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Brief Report

Test–retest reliability of Quantitative Sensory Testing in knee osteoarthritis and healthy participants

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SUMMARY

Quantitative Sensory Testing (QST), which assesses somatosensory function by recording participant's responses to external stimuli of controlled intensity, is a useful tool to provide insight into the complex pathophysiology of osteoarthritis (OA) pain. However, QST is not commonly used in rheumatology because the test–retest reliability properties of QST in OA patients have not yet been established. This brief report presents the finding of a study which assessed the test–retest reliability of light touch thresholds, pressure pain thresholds, thermal sensation thresholds and thermal pain thresholds in 50 knee OA patients and 50 healthy participants. Pressure pain thresholds were found to be the least variable measurement, as median thresholds did not differ significantly over the 1 week period and the results were highly correlated. This provides support for the inclusion of pressure algometry in studies assessing pain perception abnormalities in OA.

Introduction

QST, which assesses somatosensory function by recording participant's responses to external stimuli of controlled intensity, is a useful tool to provide insight into the complex pathophysiology of OA pain. However, QST is not commonly used in rheumatology because the test–retest reliability properties of QST in OA patients have not yet been established. The aim of this study was to assess the test-retest reliability of light touch thresholds, pressure pain thresholds, thermal sensation thresholds and thermal pain thresholds in knee OA patients and healthy participants.

Method

Ethics approval for this study was obtained from Southmead Research Ethics Committee and all study participants provided informed consent. The procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Patients on the waiting list for a primary total knee replacement (TKR) because of OA were invited to participate in the study *via* post. Healthy participants (defined as people who had no pain in either knee and had not previously had a TKR) were recruited through three methods: *via* knee OA patients (friends or family members); from upper limb, urology or skin pigmentation clinics; and from colleagues of the research team. An inclusion criterion for OA patients and healthy participants was being pain-free in their right forearm. Because QST involves the full co-operation of participants, individuals who had cognitive impairment or dementia were excluded.

Quantitative sensory testing

All participants attended the hospital for two 1-h testing sessions, separated by a week. Before testing began, the knee OA patients completed a Western Ontario and McMaster Universities Arthritis Index (WOMAC) questionnaire[1]. All participants underwent the same testing protocol and each test was performed at three different body sites which were, in order tested, the medial side of the right knee, the medial side of the left knee and the volar surface of the right forearm. These body sites were chosen because in the knee OA patients they represent a painful area (knee listed for surgery), its contra-lateral area (contra-lateral knee) and a distant pain-free area (forearm). Light touch thresholds, pressure pain thresholds, and thermal detection and pain thresholds were tested at all three body sites, in the order listed above.

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Light touch thresholds

Von Frey monofilaments (Somedic, Sweden) were used to measure participants' light touch thresholds using the ascending method of limits. Participants closed their eyes and monofilaments of increasing diameter were applied to the skin until the monofilament buckled. The light touch threshold (g/mm^2) was defined as when the participant felt three out of four stimuli.

Pressure pain thresholds

A digital algometer (Somedic, Sweden) with a 1 cm probe was used to assess pressure pain thresholds. The probe was held perpendicular to the skin and force applied at a constant rate of 10 kPa/s. The patient was instructed to say 'stop' when the sensation of pressure became the very first sensation of pain. Pressure algometry was repeated three times at each test site, and the average from the last two readings was calculated as the pressure pain threshold.

Thermal detection and pain thresholds

These were assessed using a QST analyser with a 25 × 50 mm^2 thermode (Thermotest Modular Sensory Analyzer, Somedic, Sweden). The thresholds were tested in the order of: warm detection threshold, cold detection threshold, hot pain threshold and cold pain threshold. The method of limits algorithm was used, and the thermode adaptation temperature of 32°C rose or fell at a rate of 0.5°C/s, as this rate of temperature change minimises intra-individual variation[2]. Each stimulus was generated after a randomised 4–6 s interval, and each of the four sensations was tested four times and a mean value from the last three readings was calculated. Cold pain thresholds were excluded from analysis because a large number of participants did not perceive cold pain before the Modular Sensory Analyser (MSA) Thermotest reached its safety cut off temperature of 5°C.

Repeat testing

To determine the test–retest reliability of QST, participants underwent the same tests again 1 week later. The same protocol was adhered to and the same experimenter (VW) performed all the tests on the repeat visit. All tests were performed in the same order for all participants at both time points.

Sample size

Previous QST studies assessing the reliability of QST methods in other conditions have included between 9 and 36 participants[3–12]. Therefore a sample size of 50 knee OA patients and 50 healthy participants was deemed adequate to assess the reliability of QST in this study.

Statistics

Test–retest reliability was analysed using two different statistical tests. Wilcoxon signed-rank tests were used to determine if there were significant differences in the baseline and 1 week QST results. Intraclass correlation coefficients (ICCs) were calculated to assess the correlation between the baseline and 1 week QST results. ICCs were calculated using a two-way random effects analysis of variance (ANOVA) model, type absolute agreement with single measures[13]. The ICC can range from 0 (no correlation) to 1 (perfect correlation). The strength of correlation can be interpreted as 0.00–0.25 = none-little correlation, 0.26–0.49 = low correlation, 0.50–0.69 = moderate correlation, 0.70–0.89 = high correlation, 0.90–1.00 = very high correlation[14].

Participant groups, body site and QST modality were analysed separately to aid the identification of any sample population-, body site- or modality-specific unreliability in the results. A *P*-value of <0.05 was considered statistically significant.

Results

Participant demographics and clinical characteristics

Fifty knee OA patients and 50 healthy participants participated in this study. Knee OA patients had a mean age of 71 years (standard deviation (SD) 7.6) and 23 were female. Healthy participants had a mean age of 68 (SD 7.9) and 21 were female. The median WOMAC pain score for the index knee was 35 (30–55), on a scale of 0–100 (worst to best) and the median WOMAC pain score for the contra-lateral knee (knee not listed for surgery) was 75 (57.5–95). The contra-lateral knee had been replaced in five patients (10%).

Table I
Results of the reliability analysis of median (interquartile range) baseline and 1 week thresholds in OA patients

	Median (IQ range) baseline threshold	Median (IQ range) 1 week threshold	Wilcoxon signed-rank test (p-value)	ICC (95% confidence interval)
Light touch g/mm^2				
Index knee	3.9 (2.9–6.8)	3.9 (2.9–6.8)	0.7	0.59 (0.38–0.75)
Contra-lateral knee	3.1 (2.9–6.8)	3.3 (2.9–6.8)	0.74	0.56 (0.34–0.73)
Forearm	3.3 (2.9–6.8)	4.5 (2.9–6.8)	0.009†	0.58 (0.37–0.74)
Warm detection °C				
Index knee	35 (34.1–38)	34.4 (33.5–36.5)	0.006†	0.70 (0.49–0.83)
Contra-lateral knee	34.9 (34.1–37.4)	34.3 (33.7–35.6)	0.045*	0.68 (0.49–0.80)
Forearm	34.7 (33.7–36.2)	34.7 (33.9–36.3)	0.64	0.52 (0.29–0.70)
Cold detection °C				
Index knee	29.7 (30.9–28.1)	30.4 (30.9–28.8)	0.156	0.70 (0.53–0.82)
Contra-lateral knee	30.2 (30.8–28.4)	30.2 (30.9–29.2)	0.111	0.35 (0.08–0.57)
Forearm	30.6 (31–29.8)	30.5 (30.8–30)	0.571	0.41 (0.15–0.62)
Pressure pain kPa				
Index knee	213 (120–321)	228 (121–317)	0.831	0.83 (0.72–0.90)
Contra-lateral knee	211 (170–325)	223 (110–345)	0.654	0.77 (0.63–0.86)
Forearm	184 (120–300)	225 (109–294)	0.055	0.86 (0.77–0.92)
Hot pain °C				
Index knee	44.8 (41.7–47.5)	44.4 (40–47.3)	0.057	0.77 (0.62–0.87)
Contra-lateral knee	44.2 (41.8–46.4)	44.7 (41.1–46.9)	0.495	0.86 (0.76–0.92)
Forearm	43.9 (40.4–47.2)	43.9 (40.2–46.7)	0.623	0.86 (0.76–0.92)

* Difference is significant at the $p < 0.05$ level.
† Difference is significant at the $p < 0.01$.