

Supplement Material

Application details for the single bedside-QST devices

Thermal perception/pain

Thermal parameters were investigated using four metal pieces with a size of 3x3 cm, approximately the size of the lab-QST thermode. Cold detection and cold pain thresholds were examined using metal pieces of 8°C (stored in a fridge) and 22°C (left at room temperature). Warm perception and heat pain thresholds were investigated using metal pieces heated up in a vial warmer ("Babycare," Breuer GmbH, Ulm, Germany) to 37°C and 45°C. Every metal piece was applied for approximately three seconds. First, patients were asked about the quality of the stimulus, i.e. perceived/not perceived, cold/warm (yes/no) and if perceived about the perception intensity (NRS, "0 = no perception" to "10 = strongest imaginable perception"). Afterwards, patients had to indicate whether the stimulus had also been painful (yes/no) and if painful, rate the pain intensity (NRS, "0 = no pain" to "10 = strongest imaginable pain").

Touch sensation

The dynamic mechanical detection sensitivity was examined by use of a Q-tip stroke of 5 cm first applied in the control area and directly afterwards in the most affected area. Subjects were asked to rate the perception intensity of the stimulus at the test area as compared to the control area from 0 to 20 ("0 = not perceived at test area", "<10 = less intensity at test area as compared to control", "10 = equal intensity as compared to control area", ">10 = stronger intensity at test area as compared to control").

Static mechanical detection was investigated by use of a Neuropen filament (monofilament with defined pressure of 10 g) and a 64-mN von Frey hair (Optihair2-Set; Marstock Nervtest). Both tools were applied three times in each area. Patients had to indicate the number of perceived stimuli, documented as "perceived at least two times" (yes/no) and to compare the perception intensity between both areas (i.e., 0 = same intensity in control and test area, 1 = control area more intense, and 2 = test area more intense).

Mechanical pain sensitivity

To test for pinprick hyperalgesia and hypoalgesia, a 0.7-mm CMS hair (CMS, Chicago Medical Supply, LLC) and a Neuropen with a Neurotip (disposable needle with a defined pressure of 40 g) were applied to both areas. Participants had to evaluate whether the stimulus was perceived as blunt touch or as a pinprick. If the stimulus was perceived as a pinprick, they had to rate the pain intensity (NRS, "0 = no pain" to "10 = worst imaginable pain").

Wind Up

Temporal pain summation as an indicator for central sensitization was investigated by applying the 0.7 mm CMS hair and the Neurotip at the control and the test area. Both devices were first applied once and subjects had to rate the single stimulus pain intensity (NRS, “0 = no pain” to “10 = worst imaginable pain”). Afterwards they were exposed to a series of 10 stimuli with a frequency of 1/s and had to indicate the pain intensity of the last few stimuli. Wind-up ratio was calculated as the ratio of the last few stimuli of the row of ten divided by the single stimulus pain intensity.

Dynamic mechanical allodynia

Dynamic mechanical allodynia was assessed using a Q-tip by drawing a cross twice with an angle of 90° and lines of 3-5 cm on the skin. Subjects had to indicate whether the stimulus was painful (yes/no) and if painful, rate the pain intensity (NRS, “0 = not painful” to “10 = worst imaginable pain”). Afterwards they were asked about any burning, prickling or unpleasant after sensation (yes/no) and in case of postallodynia sensation pain, the pain intensity was rated (NRS, “0 = not painful” to “10 = worst imaginable pain”).

Pressure pain sensitivity

A bedside algometer (10-mL syringe sealed with a plug and felt pad with a contact area of 1 cm²) was placed above a muscle located in the control area and test area to evaluate deep somatosensory pressure pain. First the syringe was slowly compressed up to 4 mL and subjects had to indicate, whether this compression was painful (yes/no) and if painful, rate the pain intensity (NRS, “0 = no pain” to “10 = worst imaginable pain”). Afterwards the syringe was compressed again with 1mL/s and the participants had to evaluate when the pressure started being painful. This pain threshold was defined by the milliliter of compressed air in the syringe.

Vibration detection

Vibration detection threshold was investigated using a standardized tuning fork (64 Hz, 8-point scale), placed over a bony prominence located in the control and in the test area. Subjects had to state the moment when the vibration stimulus had disappeared (0 = no vibration stimulus perception, 8 = best possible vibration detection).

Supplement Table 1. Equipment details for lab- and bedside-QST parameters

Parameters	Tool	Description	Vendor/Address
Lab-QST			
CDT, WDT, TSL, PHS, CPT, HPT	Medoc TSA II system thermode	Temperature range: 0-50 °C, 1 °C/s ramp	Medoc Advance Medical System, Ramat, Yishai, Isreal
MDT	Von Frey filaments	Forces between 0.25 and 512 mN	Optihair2-Set, Marstock Nervtest, Heidelberg, Germany
MPT, MPS, WUR	Pinprick stimulators	Weighted pinpricks: forces between 128 mN to 256 mN	MRC Systems GmbH, Heidelberg, Germany
DMA	Brush, cotton wisp, cotton wool	Brush: force of 200 -400 mN Cotton wisp: force of 3 mN Cotton wool tip fixed to an elastic strip: force of 100 mN	Somedic, Sweden
PPT	Pressure Algometer	Probe area of 1 cm ² (probe diameter of 1.1 cm) that exerts pressure up to 20 kg/cm ² /200 N/cm ² /2000 kPa Increasing ramp of 50 kPa/s	FDN 200; Wagner Instruments, Greenwich, CT
VDT	Tuning fork	128 Hz tuning fork with damper to generate a frequency of 64 Hz, 8/8 scale (Rydel-Seiffer)	
Bedside-QST			
Thermal perception/pain	Metal pieces	3x3 cm hot-rolled steel (thermal conductivity: ~52-55 W/m-K)	
	Metal cubes*	2.7x2.7x2.7 cm stainless steel (thermal conductivity: ~15 W/m-K)	e.g. Edelstahl Whisky Stein Eiswürfel Square Glacier Chiller Drink Wiederverwendbar eBay
Warm perception; Heat pain thresholds	Vial warmer	To heat up the metal pieces to 37°C and 45°C	e.g. Beurer BY 52 (95402) (Beurer Babykost- und Fläschchenwärmer - BY 52 Beurer Onlineshop (beurer-shop.de))

Static mechanical detection	Neuropen filament	Monofilament with a defined pressure of 10 g	Neuropen Owen Mumford; https://www.owenmumford.com/en
MPT, MPS, WUR	Neuropen with a Neurotip	Disposable needle with a defined pressure of 40 g	
Static mechanical detection	64 mN von Frey filament		Optihair2-Set, Marstock Nervtest, Heidelberg, Germany
Mechanical pain sensitivity; Temporal pain summation	0.7-mm CMS hair		CMS, Chicago Medical Supply, LLC
Dynamic mechanical detection/allodynia	Q-tip		e.g. Q-Tips Care swabs / cotton buds, pack of 3 (3 x 206 sticks).: Amazon.de: Beauty
Pressure pain sensitivity	Bedside algometer	10-mL syringe sealed with a plug and felt pad with a contact area of 1 cm ²	BRAUN-4617100V
VDT	Tuning fork	128 Hz tuning fork with damper to generate a frequency of 64 Hz, 8/8 scale (Rydel-Seiffer)	e.g. medicalax.de - Zellamed Neurological tuning fork by Rydel-Seiffer Tuning Fork Diagnostics

*Not used in the present study but proposed as an alternative due to better practicability. CDT, cold detection threshold; CPT, cold pain threshold; DMA, dynamic mechanical allodynia; HPT, heat pain threshold; MDT, mechanical detection threshold; MPS, mechanical pain sensitivity; MPT, mechanical pain threshold; PHS, paradoxical heat sensation; PPT, pressure pain threshold; TSL, thermal sensory limen; VDT, vibration detection threshold; WDT, warm detection threshold; WUR, wind-up ratio

Supplement Table 2. Sensitivity and specificity of dichotomous bedside-QST parameters as compared to abnormal lab-QST parameters

Lab-QST (normal/abnormal)	Bedside-QST sensation perceived (yes/no)	Positive predictive value %	Negative predictive value %	Sensitivity %	Specificity %	Accuracy %
zCDT Pathological: <-1.96	22°C metal Perception (cold hypoesthesia)	61.9	76.9	59.1	78.9	71.7
zCDT Pathological: <-1.96	08°C metal Perception (cold hypoesthesia)	85.7	69.8	27.3	97.4	71.7
zWDT Pathological: <-1.96	37°C metal Perception (warm hypoesthesia)	25.0	77.3	28.6	73.9	63.3
zWDT Pathological: <-1.96	45°C metal Perception (warm hypoesthesia)	25.0	77.1	21.4	80.4	66.7
PHS Pathological: >1 PHS	PHS 22°C metal Perception (PHS)	66.7	59.6	8.0	97.1	60.0
PHS Pathological: >1 PHS	PHS 08°C metal Perception (PHS)	75.0	60.7	12.0	97.1	61.7
zCPT Pathological: <-1.96	22°C metal "loss" (cold hypoalgesia)	n.a.				18.3
zCPT Pathological: <-1.96	08°C metal "loss" (cold hypoalgesia)	n.a.				21.7
zCPT Pathological: >+1.96	22°C metal "gain" (cold hyperalgesia)	27.3	91.8	42.9	84.9	80.0
zCPT Pathological: >+1.96	08°C metal "gain" (cold hyperalgesia)	23.1	91.5	42.9	81.1	76.7
zHPT Pathological: <-1.96	37°C metal "loss" (heat hypoalgesia)	7.1	100.0	100.0	7.1	13.3
zHPT Pathological: <-1.96	45°C metal "loss" (heat hypoalgesia)	11.1	100.0	100.0	42.9	46.7
zHPT Pathological: >+1.96	37°C metal "gain" (heat hyperalgesia)	50.0	89.3	25.0	96.2	86.7
zHPT Pathological: >+1.96	45°C metal "gain" (heat hyperalgesia)	29.2	97.2	87.5	67.3	70.0
zMDT Pathological: <-1.96	Q-tip Perception (mechanical hypoesthesia)	65.2	73.0	60.0	77.1	70.0
zMDT Pathological: <-1.96	Neurotip Perception (mechanical hypoesthesia)	92.3	76.7	54.5	97.1	80.4
zMDT Pathological: <-1.96	64mN Perception (mechanical hypoesthesia)	81.8	67.3	36.0	94.3	70.0
zMPS Pathological: <-1.96	0.7mm CMS "loss" Pain (mechanical hypoalgesia)	27.3	100.0	100.0	86.0	86.7
zMPS Pathological: <-1.96	Neuropen "loss" Pain (mechanical hypoalgesia)	25.0	100.0	100.0	83.0	83.9
zMPS Pathological: >+1.96	0.7mm CMS "gain" Pain (mechanical hyperalgesia)	16.3	100.0	100.0	21.2	31.7
zMPS Pathological: >+1.96	Neuropen "gain"	18.2	100.0	100.0	25.0	35.7

	Pain (mechanical hyperalgesia)					
zMPT Pathological: <-1.96	0.7mm CMS "loss" Pain (mechanical hypoalgesia)	63.6	98.0	87.5	92.3	91.7
zMPT Pathological: <-1.96	Neuropen "loss" Pain (mechanical hypoalgesia)	58.3	97.7	87.5	89.6	89.3
zMPT Pathological: >+1.96	0.7mm CMS "gain" Pain (mechanical hyperalgesia)	14.3	100.0	100.0	20.8	30.0
zMPT Pathological: >+1.96	Neuropen "gain" Pain (mechanical hyperalgesia)	15.9	100.0	100.0	24.5	33.9
zWUR Pathological: <-1.96	CMS WUR ratio "loss" Pain (central sensitization)	n.a.				13.0
zWUR Pathological: <-1.96	Neuropen WUR ratio "loss" Pain (central sensitization)	n.a.				2.3
zWUR Pathological: >+1.96	CMS WUR ratio "gain" Pain (central sensitization)	5.0	100.0	100.0	13.6	17.4
zWUR Pathological: >+1.96	Neuropen WUR ratio "gain" Pain (central sensitization)	4.7	100.0	100.0	2.4	6.8
logDMA Pathological: >0.1	Q-tip allodynia Pain	46.7	100.0	100.0	84.9	86.7
logDMA Pathological: >0.1	Q-tip postallodynia sensation Pain	30.0	97.5	85.7	73.6	75.0
zPPT Pathological: <-1.96	Pressure algometer at 4- mL "loss" Pain (deep somatosensory hypoalgesia)	16.7	97.2	100.0	62.5	65.0
zPPT Pathological: >+1.96	Pressure algometer at 4- mL "gain" Pain (deep somatosensory hyperalgesia)	58.3	100.0	95.5	63.2	75.0

Bold parameters; parameters with a sensitivity and specificity about $\geq 60\%$
n.a., not applicable