Reliability of Mechanical Sensitivity Mapping in the Orofacial Region of Healthy Chinese Individuals: Towards Standardized Assessment of Somatosensory Function

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Aims: To investigate the test-retest reliability of mechanical sensitivity mapping in the masseter and temporomandibular joint (TMJ) regions between sessions, days, and examiners with a fixed and standardized pressure stimulus, as well as to compare mechanical sensitivity between sides and sites. Methods: A total of 20 healthy young volunteers participated. Pressure stimulation was applied to 15 sites in the masseter region with a Palpeter device of 1.0-kg force and to 9 sites in the TMJ region with a Palpeter of 0.5-kg force. All participants were tested twice in two separate sessions on the same day by Examiner 1 with an interval of 3 hours between tests. After 1 week, the protocol was repeated in the same manner in two separate sessions by Examiner 1 and Examiner 2 (one session each). Results: Analysis of variance (ANOVA) of numeric rating scale (NRS) scores and center of gravity (COG) values in both regions showed no significant main effects of examiner, day, or session (P ≥ .167). The test-retest reliability of data implied excellent agreement (intra-class correlation coefficients all > 0.75) between different examiners, days, and sessions. In addition, the ANOVA of the mean NRS scores in both regions showed significant main effects of site (P = .001). Conclusion: This feasible and reliable technique may provide a new tool for comprehensive evaluation of mechanical allodynia and hyperalgesia in the orofacial region, which are common features related to temporomandibular disorders and other chronic craniofacial pain conditions. J Oral Facial Pain Headache 2018;32:400–408. doi: 10.11607/ofph.2137

Keywords: mechanical sensitivity mapping, numeric rating scale, palpometer, reliability, trigeminal pain physiology

Temporomandibular disorders (TMD) are a group of conditions that stem from musculoskeletal structures of the masticatory system and are reported to affect approximately 6% to 12% of the population.1 It has been found that pain associated with TMD affects approximately 10% of the adult population.2 In fact, pain involving masticatory muscles, temporomandibular joints (TMJs), or both is the next most common complaint reported by TMD patients in dental clinics.3 Although TMD are common disorders, an accurate diagnosis can be difficult. The variation in pain location reported by patients and uneven distributions of hypersensitivity within the same masticatory muscle or within the TMJ region, or even across muscles, may contribute to less than optimal management in patients.

In order to provide a comprehensive description of somatosensory changes in the TMJ region and masticatory muscles in pain-related TMD conditions, a battery of sensitive and reproducible psychophysical techniques is required. A standardized quantitative sensory testing (QST) protocol developed by the German Research Network on Neuropathic Pain (DFNS) has been demonstrated to have good reliability in the orofacial region and upper and lower limbs.4–6 It was also concluded that inter- and intra-examiner reliabilities of most QST measurements are acceptable for evaluation of somatosensory function in the orofacial area.5 The sensitivity and reproducibility of a selected
QST battery in terms of spatial changes in somatosensory function in the midface after an infraorbital nerve block have been demonstrated to be sufficient by a previous test-retest study.7

Although the utility of QST in assessing somatosensory function in the orofacial region has been shown, these sophisticated and instrumentation-heavy techniques are not easily transferred to clinical practice owing to low availability, intricate calibration issues, and need for electrical power. Furthermore, the application of a pressure algometer for pressure pain threshold (PPT) mapping is much more time-consuming than manual palpation in clinical examination. While the reliability of manual palpation techniques applied to masticatory muscles and TMJs has been stated to be “adequate” in several preceding studies,8–10 the need for new techniques with both satisfactory reliability and low complexity is apparent. A quantitative palpometer that is easy to use with low costs has been affirmed as proper for standardization of palpation pressure during clinical examinations for pain-related TMD and is indicated beneficial for decreasing variability in clinical diagnosis and management.11 Nevertheless, it has not been tested whether this quantitative palpometer, as a standardized mechanical device, can be used to assess spatial aspects of mechanical sensitivity—for example, by testing multiple sites across the boundary of the masseter or TMJ region. Therefore, the aim of this study was to investigate the test-retest reliability of mechanical sensitivity mapping in the bilateral superficial masseter and TMJ regions between sessions of mechanical sensitivity mapping in the bilateral superficial masseter and TMJ regions. An additional aim was to compare mechanical sensitivity between sides and sites.

Materials and Methods

Study Participants

This study was conducted in accordance with the guidelines set forth in the Declaration of Helsinki II,12 and informed consent was obtained from all participants prior to the start of the experiment. The study was approved by the Nanjing Medical University Research Ethics Committee (PJ 2017-041-001). Twenty young adults (10 men and 10 women; mean age ± standard deviation [SD]: 25.1 ± 0.3 years; range: 24–27 years) were recruited from among students and faculty members of Nanjing Medical University. Medical and dental histories were collected from each participant, and simple physical examinations of the orofacial region were performed in order to confirm that all participants met the criteria.

Inclusion criteria were: good health with no orofacial pain complaints and no signs or symptoms of pain in the head, face, and neck regions. Exclusion criteria were: history of trauma in the orofacial area that interfered with normal somatosensory function; any acute or chronic orofacial diseases (eg, burning mouth syndrome, trigeminal neuralgia, chronic headache, systemic musculoskeletal pain disorders such as fibromyalgia or symptoms of rheumatoid arthritis, etc); use of medication such as muscle relaxants, anticonvulsants, antidepressants, or anxiolytics within the last month; present use of caffeine or alcohol within 24 hours of the day of the test; and/or severe systematic diseases or mental disorders.

Palpometer

A quantitative mechanical algometer (Palpeter, Sunstar Suisse SA) was used for standardized palpation in the bilateral superficial masseter areas and TMJ regions. The palpometer consisted of a circular metal rod (like a cylindrical stamp) and a plastic cylindrical shell in which there was a stainless steel spring in contact with the circular metal rod. The circular metal rod was 10 mm in diameter and made of aluminum.11 There was a hole at the other end of the palpometer to let the stamp-tapering end pass through. As soon as the examiner felt the tapering end on their finger, it corresponded to a pressure force of 0.5 or 1.0 kg. During this experiment, a palpometer with 1.0-kg force was used in the masseter region and a palpometer with 0.5-kg force in the TMJ region in accordance with the Diagnostic Criteria for TMD (DC/TMD) guidelines for manual palpation.13 The palpometer was held perpendicularly to the surface skin of the participants with the examiner’s thumb and middle finger. The examiner would detect the tapering end with the index finger as the correct force was applied. It has previously been demonstrated that these palpometers have low test-retest variability and may assist in providing a more precise and reproducible pressure stimulus than manual palpation.11

Experimental Protocol

In order to investigate the test-retest reliability between sessions of mechanical sensitivity mapping in the superficial masseter and TMJ regions by use of this quantitative palpometer, the superficial masseter was divided into 3 × 5 grids and the TMJ region into 3 × 3 grids (Figs 1a and 1b). The palpometer with 1.0-kg pressure force was applied to each of the 15 grids (masseter), and the palpometer with 0.5-kg pressure force was applied to the 9 grids (TMJ) in a randomized order.13 All test sites were stimulated for approximately 2 seconds during each measurement. After each measurement, there was a 10-second interval for the participant to rate the perceived intensity of the stimulus on a 0–100 numeric rating scale (NRS) on which 0 meant no sensation, 50 a sensation that was just barely painful, and 100 the most
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The superficial masseter was evenly divided into $3 \times 5$ grids. Point A = intersection point between the superior margin and posterior margin of the superficial masseter. (b) TMJ region with hinge axis point as the center (on average 13 mm in front of the middle of the tragus) was evenly divided into $3 \times 3$ grids. (c) A quantitative mechanical palpometer with 1.0-kg pressure force was applied to the 15 masseter grids and a palpometer with 0.5-kg pressure force was applied to the 9 TMJ grids.

**Fig 1** (a) The superficial masseter was evenly divided into $3 \times 5$ grids. Point A = intersection point between the superior margin and posterior margin of the superficial masseter. (b) TMJ region with hinge axis point as the center (on average 13 mm in front of the middle of the tragus) was evenly divided into $3 \times 3$ grids. (c) A quantitative mechanical palpometer with 1.0-kg pressure force was applied to the 15 masseter grids and a palpometer with 0.5-kg pressure force was applied to the 9 TMJ grids.

**Fig 2** Overview of study design.

Examiner 1
Session 1

Examiner 2
Session 1

1-wk interval

3-h interval
same day

Examiner 1
Session 2

Examiner 2
Session 2

3-h interval
same day

In order to minimize the error during the operation, a personalized hard board with 15 holes was fabricated as a customized template to identify the test regions according to the size and shape of the masseter prior to the test. The 15 points were marked on the skin of the masseter region with a marker pen in accordance with the personalized template (Fig 1c). The distance between point A (Fig 1a) and the midpoint of the tragus was recorded after the first session on the first day to confirm that the template was in the same position each trial. A standard template with nine holes was manufactured to identify the TMJ test sites, which were defined as a square region with the hinge axis point at its center, on average 13 mm in front of the middle of the tragus. The side of the square was 30 mm, corresponding to three times the size of the palpometer probe.

The entire experiment included four parts. All participants were tested twice in two separate sessions on the same day with an interval of 3 hours between sessions by Examiner 1 (Z.T.) for intra-examiner reliability assessment. After 1 week, Examiner 1 and Examiner 2 (Y.C.) repeated the protocol in exactly the same manner in two separate sessions (one session per examiner) for each participant in one day to determine inter-examiner reliability (Fig 2).16
Before the tests, all participants were informed about the aim of the experiment and were informed to rate the perceived pressure or pain according to the NRS. During the procedure, the participants were seated in a supine position with the head stabilized in a dental chair. The participants were asked to focus their attention on the test stimulus without any disturbance. The tests were performed in a quiet and temperature-controlled room.

Statistical Analyses
All data were tested for normality distribution before further statistical analysis. Intra-class correlation coefficients (ICCs) and 95% confidence intervals (CIs) were presented to analyze the consistency of the NRS values over sessions, days, and examiners. ICC is considered to be the most effective technique to estimate the test-retest reliability of data. ICC is equal to the individual variation divided by the total variation, which means the value of an ICC is between 0 and 1. An ICC of less than 0.4 represents a poor agreement, an ICC of 0.4–0.59 fair agreement, an ICC of 0.6–0.75 good agreement, and an ICC > 0.75 excellent agreement.17

Three-way analysis of variance (ANOVA) was used to test for differences in mean NRS scores over sessions, days, and examiners. Session reliability was obtained through trials accomplished by Examiner 1 on the same day. Day reliability was attained through trials completed by Examiner 1 on separate days. Differences between outcomes achieved by Examiner 1 and Examiner 2 were computed to present inter-examiner reproducibility. The mean values and standard errors (SEs) of all NRS values at every test site in the four trials were calculated. Two-way ANOVA for repeated measurements (RM) was used to test differences in NRS scores with the following factors: side (2 levels) and test site (15 levels for masseter region and 9 levels for TMJ region). The scores at the most sensitive site and the least sensitive site are presented as mean ± standard error of the mean (SEM).

The center of gravity (COG) was calculated according to the technique used in assessment of cortical mappings of motor-evoked potentials.18 The COG coordinates \( x = \text{anterior-posterior direction} \) and \( y = \text{cervical-apical direction} \) (Fig 3) were defined as: \( \Sigma x^* \text{grid value} / \Sigma \text{grid value} \); \( \Sigma y^* \text{grid value} / \Sigma \text{grid value} \). The NRS scores were used as grid values. Three-way ANOVA was used to compare the COG values over sessions, days, and examiners.

Shannon Entropy,19–21 which can show the complexity and diversity of a mechanical sensitivity map, was calculated as well. Three-way ANOVA was used to compare the entropy values over sessions, days, and examiners.

Data Availability Statement
Statistical package for Social Sciences version 19 (SPSS, IBM) was used. The data sets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Results
This study was carried out from February 1, 2017 to May 30, 2017. All NRS scores obtained from 20 healthy volunteers for pressure stimuli varied from 10 to 48 (nonpainful range) in the masseter region and from 3 to 35 (nonpainful range) in the TMJ region.

Effect of Day, Session, and Examiner
The ANOVA of NRS scores in both the masseter and TMJ regions showed no significant main effects of different examiners, days, or sessions (\( P \geq .266 \)) (Tables 1 and 2). ANOVA of COG in the masseter region and TMJ region also showed no significant differences between examiners, days, or sessions (\( P \geq .167 \)) (Table 3) for either region, nor did ANOVA for entropy (\( P \geq .166 \)) (Table 4).
Table 1: Analysis of Variance Results (F estimates and P values) of Within- and Between-Participant Effects for 0–100 Numeric Rating Scale (NRS) Scores of Mechanical Stimuli in Bilateral Masseter Region over Different Sessions, Days, and Examiners

<table>
<thead>
<tr>
<th>Examiner Day Session</th>
<th>Side/site</th>
<th>F</th>
<th>P</th>
<th>F</th>
<th>P</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1, 1)</td>
<td></td>
<td>0.042</td>
<td>0.839</td>
<td>0.472</td>
<td>0.494</td>
<td>0.133</td>
<td>0.716</td>
</tr>
<tr>
<td>(2, 1)</td>
<td></td>
<td>0.790</td>
<td>0.377</td>
<td>1.482</td>
<td>0.227</td>
<td>1.141</td>
<td>0.289</td>
</tr>
<tr>
<td>(3, 1)</td>
<td></td>
<td>0.186</td>
<td>0.668</td>
<td>0.905</td>
<td>0.344</td>
<td>0.186</td>
<td>0.668</td>
</tr>
<tr>
<td>(1, 2)</td>
<td></td>
<td>0.059</td>
<td>0.809</td>
<td>1.043</td>
<td>0.310</td>
<td>0.310</td>
<td>0.579</td>
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<tr>
<td>(2, 2)</td>
<td></td>
<td>0.205</td>
<td>0.652</td>
<td>1.001</td>
<td>0.320</td>
<td>0.420</td>
<td>0.519</td>
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<tr>
<td>(3, 2)</td>
<td></td>
<td>0.022</td>
<td>0.881</td>
<td>0.733</td>
<td>0.395</td>
<td>0.129</td>
<td>0.721</td>
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<tr>
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<td></td>
<td>0.080</td>
<td>0.778</td>
<td>0.929</td>
<td>0.338</td>
<td>0.248</td>
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<tr>
<td>(2, 3)</td>
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<td>0.083</td>
<td>0.774</td>
<td>0.906</td>
<td>0.344</td>
<td>0.530</td>
<td>0.469</td>
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<tr>
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<td>0.019</td>
<td>0.892</td>
<td>1.380</td>
<td>0.244</td>
<td>0.291</td>
<td>0.591</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>(1, 1)</td>
<td></td>
<td>0.008</td>
<td>0.928</td>
<td>0.521</td>
<td>0.473</td>
<td>0.002</td>
<td>0.964</td>
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<td></td>
<td>0.225</td>
<td>0.637</td>
<td>1.002</td>
<td>0.320</td>
<td>0.340</td>
<td>0.562</td>
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<tr>
<td>(3, 1)</td>
<td></td>
<td>0.073</td>
<td>0.788</td>
<td>0.889</td>
<td>0.349</td>
<td>0.356</td>
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<tr>
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<td>0.052</td>
<td>0.820</td>
<td>0.450</td>
<td>0.504</td>
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<td>0.141</td>
<td>0.708</td>
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<td>0.294</td>
<td>0.588</td>
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<tr>
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<td></td>
<td>0.011</td>
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<td>0.679</td>
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<tr>
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<td>0.396</td>
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<td>0.281</td>
<td>0.598</td>
</tr>
<tr>
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<td></td>
<td>0.002</td>
<td>0.962</td>
<td>0.110</td>
<td>0.741</td>
<td>0.099</td>
<td>0.754</td>
</tr>
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</table>

Reliability Findings
The ICC values and 95% CIs of all NRS values are listed in Table 5 (masseter region) and Table 6 (TMJ region) for different examiners, days, and sessions. All ICC values were above 0.75 between different examiners (ICC masseter: 0.818–0.968; ICC TMJ: 0.858–0.961), days (ICC masseter: 0.848–0.965; ICC TMJ: 0.848–0.979), and sessions (ICC masseter: 0.818–0.968, ICC TMJ: 0.858–0.961).
The main finding of the present study was that mechanical sensitivity mapping of the masseter and TMJ regions can be performed with the application of a quantitative palpmeter. The results suggest that this technique provides excellent test-retest reliability in healthy Chinese individuals in a laboratory scenario and may imply that the protocol is reproducible and valuable for utility in future research on painful TMD and clinical examination of various orofacial pain conditions.

**Effect of Side and Site**

The mean NRS values of four tests were calculated. The ANOVA of the mean NRS scores in the masseter and TMJ regions showed no significant main effects of side. However, there were significant main effects of in both the masseter region and TMJ region (Table 7). In the masseter region, the minimum mean NRS value (lowest sensitivity) was 24.7 ± 0.9 at site (x, y) = (1, 3), and the maximum mean NRS value (highest sensitivity) was 29.7 ± 1.1 at site (x, y) = (3, 1). In the TMJ region, the minimum mean NRS value (lowest sensitivity) was 16.1 ± 0.5 at site (x, y) = (1, 1), and the maximum mean NRS value (highest sensitivity) was 17.8 ± 0.5 at site (x, y) = (3, 2).

Two-dimensional illustrations of the mean NRS values at the 15 sites in the masseter region and at the 9 sites in the TMJ region are presented in Fig 3 to show the site-to-site differences in mechanical sensitivity.

**COG and Entropy Results**

The COG coordinates in the masseter region were (x, y) = (1.98, 3.02). The COG coordinates in the TMJ region were (x, y) = (2.03, 2.00). The entropy was 1.97 in the masseter region and 2.04 in the TMJ region.

**Discussion**

The main finding of the present study was that mechanical sensitivity mapping of the masseter and TMJ regions can be performed with the application of a quantitative palpmeter. The results suggest that this technique provides excellent test-retest reliability in healthy Chinese individuals in a laboratory scenario and may imply that the protocol is reproducible and valuable for utility in future research on painful TMD and clinical examination of various orofacial pain conditions.
Standardization of Mechanical Stimulus for QST

Manual palpation has been used as an effective and easy way for assessment of deep pain sensitivity in masticatory muscles and in the TMJ region in patients with TMD or other musculoskeletal pain conditions. Nevertheless, many uncontrolled factors can affect the accuracy of manual palpation; for example, examiner expectations, training, and psychological state. PPTs have been demonstrated to be useful aids for evaluating mechanical pain sensitivity in the masseter muscles and TMJ region. Many different electronic algometers have been manufactured for measurement of PPTs in deep tissues. Most of these algometers require a power supply, coordinated software, calibration, and systematic training for examiners and are sophisticated to operate. Although some less complicated devices—such as a simple pressure algometer for palpation and a finger-tip adjustable palpometer—were invented to assess deep pain sensitivity, these techniques still have not adequately solved the problems mentioned above. The advantages of the present novel palpometer are that it is small, light, and has no need for a power supply and coordinated software, which means it is easier to transfer to clinical practice and much cheaper than electronic pressure algometers. Indeed, it has been demonstrated that this new palpometer has a low test-retest variability and provides a more precise and reproducible pressure stimulus than manual palpation. Moreover, compared to manual palpation, the standardized palpometer makes it easier to create a map of mechanical sensitivity, which is considered to present more (spatial) details in patients complaining of pain.

Individual Templates and Mapping

Several studies on the assessment of orofacial somatosensory sensitivity have been carried out at anatomical landmarks using a pen to define the area of investigation. Obviously, it is difficult to reproduce the exact same position and area of investigation in test-retest studies. To minimize the error between the two trials in the present study, an individual template was manufactured in accordance with the area of the superficial masseter muscle. The distance between point A (Fig 1a) and the midpoint of the tragus was recorded after the first session on the first day so as to confirm the template was, indeed, in the same position in each trial. However, individual templates for the TMJ region were not made due to the smaller size of that region. Six sites in the masseter muscle and two sites in the TMJ region were tested in previous studies. Mechanical sensitivity mapping was chosen to be carried out because mapping is considered a pivotal approach to a comprehensive survey of the somatosensory system pathology and can provide an overall description of changes in somatosensory function with time or sensitivity variations among test sites. The ANOVA of mean NRS scores in the masseter region showed significant main effects of site, which indicated that mechanical sensitivity is non-uniformly distributed over the entire masseter. The midpoint of the anterior border of the masseter was the most sensitive site. The mean NRS value in the masseter region showed an anterior to posterior decreased inclination, and muscle belly locations of the masseter were more sensitive than musculotendinous junction sites in the healthy participants. It has been reported that muscle belly locations of the upper trapezius muscle are more sensitive to pressure pain than musculotendinous junction sites. This may in part explain the greater sensitivity in the midpoint of the anterior border of the masseter in this study. In addition, the anterior border of the masseter muscle is also the anterior border of the mandibular ramus, which is located behind the buccal pad and at the junction of the soft and hard tissue. In contrast, the posterior part of the masseter muscle is located on the mandibular ramus, which means it is totally supported by hard tissue. It could be speculated that differences in anatomical structures lead to differences in mechanical muscle sensitivity. The midpoint of the posterior border of the TMJ region was the most sensitive site, which corresponds to the bilaminar zone of the TMJ region. The bilaminar zone of the TMJ is full of loose connective tissue with nerves and vessels and is traditionally regarded as a sensitive zone in the TMJ region. In a study by Chung et al, it was also observed that the PPT value in the posterior TMJ site was lower than that in the lateral TMJ site in healthy individuals. In addition, the NRS maps showed a posterior to anterior decrease in sensitivity in the TMJ region. The range of sensitivity within the masseter was 5.0 (24.7–29.7); for the sites overlying the TMJ, the range was much smaller. This difference in range could be due to the lower pressure applied to the TMJ region. Differences in anatomy could also contribute to the difference in mechanical sensitivity.

<table>
<thead>
<tr>
<th>Region</th>
<th>Masseter</th>
<th>TMJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site</td>
<td>F</td>
<td>P</td>
</tr>
<tr>
<td>Side</td>
<td>1.990</td>
<td>.175</td>
</tr>
<tr>
<td>Site</td>
<td>8.835</td>
<td>.001</td>
</tr>
<tr>
<td>Side*Site</td>
<td>1.425</td>
<td>.215</td>
</tr>
</tbody>
</table>

Table 7 Results of Analysis of Variance (F estimates and P values) of Side and Site Effects for 0–100 Numeric Rating Scale (NRS) Scores for Mechanical Stimuli in Masseter and TMJ Regions
It should be noted that the range between the most and the least sensitive sites in a given region only captures part of the spatial diversity in mechanical sensitivity. Recently, it has been proposed that entropy could be a useful measure to quantify the spatial diversity of pain sensitivity in a region. The entropy scores in the present study were quite similar between the masseter (1.97) and TMJ (2.04) regions, suggesting that the spatial variation in pain sensitivity is relatively homogenous in healthy individuals. Future studies should measure entropy scores in the masseter and TMJ regions of patients with painful TMD to gain a better understanding of the spatial variation in deep pain sensitivity. The present study demonstrated that the entropy scores in the masseter and TMJ regions showed no significant differences between examiners, days, or sessions, suggesting that this particular measure of spatial variation could be useful in clinical follow-up studies.

**Study Limitations**

It should be recognized that the present study was performed using a relatively small sample size of healthy volunteers, which does not allow for evaluation of a possible gender difference in mechanical sensitivity. Further studies with larger sample sizes should be performed to reconfirm the present conclusion and investigate a possible gender difference. In terms of rating scales, 50 was the critical point for pain in the 0–100 NRS used in this experiment. Although the reproducibility of the NRS in general has been confirmed, it has been noted that a reference value (50) used in the rating scale may have further improved the reliability of experiments. Nevertheless, the rating scale was chosen in this experiment because it could encompass both nonpainful (< 50) and painful (≥ 50) mechanical sensations in one scale. Furthermore, the 0.5-kg and 1.0-kg stimuli applied with the palpometer in the present study were nonpainful for all participants. Higher-intensity forces (for example, 1.0 kg for the TMJ region) should be considered in test-retest reliability studies in the future. However, there are no reasons to anticipate a different outcome for painful mechanical sensitivity. The 0.5-kg and 1.0-kg force values were chosen in accordance with the DC/TMD guidelines, and the present findings as such illustrate that these forces are not painful for healthy individuals without TMD pain.

The long-time stability of the new palpometer is unknown, but it can be appropriately calibrated by means of an electronic scale (0–5 kg, accuracy ± 5 g). Although it has no control over the rate of force application, it seems unlikely that variation in rate of force application had a big impact on the results, as participants were simply instructed to achieve the required force in 2 seconds in accordance with the clinical examination. The coefficient of variation (CV) values for the palpometer are, indeed, very low. Only mechanical pressure stimuli can be applied with the palpometer, which means that other tools are needed for a comprehensive assessment of somatosensory function.

In addition, only young healthy participants were involved in the present study, and no information on potential age-related effects can be deduced from the results. Finally, it will be interesting to test for differences in mechanical sensitivity mapping between healthy individuals and patients with different types of painful TMD or other orofacial pain conditions.

**Conclusions**

Excellent reliability was found for the new technique for mechanical sensitivity mapping in the masseter muscle and TMJ regions with the quantitative palpometer and simple templates. The results suggest that this new technique will be of value in prospective, longitudinal studies of patients with mechanical allodynia or hyperalgesia in the orofacial region, and it can be speculated that the technique can be a more reliable tool in clinical examination of idiopathic orofacial pain—for example, painful TMD. The validity of the technique used in patients with various orofacial pain conditions needs to be tested.

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