Comparison of Algometry and Palpation in the Recognition of Temporomandibular Disorder Pain Complaints

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Aims: *To determine the construct validity of algometry and to compare it with that of palpation, and to compare tenderness of masticatory muscle sites and the temporomandibular joint (TMJ) on palpation and on algometry.* ***Methods:*** *Two hundred fifty subjects, 148 with temporomandibular disorder (TMD) pain complaints, underwent a standardized blinded physical examination that included pain-intensity measures on palpation and pressure pain threshold measures on algometry of masseter muscle sites, temporalis muscle sites, and the TMJ.* ***Results:*** *Logistic regression analysis indicated that the recognition of TMD pain complaints based on pressure algometry was comparable to that of palpation (R^2 = 0.22 and R^2 = 0.21, respectively). The masseter muscles were most tender to palpation and algometry, followed by the TMJs and the temporalis muscles.* ***Conclusion:*** *Construct validity of algometry in the recognition of TMD pain complaints is comparable to that of palpation, and differences in tenderness on palpation and on algometry are found between masticatory muscle sites and the TMJ.* J OROFAC PAIN 2004;18:214–219

Key words: algometry, construct validity, palpation, temporomandibular pain

Tenderness or pain in muscle or joint regions is the most commonly reported symptom in patients with chronic musculoskeletal disorders.[1–4] In general clinical practice, a physical examination is usually performed to confirm whether a patient's complaints originate from the musculoskeletal structures. To that end, a wide variety of clinical tests, such as active movements, palpation, and function tests, have been suggested.[5–7] For the recognition of temporomandibular disorders (TMD), the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) are commonly applied.[5] These criteria recommend a standardized examination method that leads to the classification of patients into 1 or more subgroups of TMD. The results of palpation tests play a dominant role in the classification of patients with TMD pain.

In a previous study, the ability of several clinical tests to recognize TMD pain complaints was compared. It was shown that palpation only moderately discriminated between patients with TMD pain complaints and controls.[6] This is probably a reflection of the

finding that tenderness to palpation is quite common in the general population.[6,8,9] Other complicating factors in the use of palpation are that it is difficult to control for the pressure applied[10] and that various anatomic structures show differences in tenderness to palpation.[1,8,9]

Pressure standardization might be achieved if pressure pain threshold (PPT) measures on algometry could be used to diagnose TMD pain. As a group, TMD patients are more tender to algometry than healthy subjects,[11–13] indicating that PPT measures might be useful in the recognition of TMD pain. However, for diagnostic purposes, decisions regarding the presence of a disorder are made on an individual level, and more detailed information about these tests, such as sensitivity and specificity levels, is needed. Such information is preferably obtained by comparing the results of clinical tests to those of a "gold standard." For TMD pain, as for many other musculoskeletal disorders, a gold standard is not available. Therefore, in this study, the standard was based on logical argumentation. The first aim of the study was to determine the construct validity of algometry and to compare it with that of palpation.

The RDC/TMD acknowledge that different sites vary in their tenderness to palpation; they recommend that less palpation pressure be used for the intraoral muscles and the temporomandibular joint (TMJ) than for extraoral muscles.[5] This is supported by studies that have reported intraoral muscle sites to be more tender to palpation than extraoral muscle sites.[1,8,9,14] However, comparisons with the TMJ have not been described yet. Therefore, the second aim of the study was to compare tenderness of the masticatory muscle sites and the TMJ on palpation and on algometry.

Materials and Methods

Subjects

Two hundred fifty people (179 women and 71 men, mean age 34 (13.3 years) participated in this study. One hundred forty-seven subjects were consecutively recruited from persons referred to the Academic Centre for Dentistry Amsterdam (ACTA) for TMD complaints and 103 subjects were friends or relatives of the recruited persons or friends or relatives of coworkers from the department of Oral Function of ACTA. At intake, a general medical history was taken and a dental examination was performed to evaluate subjects for the following exclusion criteria: the presence of general joint disorders that might involve the head or neck region (eg, rheumatoid arthritis), the presence of orofacial pain complaints likely to originate from other structures than the masticatory muscles or TMJs (eg, dental pain, trigeminal neuralgia, or parodontitis), a history of jaw fractures or orthognathic surgery, or active treatment for TMD. A good understanding of the Dutch language was considered an inclusion criterion. The scientific and ethical aspects of the protocol were reviewed and approved by the review board of the Netherlands Institute for Dental Sciences, and written informed consent was obtained from all subjects.

Examination

This study was part of an investigation of temporomandibular and cervical spinal pain and consisted of a standardized oral history and a (blindly performed) physical examination of the masticatory system and of the neck. Since for this paper only the results of the examination of the masticatory system are used, this part is explained in more detail. The complete protocol has been described earlier.[6]

Oral History. The oral history was always taken by the same examiner (CV) and included questions on pain in the orofacial region. When pain was present, its location, nature, duration, and radiation were determined. Moreover, aggravation of pain on function of the masticatory system was noted.

After the history taking, the subject was instructed on the use of a visual analog scale (VAS). The VAS consisted of a 100-mm line with endpoints defined as "no pain" (left) and "worst pain imaginable" (right).[15] The subjects were asked to mark pain intensity with a pencil on this line. Pain intensity was then expressed as the distance in millimeters from the left endpoint to the pencil mark. Moreover, instructions regarding the blind aspect of the study were given.

Physical Examination. The physical examination was performed by 1 of 3 trained dentists who did not know whether the subject suffered from TMD complaints. The examiners were retrained on a regular basis. The examination included, in a random order, palpation tests and pressure algometry. During these tests, the subject was seated in an upright position and was asked to relax the muscles with the teeth apart. The subject's head was supported by a headrest.

Palpation was performed using the index and middle finger, at a force of approximately 10 N, as estimated from a weight scale. The sites tested

were the lateral pole of the temporomandibular condyle; the anterior, middle, and posterior parts of the temporalis muscle; the origin, muscle belly, and insertion of the masseter muscle (palpated with 1 finger placed intraorally and 2 fingers of the other hand placed extraorally); and the deep part of the masseter muscle (palpated extraorally). After each palpation test, the subject was asked to rate the pain intensity on the VAS.

A pressure algometer (Pain Diagnostics and Thermography) was used to determine the PPT of the same test sites, which were tested in the same order described for palpation. The area of the algometer tip was 1 cm^2 and the application rate approximately 2 $kg/cm^2/s$. The operator learned to apply pressure at a controlled rate using a stopwatch. Before the examination, the procedure was demonstrated on the investigator's hand, and a practice trial was performed on the subject's forehead. At the PPT, defined as the point at which a sensation of pressure changes into pain, the subject signaled the operator, the algometer was removed, and the PPT was noted.

Classification of TMD Pain Complaints

Two investigators who were blind to the outcome of the physical examination evaluated the oral histories and independently determined whether or not persons had temporomandibular pain complaints. The criterion for temporomandibular pain complaints was the presence of pain or tenderness in the area of the masticatory muscles, the preauricular area, or the TMJ area during the previous month (n = 148, 118 women and 30 men, mean age ± SD 33.8 (12.5 years). The other subjects did not report pain complaints and were classified as not suffering from temporomandibular pain (n = 102, 61 women and 41 men, 35.2 (14.4 years). The investigators initially disagreed on 2 persons. After discussing the oral histories, they came to an agreement. In the end, 5 persons recruited from the TMD clinic were placed in the pain-free group, and 6 persons recruited from friends and relatives were placed in the group with TMD pain complaints.

Statistical Analysis

Construct Validity. Construct validity is the degree to which a useful interpretation (based on logical argumentation) can be inferred from a measurement.[16] To this end, the ability of algometry to discriminate between persons with or without TMD pain complaints was determined. For each individual, the lowest PPT of all 16 test sites was used as a predictor in a single logistic regression analysis. Age and gender were included as covariates. The Nagelkerke R^2 result of this logistic regression was used as an indicator of the proportion of explained variance, and sensitivity and specificity were determined. In agreement with the earlier study on this topic,[6] that cutoff value was chosen for which the sensitivity and specificity were as similar as possible.

Comparison Between Muscle and Joint Sites. For palpation and for algometry, a repeated-measures analysis of variance, with test sites and test sides (left/right) as within-subject factors and age and gender as covariates, was performed, followed by a post hoc comparison of means (Bonferroni *t* tests). To prevent bias based on an unbalanced inclusion of subgroups of TMD pain (ie, patients with mainly myogenous or arthrogenous pain), only the subjects without TMD pain complaints were included for these analyses. Levels of $P < .05$ were considered statistically significant. For all statistical analyses, SPSS 11.0 software was used.

Results

Construct Validity of Algometry

The proportion of explained variance (R^2) for PPT measures was 0.22 ($P < .001$), with a cutoff value of 1.78 kg/cm^2 and a sensitivity and specificity of 64% and 68%, respectively. No age or gender effect was found (age: $P = .573$, gender: $P = .397$). In an earlier publication, the explained variance of palpation was shown to be 0.21. At a cutoff value of 24 mm on the VAS (pain intensity reported on at least 1 of the 16 palpation tests has to exceed the cutoff value), sensitivity and specificity levels were 71% and 72%, respectively.[6]

Comparison Between Muscle and Joint Sites

Descriptive values of pain intensity on palpation and of PPTs are presented in Table 1. For palpation as well as for algometry, differences in tenderness between anatomic sites were found ($F_{palpation} = 3.15$, df = 7, $P = .005$; $F_{algometry} = 8.37$, df = 7, $P < .001$). Table 1 shows the post hoc comparisons of means, corrected for any side, age or gender effects. It shows that site differences were found within the masseter muscle and, for algometry, the temporalis muscle. Moreover, in general, the masseter muscle sites were more tender than the temporalis muscle sites, and tenderness of the TMJ was found to be in between that of the masseter

muscle sites and the temporalis muscle sites. For palpation, a side (left/right) effect (F = 14.4, df = 1, $P < .001$) and an interaction between the anatomic sites and the side of the face was found (F = 3.5, df = 7, $P = .002$): pain intensity on palpation was higher on the right side of the face, and the distribution of homogeneous groups (ie, groups with statistical equal means) was slightly different for the left and right sides (data not shown). For algometry, an interaction between the anatomic sites and age was found (F = 5.2, df = 7, $P < .001$). Subsequent analysis of variance with subgroups of age showed minor shifts in the distribution of homogeneous groups (data not shown). No other effects were found.

Table 1 Mean Values, Standard Deviations, and Post Hoc Comparison of Means of the Pain Intensities on Palpation and the PPTs on Algometry for the Pain-free Group, Corrected for Side, Age, and Gender Effects (n = 102)

	Palpation (VAS, mm)		Algometry (kg/cm^2)	
	Mean	SD	Mean	SD
Masseter				
Lower	14.5[a]	21.4	2.7[a]	0.9
Middle	9.7[a,b]	15.1	2.6*[a]	0.7
Upper	8.6[b,c]	13.4	2.9[†]	0.8
Deep	5.6[b,c,d]	13.3	3.4*[b]	0.8
TMJ	6.2[b,c,d]	12.9	3.6[b]	1.1
Temporalis				
Anterior	3.2[c,d]	8.1	4.0	1.2
Middle	2.6[d]	8.0	5.0	1.6
Posterior	2.0[d]	6.5	5.7*	1.9

Groups with the same letter (a through d) are homogeneous groups, ie, groups with statistical equal means ($P < .05$).
*n = 101.
[†]n = 100.

Discussion

This study has shown that the ability of algometry to discriminate between persons with TMD pain complaints and pain-free subjects was comparable to that of palpation, as found in an earlier study.[6] Moreover, differences in tenderness on pressure between masticatory muscle sites and the TMJ were found.

In algometry, 2 methods can be used: determination of PPTs and palpometry (application of a predetermined pressure). At present, no valid data are available on the pressure that should be applied to differentiate between TMD pain patients and healthy subjects, so the PPT method was chosen. PPT measurements are known to be influenced by the rate of pressure application, the reaction time of both the subject and the examiner as the pain arises,[17,18] and the examiner's expectancy as to whether a measurement site is painful or not.[19] To account for these factors, the examination procedures were standardized and performed by trained examiners who were blind to the subjects' complaints. In addition, the use of mean scores of several PPT measures for each test site has been advised.[11,12,18] This was not included in the protocol because the algometry measures were part of an extensive physical examination of the masticatory system and the cervical spine, and it was not considered ethical to further prolong the examination. Since the same procedure was used for all subjects, the internal validity of the PPT measurements is probably not compromised. Moreover, the PPT values of the subjects without TMD pain complaints are in line with findings in a previous study of a nonpatient group,[1] which adds support to the generalization of the results.

Studies examining the validity of clinical tests should ideally compare test results with a gold standard. Unfortunately, a gold standard is not available for musculoskeletal disorders like TMD. Therefore, the authors chose to determine the construct validity of algometry based on the degree to which a useful interpretation, based on logical argumentation, can be inferred from a measurement.[16] The "logical argumentation" was applied to the classification of TMD pain complaints. First, a dentist screened all subjects in an attempt to exclude patients with orofacial pain originating from sources other than the musculoskeletal structures, such as dental pain, trigeminal neuralgia, or parodontitis. Second, the information derived from the standardized oral history on pain complaints in the orofacial region was blindly evaluated, which resulted in the classification of subjects into either the group with TMD pain complaints or the pain-free group. Even though the possibility that some subjects were misjudged cannot be excluded, the above-described procedure is likely to guarantee a proper classification for the majority of the subjects.

The results showed that the construct validity of algometry, described in terms of explained variance, sensitivity, and specificity, was comparable to that of palpation. As mentioned in the "Materials and Methods" section, that cutoff value was chosen for which sensitivity and specificity levels were as similar as possible. The choice of a cutoff value depends on subjective considerations such as the mortality associated with a disease, clinical consequences, and costs of treatment. In this study, it was considered equally important to recognize

TMD pain patients and pain-free subjects. Farella et al[13] found somewhat higher levels of sensitivity and specificity on algometry. This is probably a reflection of differences in inclusion criteria for the TMD patient groups: In the Farella et al study, subjects were included in the patient group when their subjective pain complaints were provoked in a physical examination (including palpation tests). In the present study, several clinical tests to recognize a subject's pain complaints were compared. Therefore, to avoid circular arguments, the results of these tests could not be used as inclusion criteria.

The first part of this study indicates that replacement of palpation tests by pressure algometry does not improve the recognition of TMD pain complaints. In the second part of the study, the tenderness of masticatory muscle sites and the TMJ were compared. For these comparisons, only the results of the pain-free subjects were used. Otherwise, the data would have been influenced by the relative representation of subgroups of TMD patients (ie, patients with mainly myogenous or arthrogenous pain complaints). Table 1 shows within-muscle differences in tenderness for the masseter muscle as well as for the temporalis muscle, which is in agreement with the results of earlier studies.[1,8] Moreover, the tenderness of the TMJ was roughly in between that of the masseter muscle and the temporalis muscle. These findings confirm the suggestion of the RDC/TMD to adjust palpation pressure to location. Specifically, the RDC/TMD recommended that intraoral muscle sites and TMJs be palpated with half the pressure applied to extraoral muscle sites. The present data, however, suggest an even more refined differentiation in palpation pressure for the various extraoral muscle sites. Even though the palpation technique used was slightly different from the RDC description (viz masseter muscles were palpated by a combined intra- and extraoral technique), the algometry data confirm that the masseter muscles are more tender to pressure than the temporalis muscles. Moreover, in contrast with the RDC/TMD, the present data suggest that the masseter muscles should be palpated with less pressure than the TMJs. Future studies comparing different palpation pressures are needed to explore further the optimal palpation pressure for different locations.

Palpation results on the right side of the face were found to be higher than on the left side. For algometry, this has previously been described by Jensen et al,[9] who related it to the dominant body side of the subjects. Possible other explanations for the side effect are the fact that all examiners were right-handed and that the test sites were examined in a fixed sequence (ie, the right side of the face was examined first). Moreover, interactions with side (for palpation) and age (for algometry) were found. Although subsequent analysis showed that these interactions only had a small influence in the distribution of homogeneous groups, their presence demonstrates that palpation and algometry are sensitive for other influences than the one of interest (ie, variations in tenderness of the musculoskeletal structures).

In conclusion, the construct validity of algometry in the recognition of TMD pain complaints is comparable to that of palpation, and significant differences in tenderness on palpation and on algometry are found between masticatory muscle sites and the TMJ.

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