalent threshold (IET) at which the subject starts to perceive the equivalent strength as ongoing itch. Itch degree (ID) is calculated from two parameters as follows. Itch degree (ID) was calculated as (IET - MPT)/MPT. To determine the relationship between iVAS and ID, Pearson correlation coefficient was determined and p values less than 0.05 were considered significant.

Results: The mean iVAS was 39.4 ± 6.2; the mean ID was 106 ± 27.5. The correlation coefficient was r = 0.639 (95% confidence interval 0.163-0.873, p = 0.012).

Conclusions: Our data demonstrated that the ID showed a significant positive correlation with the iVAS. To our knowledge, this is the first study showing the objective, quantitative and noninvasive assessment of itch, especially itch sensation, except measuring scratching activity. PainVision® may be helpful for the assessment of itch sensation.
A STUDY OF CHANGES IN PAIN USING A NEW PAIN INTENSITY MEASUREMENT METHOD FOR PAIN TREATMENT

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Evaluating pain intensity in patients who suffer from chronic pain is an important task. The newly developed device PainVision TM PS-2100 (Nipro Co., Osaka, Japan) for the quantitative analysis of perception and pain sensation was used to obtain pain intensity readings as "degree of pain" and to compare the change in pain intensity following treatment using a visual analogue scale (VAS). To measure degree of pain, bipolar electrodes were attached to the forearm (another part of the body could also be used) and a current was passed through, creating heteresthesia in the patient. The strength of the current was increased gradually and the minimum perceived current was measured first as the "current perception threshold," followed by the level of current that produces a pain-equivalent sensation in the patient as the "pain equivalent current." The "degree of pain" is then calculated as 100 x (Pain equivalent current - Current perception threshold)/Current perception threshold. The clinical study targeted patients at 29 facilities around Japan who were in treatment for chronic pain. Approval was granted at each institution by an ethics committee, and the study was explained both in writing and verbally to each patient, who signed a letter of consent. The study targeted 457 males and 595 females; a total of 1052. The average age was 59.7 (19 to 91). Some of the conditions included postherpetic neuralgia, lumbar disease, cervical vertebra disease, complex regional pain syndrome, and trigeminal neuralgia. Pain treatment was given to each patient and the degree of pain and VAS were measured before and after the treatment. Following treatment, the current perception threshold rose significantly and the pain equivalent current dropped significantly, resulting in a significant lowering of the degree of pain. The average the degree of pain before treatment was 258.9 ± 314.0 and 141.6 ± 223.3 after treatment. Analyzed by age segment and by gender, the current perception threshold was higher the older the person was, both before and after treatment for both genders. There was a tendency for the degree of pain values to be lower the older the person was, whether before or after treatment for both genders. On the other hand, the VAS decreased significantly after treatment as well. Both before and after treatment there was no difference by gender or age. Prior to treatment, the average VAS value was about 50 mm, dropping to about 30 mm after treatment. This indicated a low correlation between degree of pain and the VAS. Such results suggest the possibility of lower sensitivity to pain the older one gets, and that the VAS is easily affected by a patient's mental state. By measuring degree of pain it is possible to measure pain intensity in a more objective way.
A STUDY ON THE RELATIONSHIP BETWEEN VAS AND “DEGREE OF PAIN” EVALUATED BY QUANTITATIVE ANALYSIS IN CHRONIC PAIN

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Visual analogue pain scale (VAS) is believed a gold standard tool to evaluate pain intensity. However, in practice it is not so easy to evaluate pain intensity in chronic pain by conventional assessment tool including VAS. Especially VAS is considered to be affected by a patient’s mental state. Recently a newly developed device Pain VisionTM PS-2100(Nipro Co., Osaka, Japan) for the quantitative analysis of perception and pain sensation was used to obtain pain intensity readings as “degree of pain”.

We investigated the relationship between VAS and “degree of pain” on the patient with three different pain mechanisms, nociceptive, neuropathic and psychogenic pain in chronic pain. The study was undertaken at 29 facilities in Japan. Approval was granted at each institution by an ethics committee, and the details of informed consent were obtained from patients. To measure degree of pain, bipolar electrodes were attached to the forearm and a current was passed through, creating heteresthesia in the patient. The strength of the current was increased gradually and the minimum perceived current was measured first as the “current perception threshold”, followed by the level of current that produces a pain-equivalent sensation in the patient, which called the “pain equivalent current”. The “degree of pain” is calculated as 100 x (pain equivalent current - current perception threshold)/ current perception threshold. The study targeted 439 males and 541 females; a total of 980. The average age was 59.8±16.8. A degree of pain and VAS were measured before and after the treatment on the same day in each patient. In nociceptive pain (n=351), VAS scores significantly decreased from 49.7±23.8 (mean±SD) to 27.8±23.0. Degree of pain scores significantly decreased from 312±363 to 171±272. In neuropathic pain (n=610), VAS scores significantly decreased from 48.5±23.4 to 31.3±23.1. Degree of pain scores significantly decreased from 232±288 to 120±179. While, in psychogenic pain (n=19), VAS scores significantly decreased from 67.6±24.6 to 62.1±29.7. This change significantly minimized compared with those in nociceptive and neuropathic pain. Degree of pain scores decreased from 340±297 to 277±406. However this change was not different among three different pain components. These results suggest that a degree of pain is considered to be not affected patient’s mental state compared with VAS. A new device Pain VisionTM calculating a “degree of pain” in addition to VAS may be helpful tool to assess psychogenic pain component in chronic pain.
Topical Clonidine for Post-Herpetic Itch: Quantitative Assessment by PainVision®

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INTRODUCTION: Recent basic science studies have revealed that activation of α2-adrenergic receptors can produce antipruritic action as well as analgesia. However, few data are available regarding the antipruritic effects of α2-adrenergic agonists in patients with neuropathic itch. Recently a new method for quantitative measurement of pain intensity using a painless electrical stimulation, PainVision®(PV: Nipro Co., Osaka, Japan) has been developed in Japan. Furthermore, we demonstrated PV was helpful for the quantitative measurement of itch sensation. The purpose of our study was to examine the effects of single topical application of CC in patients with post-herpetic itch (PHI) using PV.

METHODS: CC was prepared by mixing plastibase (polyethylene resin 5%, liquid paraffin 95%) as vehicle at a concentration of 150 μg/g. A total of 16 outpatients (mean age, 74 years; range, 51 to 88 years) with neuropathic itch after herpes zoster were enrolled into this study. CC(150 μg/1g) was applied to their itchy area in the affected skin at the time of visit. (1) Subjective assessment: A visual analog scale (VAS) from 0 to 100mm was utilized to subjectively measure the severity of itch, before and 60 min after the application of CC. (2) Quantitative assessment by PV: Two different types of current perception threshold (CPT) were measured by PV, before and 60 min after the application of CC. One CPT was the minimum perception threshold (MPT) defined by the lowest electrical current detected; the other CPT was itch equivalent threshold (IET) at which the subject starts to perceive the equivalent strength as ongoing itch. ID is calculated from two parameters as follows. ID was calculated as (IET-MPT)/MPT. Statistical analysis was carried out by paired t-test and p values less than 0.05 were considered as statistically significance.

RESULTS: Single topical application of CC decreased the average VAS scores from 38.6±15.9 mm to 10.9±13.3mm (p< 0.0001) and the average ID fron 107.4±82.1 to 24.8± 25.7 (p= 0.0006).

CONCLUSIONS: Our data demonstrated that single topical application of CC has antipruritic activity in patients with post-herpetic itch. PV may be useful for quantitative assessment of therapeutic efficacy of antipruritic agents.
Quantitative assessment of diabetic neuropathy using a newly developed device

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Aims: Screening for the onset of diabetic neuropathy is a major concern in clinical practice. Conventional methods for clinical assessment of sensory function have been unsatisfactory. There is a need for a quick, objective, quantitative sensory test for wide use in an outpatient clinic. Recently, a new, sensitive tool for detection of neuropathy was developed. The Painvision® (Osachi, Inc.) is a device to quantitatively evaluate the degree of pain. This portable and battery-operated device provides a sensitive quantitative measure of sensory function, and is quick and easy to use.

Methods: We applied the electrodes to the medial forearms of the subjects and measured the minimum perceived current (MPC) produced by low frequency current (50 Hz, 0-150 microA, pulse width 0.5 ms). We investigated the relationship between MPC and clinical grade obtained by using the conventional tests, including the vibratory perception threshold and the heart rate variability analysis. Seventy-nine diabetic patients (aged 16-89 years, known duration of diabetes > 10 years) and one hundred and four non-diabetic age-, and gender-matched control subjects were studied.

Results: The mean (±SD) MPC was 16 ± 6 microA in non-diabetic subjects (group A), 20 ± 8 microA in 40 diabetic patients without clinical evidence of neuropathy (group B) and 24 ± 8 microA in 39 diabetic patients with clinically discernible neuropathy (group C), respectively (group A vs. group B, P< 0.005; group B vs. group C, p < 0.05; group A vs. group C, P< 0.0001, respectively). Age-related increase in MPC was found in all groups. By using a quantitative evaluation of MPC, sensory dysfunction was detected in a substantial number of group B who was judged to be "normal" based on the conventional tests.

Conclusions: A quantitative evaluation of MPC is a very sensitive test for the detection of neuropathy in diabetic patients.
Acupuncture Attenuates the Pain Sensation Induced by an Experimental Weight-Loaded Pain

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Objectives: To clarify the effectiveness and mechanisms of acupuncture for intractable or chronic pain, we evaluated effects on changes of threshold for painless electrical stimulation during acupuncture.

Method: 17 of healthy adult male volunteers were randomly divided to acupoint group (n=10) and non-acupoint group (n=7). In acupoint group, volunteers had acupuncture procedures at bilateral zusanri acupoint for 10 minutes. In non-acupoint group, they had acupuncture procedures at non-acupoints 2-3 cm lateral to the zusanri acupoint for 10 minutes. A volunteer was applied a 200g weight-loaded stumped aluminum rod (diameter 3mm) at his one forearm. Two different types of the current perception (CPT) threshold were measured by a commercially available microprocessor-controlled electrical neurostimulator (Pain vision™, Nipro Japan) which delivers a sinusoidal constant alternating current (frequency 50 Hz, pulse width 0.3 ms, intensities 0-250 micro A). One CPT is the minimum perception threshold (MPT) which a volunteer starts to perceive the current applied non weight-loaded forearm. The other CPT (pain equivalent threshold PET) is the current threshold which the volunteer starts to perceive the equivalent strength as pain stimulus by the weight-loaded rod. These measures were performed 5 minutes before the acupuncture and 5 minutes after the acupuncture. Pain degree was calculated: (PET-MPT)/MPT.

Results: There were no significant changes of mean MPT and mean PET in non-acupoint group between pre-acupuncture and post-acupuncture. In acupoint group, mean MPT was significantly elevated and decreased Pain degree after acupuncture procedures (fig1, fig2).

Conclusion: These results suggest that Acupuncture attenuates the pain sensation induced by an experimental weight-loaded pain.
Evaluation of diabetic neuropathy by the PainVision

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PainVision PS-2100 is an instrument to measure the current perception threshold in humans without giving any pain. In this method 50Hz of pulse stimulation with 0.3 msec duration is given in an increasing manner through the surface electrodes. PainVision reflects the function of Aβ and Aδ fibers in the peripheral nerve trunk. We studied appropriateness to use the PainVision in the evaluation of diabetic neuropathy. A total of 205 patients with diabetes mellitus were examined the current perception threshold in addition to the clinical evaluation of neuropathy and the electrophysiological evaluation by nerve conduction studies. Their mean age was 58-years, mean disease duration was 9 years and no difference was shown in the severity of neuropathy between men and women. The current perception threshold was examined at the center of the flexor side in the forearm and at the dorsal aspect of the proximal phalanx in the great toe. Measured current perception threshold was 13±6 (mean+ SD) µA in both forearm, 33±23µA and 31±23µA in the right and left great toe, respectively, which presented a significant difference (p < 0.01). The current perception threshold level was significantly higher in men than in women (p<0.01 in the great toe and p <0.05 in the forearm) and tended to increase with the age. Measured threshold had a significant inverse correlation with the PNI-R, a calculated conduction velocity index to express the severity of polyneuropathy. The coefficient of correlation with the PNI-R was -0.42 in the PainVision in contrast to 0.49 in the vibration threshold, both in the great toe. From these data we can conclude that the PainVision can be a valuable tool in the evaluation of diabetic polyneuropathy, as well as the measurement of vibration threshold. In the present measurement current stimulation was done in an increasing manner, so the attention level of the patient can influence the results of current perception threshold. To be a more accurate and useful tool, improvement in the stimulation method, such as using a computer-based strength control, will be required.
PainVision PS-2100 is an instrument to measure the current perception threshold in humans without giving any pain. In this method 50Hz of pulse stimulation with 0.3msec duration is given in an increasing manner through the surface electrodes. PainVision reflects the function of particularly Aδ fibers in the peripheral nerve trunk. We studied appropriateness to use the PainVision in the evaluation of entrapment neuropathies. A total of 234 patients with diabetes mellitus were examined the current perception threshold in addition to the nerve conduction studies. Their mean age was 59 years, mean disease duration was 10 years. The current perception threshold was examined at the palmar aspect of the index finger and the little finger. Measured current perception was 17±5 (mean±SD) μA at the index finger, which was higher than that at the little finger (13±5 μA). The current perception threshold at the index finger had a significant negative correlation with sensory nerve action potential (SNAP) amplitude ($r = -0.45$) or sensory conduction velocity (SCV) ($r = -0.46$) of the identical median nerve between wrist and finger. Similarly, the current perception threshold at the little finger had a significant negative correlation with the SNAP amplitude ($r = -0.41$) or SCV ($r = -0.46$) of the identical ulnar nerve between wrist and finger. In patients whose current perception threshold is apparently high the SNAP amplitude or SCV of the corresponding nerve was obviously decreased. Increase in the current perception threshold can be detected easier in the median nerve with carpal tunnel lesion than in the ulnar nerve with ulnar neuropathy at the elbow. In addition to the difference of the skin thickness, some influence of latent carpal tunnel lesion might be the cause of difference in current perception threshold between index and little fingers. Characteristics of the PainVision is to give us information on the function of Aδ fibers, which is suitable for the evaluation of carpal tunnel syndrome. PainVision is useful to obtain objective data in patients with apparent neuropathy, but not slight one.
Minimal perceived sensation evaluated by painless electrical stimulation in healthy Taiwanese – a pilot study for further utilization in minimal perception current in Taiwan

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**Aims:** Minimal perception current (MPC) measurement is a novel technique which provides a quantitatively method to evaluate skin sensitivity. Painvision® (PS-2100; Osachi Co., Ltd., Japan) has been developed recently which was designed for minimal and pain perception current measurement. This study is to measure the minimal perceived sensation scale by painless electrical stimulation in healthy Taiwanese.

**Methods:** To look into the possible variation between races and to build-up a minimal perception current databank of healthy population in Taiwan, 78 Healthy Taiwanese (58 female, 20 male) who works in a medical center in Taiwan were included in the study. Minimal perception current was measured.

**Results:** The average age were 34.3 (24~56) year-old and 33.1 (21~60) year-old in male and female subjects respectively. The MPC level was 10.44 ± 2.65 uA and 8.16 ± 1.95 uA in male and female subjects respectively.

**Discussion:** Current utilization of minimal perception measurement with Painvision® lies major on the evaluation of peripheral neuropathy, especially DM neuropathy. Besides sensitivity measurement, Painvision® also provides a quantitative way, the pain equivalent current, for pain evaluation. By measuring minimal perception current, skin sensitivity could be digitalized. The decrease in skin sensitivity could be an indicator for nerve block or neuraxial block effectiveness. If to measure the pain equivalent current, the severity of pain could be digitalized too. It is important in coping with patient with pain and could aid in pain management effectiveness evaluation or direct further pain treatment by the aid of Painvision®.
Interpleural misplacement is a rare complication of epidural catheter insertion. We report a case in which the combination of catheter placement in an awake patient, loss of resistance technique, negative aspiration as well as cold sensitivity test failed to identify epidural catheter misplacement. The possible reasons for the failure to diagnose the misplacement of the epidural catheter are discussed. A novel technique to quantitatively evaluate an epidural blockade which may aid in early diagnosis of epidural catheter misplacement was introduced.

While evaluating an epidural blockade by cold sensitivity test, the decrease in cold sensitivity may reflect the effect of blockade or preexisting sensitivity variation, as in the case. A more reliable method was mandatory to evaluate epidural blockade and may aid in confirmation of epidural catheter placement. At the 2007 annual meeting of the American Society of Anesthesiologists, Yamakage et al presented their study on skin sensitivity and aging by measuring minimal perception current (MPC) with Painvision®. While there was no studies regarding the application of MPC to quantitatively evaluate epidural neural blockade been published, we suggest that by comparing the MPC measured by Painvision® before and after epidural blockade, the intensiveness and the coverage of sensory blockade could be quantitatively measured. Unexplained weak or ineffective block which may resulted from a misplaced epidural catheter could be identified before a failed block does happen.
A randomised double-blind crossover trial of the potential analgesic effect of a transdermal nicotine patch in non-smokers based on objective and subjective assessment

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Objective: The results of studies of the analgesic effect of nicotine in humans are complex because these studies have included smokers with variable smoking histories. We investigated whether the use of a 17.5 mg transdermal nicotine (TDN) patch decreased the magnitude of pressure pain on the hands of healthy non-smoking volunteers.

Design: This was a randomised double-blind crossover trial. A TDN patch or placebo (drug-free bandage) was applied randomly on the anterior chest of non-smoking volunteers 12 h before the experiments. We measured minimum perceived current and pain threshold on the right hand and then evaluated the magnitude of pressure pain by using the Pain Vision PS-2100 (Nipro Co., Osaka, Japan) which helps in objective quantitative assessment of pain magnitude. After estimating minimum perceived current, pressure pain was produced using a combination of 100-g discs and a rod. The rod and the discs weighing 0 (no disc), 200 (two discs), 400 (four discs), 200 (two discs) and 0 g (no disc) were placed consecutively in this order on the right hand and pain threshold was measured. At the same time, volunteers were asked to rate pain on a numerical rating scale (NRS). Minimum perceived current is the current at which the volunteer perceives the first sensation on applying gradually increasing pulsed current. Pain threshold is the compatible electrode current at which the volunteer feels the intensity of pressure pain. Pain degree is calculated as (pain threshold - minimum perceived current)/minimum perceived current x 100.

Participants: Forty non-smoking volunteers were enrolled in this study.

Results: No significant differences between groups were observed in minimum perceived current, pain threshold, pain degree or NRS. Of the volunteers who received the nicotine patch, four became anorexic and nauseated and two required anti-emetics.

Conclusion: The nicotine patch had no analgesic effect in non-smoking volunteers.
Acupuncture attenuates chronic pain independently from age groups in adults

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**Background and Goal of Study:** This study was to clarify the effectiveness and mechanisms of acupuncture for chronic pain between age groups using Pain Vision and VAS.

**Materials and Methods:** Twenty three of adult patients (32–84 yo.) suffering from chronic pain were candidates for this study. We divided two age groups (one group under 60 years old, the other group over 60 years old). All patients had acupuncture procedures for 40–60 minutes by needling acupuncture points with “meridian” and the vital energy “Qi”. We evaluated the effects of acupuncture on chronic pain at pre- and at post-acupuncture. Subjective evaluations of pain were visual analogue scale (VAS) of pain. Objective evaluations of pain were measured by a commercially available microprocessor-controlled electrical neurostimulator (Pain visionTM, Nipro Japan). It delivers a sinusoidal constant alternating current (50 Hz, pulse width 0.3 ms, intensities 0–250 micro A), and measure different types of the current perception (CPT) threshold. One CPT is the minimum perception threshold (MPT) which a patient perceives the current applied on a normal forearm. The other CPT (PET) is the current threshold which the patient perceives the equivalent strength as the chronic pain. Pain degree was calculated: (PET-MPT)/MPT.

**Results and Discussion:** There were significant changes of VAS (45.9+/−2.7 vs. 27.3+/−4.7 mm, mean+/−SD, p=0.0024), and pain degree (308.4+/−327.9 vs. 174.1+/−250.9, p=0.0047) between pre and post-acupuncture in the under 60 years group. There were significant changes of VAS (45.1+/−16.4 vs.25.8+/−17.4 mm, mean+/−SD, p=0.00001), and pain degree (201.7+/−245.2 vs. 73.6+/−93.9, p=0.0017) between pre and post-acupuncture in the over 60 years group. There were no significant changes between the two age groups. These results demonstrated that acupuncture attenuated chronic pain independently from age groups in adults. Pain is a subjective sensation that is difficult to measure and/or assess. VAS is subjective and depends on an individual's experience for pain. Pain vision is quantitative analysis of perception of painless stimulating current flow as intensity of pain. Our study could not reveal the difference between analgesic action and psychological action of acupuncture (1).

**Conclusion(s):** These results suggest that acupuncture attenuates chronic pain independently from age groups in adults.

**References:**