Comparison of absolute and relative thermal QST thresholds In the orofacial region of the young Korean women

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To diagnose sensory nerve damage, patient values for thermal stimuli as quantitative sensory test (QST) can be compared with the values of the general population (absolute reference data) or to values measured at contralateral unaffected side (relative reference data). It is well know that relative reference data are more sensitive for detecting sensory abnormality than absolute reference data. However it is still lack of the studies for comparisons between relative and absolute data. This study aimed to evaluate the validity of relative reference data and compare the sensitivities of the two approaches in the orofacial region. In 19 young Korean women as normal subjects, quantitative somatosensory thermotest were done in the forehead, cheek, mentum, lower lip and tongue tip bilaterally. After we get the standard deviations (SD) of average reference data and relative reference data, the ratios SD absolute data/SD relative data were calculated. Our study showed that relative reference data for side to side comparisons in the same patient have the high ratios than the absolute reference data, i.e. the side to side comparisons with relative reference data exhibit gain in sensitivity in assessment of sensory abnormality.

Keywords : facial, oral, quantitative sensory test, QST, relative and absolute, thermal threshold

Ⅰ. Introduction

Evaluation of sensory abnormality in the nerve pathologies is a challenging and often frustrating process. Based on evidence accumulated from clinical and animal experiments, quantitative sensory testing (QST) has emerged as a useful tool in the assessment of sensory nerve damage.[1] The measurement of thermal perception is an essential part of QST and reported to have acceptable reliability in the orofacial region.[2-5]

To diagnose sensory nerve damage, patient values for thermal stimuli from innocuous to noxious temperature range can be compared with the values of the general population (absolute reference data) or to values measured at contralateral unaffected side (relative reference data).[6] When using the approach of absolute reference data, the mean value and standard deviation could be obtained from an age and sex matched sample of

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healthy subjects using the same methodology of thermal QST. In this method, values beyond the limit of 2 standard deviations from the mean values are considered abnormal.[7-9] On the other hand, in the approach with the relative reference data, the normal value could be obtained from an unaffected contralateral site within the same subject. This approach is based on the hypothesis that corresponding areas on opposite sides of the affected site have approximately the same sensitivity in the normal condition.[6] On account of large inter-individual differences in the absolute values, comparison to a contralateral unaffected site in the same patient may be the best approach for the determination of sensory abnormality.[6,10] However, due to the lack of standard deviation of side difference, the cut off value between normal and abnormal is usually assigned arbitrarily.[6,11]

Thus the current study aimed to find the standard deviation of side differences in the orofacial region of the young female subjects and evaluate the sensitivity of relative reference data comparing the absolute reference data.

Ⅱ. Material and Methods

Participants in this study consisted of 19 young healthy Korean women (mean age 26.4 years, range 21 to 34) without orofacial complaints. Participants were recruited from students of the Dankook University Dental School, Cheonan, Rep. of Korea. Quantitative thermal sensory tests were performed from April to May 2013. The Institutional Review Board at Dankook University Dental Hospital approved the study (IRB No H-1303/004/003). A written informed consent was obtained from all subjects after a full explanation for the aims and procedures of the study. Participants received no monetary compensation for study participation. Thermal thresholds were measured using the TSA II neurosensory analyzer (Medoc, Israel). A Peltier thermode with a contact area of 0.25cm^2 was applied to the skin with the baseline temperature of 32℃ for extraoral sites and 36℃ for the tongue. The thermal change rate was 1.0℃/s for detection thresholds and 1.5℃/s for pain thresholds, with and interstimulus interval randomized between 4 and 6s. Cut off temperature was 0℃ for cold stimuli and 50 ℃ for warm and hot stimuli. Thermal thresholds including Cold detection (CDT), warm detection (WDT), cold pain (CPT) and heat pain (HPT) thresholds were determined bilaterally in the orofacial region.

These were the mentum (above the mental foramen); the vermilion of the lower lip; the tip of the tongue; the midpoint of the cheek and the forehead (2 cm above the midpoint of the brow).[2] Testing was carried out in a quiet room in the room temperature with subjects seated in a comfortable chair by one experiment. Three stimuli were given to determine each threshold and the mean threshold temperature of three consecutive measurements was calculated. The patients indicated when perception changed to warm, cold or pain by pressing a button. The tests were done in order of the mentum, lower lip, tongue tip, cheek and forehead last, selecting alternatively from the right and left sides. CDTs and WDTs were measured first and then CPT and HPT were determined. The subjects were asked to keep their eyes closed throughout the QST procedure. One experienced examiner made all measurements.

All variables were continuous, and mean absolute threshold values and SD which used the average of left and right thresholds were calculated. Side differences were analyzed by Paired t test. Pearson's correlation was used to find the relationship between thermal detection and pain thresholds. Statistical tests were done at the 5% significance level. All statistical calculations were made using the SPSS version 18.0.

Ⅲ. Results

There were no significant differences in thermal

thresholds reference data between the left and right sides of the orofacial region (Table 1, all P 〉 0.05), and most of correlations across the test sites were highly significant except WDT (P=0.054) and CPT (P=0.120) side differences at the mentum, CDT (P=0.073) and WDT (P=0.078) side differences at the tongue tip and WDT side difference at the forehead (P=0.087) (Table 1). Standard deviations of the absolute data which mean inter-individual differences were relatively larger than those of the relative data which indicate left-right side differences except CPT in the mentum and WDT in the tongue tip.

To compare the gain in the sensitivities of absolute and reference data, we calculated as the ratio standard deviation of absolute data divided by standard deviation of relative data. we found that the all ratios except 2 cases were larger than number 1. 16 ratios of For side to side comparisons, total 20 calculated ratios (80%) in the orofacial region showed the values larger than 1. Although the ratios of CPT in the mentum and WDT in the tongue tip were less than number 1, relative reference data were up to 4.6 times larger than the absolute reference data. Especially the ratios of CDT and HPT in the orofacial region were consistently larger than the ratio 1 unlikely those of WDT and CPT.

Table 1. Analysis of side differences for thermal QST parameters in the orofacial region

Site	Thermal QST parameters		Paired t test (*P*-value)	Correlation (*P*-value)
Mentum	CDT_L	CDT_R	0.927	0.665 (P=0.002)
	WDT_L	WDT_R	0.499	0.448 (p=0.054)
	CPT_L	CPT_R	0.364	0.369 (P=0.120)
	HPT_L	HPT_R	0.547	0.942 (P<0.001)
Lower Lip	CDT_L	CDT_R	0.271	0.564 (P=0.012)
	WDT_L	WDT_R	0.168	0.921 (P<0.001)
	CPT_L	CPT_R	0.275	0.934 (P<0.001)
	HPT_L	HPT_R	0.063	0.918 (P=0.001)
Tongue tip	CDT_L	CDT_R	0.957	0.421 (P=0.073)
	WDT_L	WDT_R	0.906	0.414 (P=0.078)
	CPT_L	CPT_R	0.140	0.863 (P<0.001)
	HPT_L	HPT_R	0.755	0.943 (P<0.001)
Cheek	CDT_L	CDT_R	0.398	0.600 (P=0.007)
	WDT_L	WDT_R	0.253	0.730 (P<0.001)
	CPT_L	CPT_R	0.194	0.865 (P<0.001)
	HPT_L	HPT_R	0.474	0.935 (P<0.001)
Forehead	CDT_L	CDT_R	0.418	0.617 (P=0.005)
	WDT_L	WDT_R	0.154	0.403 (P=0.087)
	CPT_L	CPT_R	0.151	0.940 (P<0.001)
	HPT_L	HPT_R	0.349	0.801 (P<0.001)

L means left side
R means right side
Pearson's correlation coefficient was calculated for the comparison of side differences

Table 2. Sensitivity of absolute vs. relative thermal thresholds data in the orofacial regions

Thermal QST parameters	Mentum			Lower lip			Tongue tip			Cheek			Forehead		
	SDabs	SDrel	Ratio	SDabs	SDrel	Ratio	SDabs	SDrel	Ratio	SDabs	SDrel	Ratio	SDabs	SDrel	Ratio
CDT	0.328	0.178	**1.845[a]**	0.280	0.233	**1.202**	0.930	0.884	**1.051**	0.361	0.276	**1.307[a]**	0.788	0.570	**1.383[a]**
WDT	0.658	0.485	**1.356[a]**	0.558	0.168	**3.324[a]**	1.093	1.334	**0.820[b]**	0.812	0.449	**1.808[a]**	1.985	1.549	**1.281**
CPT	18.120	27.734	**0.653[b]**	11.002	3.122	**3.525[a]**	9.253	4.485	**2.063[a]**	12.012	5.808	**2.068[a]**	12.599	3.665	**3.438[a]**
HPT	3.696	0.806	**4.586[a]**	3.158	1.186	**2.663[a]**	2.646	0.723	**3.663[a]**	4.340	1.133	**3.830[a]**	3.429	1.571	**2.182[a]**

SDabs indicates mean standard deviation of absolute data as average values of right and lef values.
SDrel indicates mean standard deviation of right-left difference.
Sensitivity in detection sensory abnormality for relative over absolute reference values wa calculated as the ratio SDabs/SDrel.
[a] clinically relevant gain over 30%
[b] no gain in sensitivity with ratio under 1.00

Ⅳ. Discussion

The primary goal of QST analysis is to evaluate whether the sensory function has changed. In the absence of normal value before sensory change, the clinician must use a comparative value. There are two approaches for comparison of evaluation of nerve function. First normative absolute values from other healthy populations can be used for comparison due to its efficiency, requiring test only in the affected side.[6] However, they show large standard deviations for the each thermal QST parameters. In consistent with that, most of standard deviations of absolute values in our data were larger than that of relative values. These findings suggest that left- right side comparisons may be more sensitive to detect sensory abnormality such as negative or positive signs than comparisons with the averaged normal values in the population (absolute reference data).

In addition, absolute values exhibit some limitations on identifying hyperesthesia and hypoalgesia. In the current study, Most of correlations between the left and right side data were highly significant with no side difference. Also we found a substantially higher sensitivity of relative than absolute QST thermotest with the comparison of ratios standard deviation of absolute data divided by standard deviation of relative data, i.e. most of the comparisons between absolute reference data and relative reference data indicated the gain in sensitivity for relative values over absolute values except CPT in the mentum and WDT in the tongue tip in the orofacial region. This finding is consistent with the previous report of the German Research Network on Neuropathic Pain (DFNS)[12] and supports validity of priority of relative reference data on absolute reference data. Thus in patients with unilateral sensory change, relative reference data will be advantageous to detect minus or plus sensory changes in the clinics. In addition to gain in sensitivity, relative reference data is relatively free to influential factors on thermal thresholds values, such as sex, age on the contrary to absolute reference data.[2,6,9,13-15] However in the assessment of bilateral sensory abnormalities, relative QST data has no advantages and absolute reference data should be compared the affected region. In this study, we found an interesting fact that especially the ratios of CDT and HPT in the orofacial region showed more gain in sensitivity than those of WDT and CPT. Such finding represent thermal QST parameters such as CDT and HPT has more advantages for detecting negative or positive sensory changes using relative reference data. However, in consideration of our small sample size (n=19), our results deserve further study with more statistical powered sample size.

Ⅴ. Conclusion

The current study has shown that the use of relative reference data in the evaluation of patients with sensory abnormality has the validity and gain in sensitivity in the orofacial region. Most of the relative values in the orofacial region presented the gain in sensitivity to the absolute values in the range of ratio from 1.051 to 4.586. Especially among 4 thermal QST parameters, the use of relative reference data in CDT and HPT has more sensitivity in detecting negative or positive sensory change.

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국문초록

젊은 한국 여성의 구강안면영역에서 절대적 온도역치와 상대적 온도역치간의 비교

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김 기 석

신경손상과 관련된 감각이상의 평가 시 정량적 감각 신경검사법 중의 하나인 열역치검사법을 사용하며 환자의 열 자극에 대한 역치 값은 건강한 집단을 대상으로 하여 얻은 정상치 (절대값)와 비교하거나 손상부와 대응되는 비이환측에서 측정한 값 (상대값)과 좌우 비교를 통해 정상여부를 판단한다. 기존의 문헌들을 통해 상대값을 이용한 좌우비교가 집단의 절대값을 이용한 방법보다 감각신경의 이상을 판단하는데 더 효율적이라고 알려져 있지만 구강안면부에서 절대값에 대해 상대값이 갖는 효율성 여부와 그 정도에 대한 연구가 부족하기에 이번 연구를 통해 구강안면부에서 상대값의 타당도를 평가하고 절대값과 효율성을 비교하고자 하였다. 19명의 건강한 성인여성을 대상으로 이마, 뺨, 이부, 하순, 혀의 양측에 정량적 온도역치검사를 시행하여 상대값과 절대값에 대한 평균과 표준편차를 계산하였다. 연구를 통해 각 구강안면부에서 상대값을 이용한 좌우비교 시 유의한 차이가 없었으며 대부분 유의한 상관관계를 보였으며 절대값을 이용한 방법에 비해 최대 4.6배 작은 표준편차를 보였다.

결론적으로 구강안면부에서 상대값을 이용한 정량적 온도역치검사법은 타당도가 있으며 절대값을 이용한 방법에 비해 감각신경의 이상을 판단하는데 유리하다고 볼 수 있다.

주제어: 구강안면, 상대값, 온도역치, 절대값, 정량적 감각신경검사