Intra- and Interrater Agreement of Pressure Pain Threshold for Masticatory Structures in Children Reporting Orofacial Pain Related to Temporomandibular Disorders and Symptom-free Children

Thaís Cristina Chaves, PT, MS
Graduate
Orthopedics, Traumatology and Rehabilitation Program
Department of Biomechanics, Medicine and Rehabilitation of the Locomotor Apparatus

Harumi Martins Nagamine, PT
Graduate Student
Physical Therapy Course

Letícia Melo de Sousa, PT
Graduate Student
Physical Therapy Course

Anamaria Siriani de Oliveira, PT, PhD
Professor
Department of Biomechanics, Medicine and Rehabilitation of the Locomotor Apparatus

Débora Bevilaqua Grossi, PT, PhD
Professor
Department of Biomechanics, Medicine and Rehabilitation of the Locomotor Apparatus

Ribeirão Preto School of Medicine
University of São Paulo
Ribeirão Preto, São Paulo, USP

Correspondence to:
Dr Débora Bevilaqua Grossi
Departamento de Biomecânica
Medicina e Reabilitação do Aparelho Locomotor
Faculdade de Medicina de Ribeirão Preto-Universidade de São Paulo-USP
Campus Universitário
CEP: 14049-900 Ribeirão Preto (SP) Brazil
Fax: +55 16 3633 0336
E-mail: deborabg@fmrp.usp.br

Aims: *To determine intra- and interrater agreement of the pressure pain threshold (PPT) values for children reporting orofacial pain related to temporomadibular disorders and symptom-free subjects when the mean of 3 consecutive measurements or the mean of the last 2 consecutive measurements was considered.* ***Methods:*** *Fourteen children reporting pain in masticatory muscles or the temporomandibular joint and 16 symptom-free children were selected at random from a sample of 100 children. Two trained raters used an algometer to obtain 3 consecutive measurements of PPT of the masticatory system sites. The children were evaluated in 3 sessions after a minimum period of 3 days after the initial evaluation. The intraclass correlation coefficient (ICC) was used to evaluate the levels of agreement.* ***Results:*** *Excellent intra- and interrater agreement was observed (ICC > 0.75) for most of the structures evaluated in symptom-free children, and excellent and moderate agreement was obtained for the symptomatic group. Discarding the first of the 3 measurements increased the number of sites with ICC values classified as excellent in both groups. For evaluations performed on different days, this procedure reduced significantly the percentage of sites with ICC values classified as excellent only for the interrater agreement for the symptomatic group.* ***Conclusion:*** *The lower levels of reproducibility for the measurements obtained on different days in the children who reported pain may have been related to instability of their clinical signs and symptoms, and a PPT assessment based on the mean of 3 consecutive measurements or the procedure of discarding the first measure should be considered for such evaluations, especially when they are conducted by different raters. Algometry was shown to be a reliable tool for the evaluation of pain threshold in the masticatory structures of children.* J OROFAC PAIN 2007;21: 133–142

Key words: agreement, children, orofacial pain, pain report, pressure pain threshold, temporomandibular disorders

Palpation by digital pressure (PDP) is the method most frequently used for the evaluation of muscle pain[1]; it is recommended by the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD)[2] for the evaluation of masticatory structures in order to diagnose temporomandibular disorders (TMD). However, this method is difficult to quantify and standardize.[3–5] This is mainly because this method depends on the amount of pressure applied by an examiner and also on the subjective report of pain.[6–9] Thus the reliability of PDP has been found to be only marginal.[10]

The pressure pain threshold (PPT) is defined as the lowest pressure capable of inducing pain or discomfort[5,11] and can be influenced by factors such as age,[12] sex,[12–14] and the region of the body evaluated.[3,11] In contrast to PDP, in which the pain evaluation is expressed on a nominal or ordinal scale, pressure algometry provides quantitative values.[3,5,15] In addition, the latter procedure permits control of the velocity and direction of pressure application.[5,16]

Pressure algometry has demonstrated excellent reliability levels for the evaluation of masticatory structures both in healthy individuals[7,15,17] and TMD patients.[1] Thus, algometry has been recognized as a valid technique for distinguishing TMD patients from symptom-free subjects.[6,18,19] A variety of methods used to increase reliability and validity of algometry can be found in the literature: previous training of the raters,[10] control of the velocity of pressure application,[18] and exclusion of the first 3 consecutive measurements of PPT,[20] which could be influenced by the subjects' lack of familiarity with the technique.

Only a few studies[13,21–23] have been conducted in which pain in children was evaluated by pressure algometry, especially in the masticatory muscles.[23] There appears to be only 1 study testing the reliability of PPT in children.[23] The volunteer sample consisted of adolescents aged 12 to 18 years, a fact that limits the applicability of the results to younger children.

One of the greatest challenges for investigators who study TMD is the standardization of case definition for research samples.[24] The RDC/TMD[2] is 1 of the more successful attempts in this respect, although its application to pediatric samples has seldom been reported in the literature.[23] Self-report is considered the gold standard for evaluation of pain,[25] and the criterion of orofacial pain report has been commonly used as the characteristic that defines TMD in research series.[24]

Prevalence of TMD pain in childhood reportedly ranges from 0.7% to 4%,[23,26–30] and pain is overwhelmingly the main reason people seek health care for TMD.[31] For many chronic pain conditions, adults have reported the onset of their pain condition during childhood and adolescence.[32] Considering the limitations inherent to the procedures of pain assessment, especially in the pediatric population, study of the reliability of tools is necessary before their use in research and clinical practice.[33] If the RDC/TMD could be used reliably with children, testing for alterations in the orofacial pain pattern in children could be carried out, and the relationship between these alterations and the onset of TMD could be examined.

Thus, the aim of the present study was to determine the intra- and interrater agreement of PPT values for children reporting orofacial pain related to TMD and a control sample when the mean of 3 consecutive measurements or the mean of the last 2 consecutive measurements was considered.

Materials and Methods

Subjects

One hundred children aged 7 to 12 years were picked at random from a sample of 600 children at a local public school, and an anamnestic questionnaire[34] was used to classify them according to the report of orofacial pain related to TMD. For this study, the severity of the TMD signs and symptoms reported was not measured; only a positive answer to 1 question about pain in the temporomandibular joint (TMJ) or masticatory muscles was used to classify children as with or without pain report. Positive answers to the other questions about pain during mastication, headache, and cervical pain were considered only to characterize the groups. This questionnaire was previously compared to a modified version of the Helkimo Clinical Dysfunction Index, and strong statistical correlation was observed.[34]

Of 100 children, 27 (mean age ± SD, 9.33 ± 1.27 years) reported pain in the TMJ or the masticatory muscles at least 1 time in the last month, and 73 (mean age ± SD, 8.96 ± 1.27 years) were symptom-free. During the administration of the questionnaire, to facilitate the response of the children, the regions of the TMJ and of the masticatory muscles were pointed out to them.

Exclusion criteria were history of facial trauma, wearing orthodontic braces, systemic diseases such as juvenile rheumatoid arthritis, dental problems that might cause episodes of orofacial pain not related to TMD (eg, a tooth abscess), limitations of mandibular movements, and past or current experience of clinical conditions that had exposed them to continuous pain (eg, extensive surgeries, use of continuous intravenous medications, systemic diseases involving constant painful procedures, or diseases causing constant pain). Thirty subjects, 14 with pain (from the initial sample of 27 symptomatic children) and 16 pain-free (from the initial sample of 73 symptom-free children), were randomly selected for the reliability procedure.

The project was approved by the local research ethics committee, and the parents or persons responsible for the children gave written informed consent.

Procedures

To obtain PPT values, specific anatomic sites were located bilaterally by PPD according to the RDC/TMD,[2] and the overlying skin was marked with an appropriate pen. These sites were transferred with a pen to sheets of draft paper in order to minimize re-marking errors during the subsequent evaluations.[1] The following sites were selected for evaluation:

- Anterior temporal muscle: the most prominent and anterior point identified by digital palpation during maximum dental clenching
- Middle temporal muscle: a distance of 3 cm from the region determined for the anterior temporal muscle
- Posterior temporal muscle: a distance of 6 cm from the region determined for the anterior temporal muscle
- Masseter muscle origin: most prominent superior region identified by digital palpation during maximum dental clenching
- Masseter muscle insertion: most prominent inferior region identified by digital palpation during maximum dental clenching
- Masseter muscle belly: midpoint between the origin and the insertion[18]
- Lateral pole of the TMJ
- Right thenar region (used as a control region)

Pressure algometry was performed by 2 raters who were trained for 15 hours in the application of a constant pressure of approximately 0.5 kg/cm^2/s and in the correct positioning of the metal tip of the device perpendicular to the anatomic surfaces evaluated.[12] A digital metronome (Korg, model A-30) with a frequency of 1 Hz was used in all evaluations by both raters in order to provide sound feedback and a standard velocity of application of the compression force.

A digital dynamometer (Kratos, model DDK-10) for compression assays was adapted for the execution of pressure algometry.[19,35] The device was capable of measuring forces from 0 to 10 kg with a precision of 0.001 kg. A rubber disk with an area of 1.0 cm^2 was fitted to the metal tip of the device to prevent damage to the surfaces evaluated.[36]

Pressure algometry was applied at random to the anatomic points in order to obtain the PPT values. A sequence was selected by drawing lots from 5 previously organized sequences containing a random order of the structures to be palpated.[17] The PPT values of each structure were obtained bilaterally in 3 consecutive measurements separated by 5-minute intervals.[37]

Before application, the entire procedure was described in detail to the children, who were instructed about the difference in the perception of pressure and the perception of the onset of pain. To familiarize the children with the algometer, the device was first applied to the thenar region of the right hand of the rater and later to the same region of each child.[38] The children were instructed to report the exact beginning of the perception of pain.

The evaluations were performed with the children in a sitting position with the elbows flexed and their hands resting on their legs. They were instructed to keep the masticatory muscles relaxed throughout the procedure,[2] and the rater applied manual resistance contralateral to the applied pressure to ensure the stabilization of the child's head.[9] The child communicated verbally the perception of pain onset, and at that time the pressure was immediately stopped and the PPT value recorded on the digital display was written down by a qualified assistant. During the evaluations, the child and the rater had no access to the PPT values.

Evaluation Protocol

Three evaluation sessions were conducted by 2 raters (rater 1 and rater 2). They were blind to the orofacial pain status of the child. In the first evaluation session all measurements were obtained by rater 1. After a period of 3 to 5 days, all the children (except for 1 girl in the pain group, who was absent) were re-evaluated by rater 2. At the third session, 1 week after the initial session, PPT values were obtained again by rater 1 for all children who attended the first session.

Thus, in the first and third session, rater 1 evaluated 30 children: the 14 children reporting pain (2 boys: 8 ± 0 years and 12 girls: 9 ± 0.85 years) who were randomly selected from the initial sample of 27 children who reported orofacial pain as well as the 16 symptom-free children (9 boys with a mean age of 8.33 ± 0.5 years and 7 girls with a mean age of 8.71 ± 0.76 years) who were randomly selected from the initial sample of 73 children who reported no orofacial pain. In the second session, 13 children with pain (2 boys with a mean age of 8 ± 0 years and 11 girls with a mean age of 9 ± 0.94 years) and the same 16 symptom-free children initially evaluated by rater 1 were re-evaluated by rater 2.

For the assessment of interrater agreement, the second session was compared to the first. For intrarater agreement, the first session was compared to the third. The interval between the evaluations conducted by rater 1 was longer than the interval

Table 1 Characterization of TMD Signs and Symptoms of the Children Evaluated According to Some Items of the Anamnestic Questionnaire (Fonseca et al[34])

	Symptomatic children (n = 14)			Symptom-free children (n = 16)		
Item	n	%	Pain intensity*	n	%	Pain intensity*
Pain during mastication	7	50.00†	3.71 ± 2.69	5	31.25	1.20 ± 1.79
Headache	11	78.57	4.73 ± 3.38	10	62.50	3.80 ± 2.20
Cervical pain	10	71.43†	3.10 ± 3.10	6	37.50	4.67 ± 2.07
TMJ pain	11	78.57†	3.82 ± 3.16	0	NA	NA
Masticatory muscle pain	8	57.14†	3.25 ± 1.07	0	NA	NA

*The intensity of pain was evaluated using the Wong-Baker Faces Pain Rating Scale.[39]
†Significant difference between the pain and symptom-free groups ($P < .05$; χ^2 test).
NA = not applicable.

between evaluations by different raters to avoid the effect of memorization regarding the collected data, since only rater 1 performed the procedure twice.

Pain Intensity Graduation for TMD Signs and Symptoms

The previously validated Wong-Baker Faces Pain Rating Scale[39] was used for the assessment of pain intensity in the questions regarding pain. The Wong-Baker scale is a 6-point scale in which the first picture is a very happy smiling face and the last is a sad, tearful face; the pictures in between show varying degrees of sadness. The child must choose which face he or she considers the most like his or hers during the painful event. For statistical purposes, the faces are assigned a numeric value (0, 2, 4, 6, 8, or 10).

The characterization of pain intensity and the frequency of some items of the questionnaire for the symptomatic and asymptomatic groups are presented in Table 1.

Statistical Analysis

To determine differences in PPT values related to gender and age, the mixed-effect linear model (analysis of variance [ANOVA], random and fixed effects)[40] was used. The intraclass correlation coefficient (ICC)[41] was used for the analysis of intrarater agreement based on the PPT values obtained in the 3 consecutive measurements and in the 2 consecutive measurements, and for the analysis of intra- and interrater agreement based on the PPT values obtained during each session. ICC values were classified as follows: < 0.4 indicated poor agreement; 0.4 to 0.75, moderate agreement; and > 0.75, excellent agreement.[42] The coefficient of variation (CV) was used to estimate the error of PPT repetition (CV = [SD × 100]/mean).[37] The percentages of ICC values in each category of classification were calculated, and the differences between percentages of ICC values classified as excellent were compared using χ^2 test with Yates correction ($P < .05$).

Results

No difference in PPT values was detected for gender for the TMJ or any muscle ($1.26 < F < 4.38$, $P \geq .05$, ANOVA) or for age ($F = 0.19$, $P = 0.39$, ANOVA). There were also no significant differences between raters 1 and 2 in PPT values at any site in the 2 groups of children when the mean of 3 consecutive measurements was considered ($0.05 < F < 1.16$, $P \geq .05$) (Table 2).

Intrarater Agreement for Consecutive PPT Values Obtained on the Same Day

Intrarater agreement of PPT values was first determined for measurements repeated on the same day for both raters. For the 3 consecutive measurements made by rater 1, 11 of the 15 sites evaluated in symptomatic children had moderate ICC values, and 4 were found to have excellent ICC values (Table 3). Similar values were observed in symptom-free children, with 9 sites showing moderate ICC and 6 showing excellent ICC (Table 3). The mean ICC values obtained for rater 2 for the 3 measurements performed on the same day also

Table 2 Mean Values and Standard Deviations (SD) of the 3 Consecutive Measurements of the PPT Values (kg/cm²) Obtained for the Masticatory Muscles and TMJ for the 2 Groups

	Rater 1				Rater 2			
	Symptomatic (n = 13)		Symptom-free (n = 16)		Symptomatic (n = 13)		Symptom-free (n = 16)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Right								
Masseter								
Origin	1.970	0.493	1.945	0.611	1.886	0.422	2.048	0.837
Belly	1.759	0.467	1.752	0.570	1.656	0.457	1.928	0.938
Insertion	1.567	0.301	1.680	0.630	1.686	0.411	1.889	0.812
Temporalis								
Anterior	1.972	0.440	2.091	0.656	2.004	0.527	2.326	1.103
Middle	2.374	0.514	2.533	0.951	2.257	0.548	2.548	1.111
Posterior	2.345	0.869	2.742	1.053	2.613	0.748	2.828	1.320
TMJ	1.768	0.386	1.979	0.601	1.808	0.375	1.932	0.682
Thenar region	3.787	1.516	3.642	1.548	4.074	1.287	3.689	1.820
Left								
Masseter								
Origin	1.833	0.481	1.871	0.592	1.795	0.331	2.062	0.912
Belly	1.515	0.360	1.642	0.532	1.681	0.368	1.882	0.920
Insertion	1.623	0.246	1.712	0.574	1.795	0.438	2.028	0.949
Temporalis								
Anterior	2.023	0.474	2.214	0.708	1.814	0.505	2.194	0.996
Middle	2.294	0.773	2.419	0.862	2.198	0.638	2.529	1.141
Posterior	2.654	0.881	2.547	0.914	2.440	0.345	2.638	1.104
TMJ	1.860	0.407	1.888	0.509	1.808	0.452	2.081	0.862

No significant differences were detected ($P > .05$, ANOVA).

Table 3 ICCs and CVs for the Consecutive PPT Measurements (Mean of Either All 3 Values or Last 2 Values)

	Mean of 3 measurements								Mean of last 2 measurements							
	Symptomatic (n = 13)				Symptom-free (n = 16)				Symptomatic (n = 13)				Symptom-free (n = 16)			
	Rater 1		Rater 2		Rater 1		Rater 2		Rater 1		Rater 2		Rater 1		Rater 2	
	Mean ICC	CV	Mean ICC	CV	Mean ICC	CV	Mean ICC	CV	Mean ICC	CV	Mean ICC	CV	Mean ICC	CV	Mean ICC	CV
Right																
Masseter																
Origin	0.75	11.32	0.67	13.70	0.71	13.03	0.71	15.17	–0.25	10.59	0.85	8.94	0.86	12.62	0.71	12.40
Belly	0.70	13.04	0.86	10.02	0.78	11.05	0.92	8.85	0.87	10.16	0.94	8.50	0.90	11.06	0.99	7.15
Insertion	0.52	18.67	0.69	12.85	0.75	15.68	0.92	12.27	0.55	16.23	0.84	9.05	0.90	11.42	0.97	10.46
Temporalis																
Anterior	0.74	13.57	0.80	12.10	0.72	12.02	0.88	15.83	0.82	11.30	0.86	11.17	0.92	10.33	0.96	12.09
Middle	0.65	13.84	0.61	15.41	0.73	14.32	0.90	12.11	0.75	14.79	0.82	12.63	0.92	13.23	0.95	10.58
Posterior	0.74	17.22	0.56	15.98	0.76	11.73	0.92	12.71	0.84	19.98	0.70	13.66	0.95	9.71	0.97	10.41
TMJ	0.76	11.95	0.68	11.69	0.78	12.35	0.83	12.57	0.83	10.29	0.82	11.12	0.88	9.72	0.95	11.63
Thenar region	0.78	17.04	0.84	12.72	0.81	12.71	0.87	14.86	0.03	16.03	0.73	12.33	0.98	14.56	0.96	11.75
Left																
Masseter																
Origin	0.79	12.77	0.51	14.36	0.65	15.89	0.84	14.74	0.93	8.73	0.85	12.12	0.91	10.31	0.97	11.67
Belly	0.70	13.89	0.70	11.71	0.69	12.85	0.93	13.06	0.56	14.25	0.81	9.98	0.92	13.84	0.96	11.92
Insertion	0.73	15.56	0.60	16.14	0.67	15.03	0.87	14.20	0.80	13.99	0.91	11.49	0.97	12.89	0.92	13.01
Temporalis																
Anterior	0.55	16.23	0.79	11.59	0.71	15.65	0.91	12.66	0.67	15.33	0.88	9.27	0.81	16.34	0.96	11.43
Middle	0.75	15.32	0.76	12.81	0.74	17.57	0.87	14.67	0.85	14.69	0.80	10.83	0.93	14.45	0.94	12.44
Posterior	0.70	13.00	0.70	13.94	0.78	13.42	0.90	11.39	0.84	13.98	0.95	12.02	0.95	14.51	0.95	8.93
TMJ	0.76	12.36	0.71	13.09	0.77	11.50	0.92	9.98	0.89	11.06	0.91	7.33	0.93	11.36	0.97	8.38

Table 4a ICC Values for Symptomatic Children (n = 13)—Same Day

	Rater 1					Rater 2				
	Mean of 3		Mean of 2			Mean of 3		Mean of 2		
	n	%	n	%	*P*	n	%	n	%	*P*
Poor	0	0	2	13.4	< .05	0	0	0	0	NS
Moderate	11	73.3	4	26.7	< .05	10	66.6	2	13.4	< .05
Excellent	4	26.7	9	60.0	< .05	5	33.4	13	86.6	< .05

χ^2 test.

Table 4b ICC Values for Symptom-Free Children (n = 16)—Same Day

	Rater 1					Rater 2				
	Mean of 3		Mean of 2			Mean of 3		Mean of 2		
	n	%	n	%	*P*	n	%	n	%	*P*
Poor	0	0	0	0	NS	0	0	0	0	NS
Moderate	9	60	0	0	< .05	1	6.7	1	6.7	NS
Excellent	6	40	15	100	< .05	14	93.3	14	93.3	NS

χ^2 test.

Table 4c ICC Values for Symptomatic Children (n = 13)—Different Days

	Intrarater					Interrater				
	Mean of 3		Mean of 2			Mean of 3		Mean of 2		
	n	%	n	%	*P*	n	%	n	%	*P*
Poor	2	13.4	3	20	NS	0	0	0	0	NS
Moderate	5	33.4	4	26.7	NS	5	33.4	11	73.3	< .05
Excellent	8	53.2	8	53.3	NS	10	66.6	4	26.7	< .05

χ^2 test.

Table 4d ICC Values for Symptom-Free Children (n = 16)—Different Days

	Intrarater					Interrater				
	Mean of 3		Mean of 2			Mean of 3		Mean of 2		
	n	%	n	%	*P*	n	%	n	%	*P*
Poor	0	0	0	0	NS	0	0	0	0	NS
Moderate	1	6.7	2	13.4	< .05	1	6.7	1	6.7	< .05
Excellent	14	93.3	13	86.6	NS	14	93.3	14	93.3	NS

χ^2 test.

ranged from moderate to excellent for most of the sites evaluated in the symptomatic group (Table 3). For the symptomatic group, the mean ICC values obtained by rater 2 were excellent for 5 sites and moderate for 10. For the same rater considering symptom-free children, the mean ICC values obtained by rater 2 were excellent for all sites evaluated except 1 (the masseter origin on the right side obtained a moderate mean ICC value; Table 3).

When the mean values of only the last 2 consecutive measurements were considered, there was a significant increase in the percentage of sites with ICC values classified as excellent for both groups of children and raters, except for rater 2 for the symptom-free children (Table 3). Thus, for rater 1, of the 15 sites evaluated in the symptomatic children, the mean ICC values were poor for 2 sites, moderate for 4 and excellent for 9, and for the symptom-free

children all sites presented excellent agreement. The percentage of ICC values classified as excellent increased from 26% to 66.6% and from 40% to 100% for symptomatic and symptom-free children, respectively (Tables 4a to 4d). For rater 2, in the symptomatic group, the mean ICC values were moderate for 2 sites and excellent for 13 sites, and for the group of symptom-free children, agreement was moderate for 1 site and excellent for 14 sites (Table 3). Thus, when considering the mean of 2 measurements in relation to the mean of 3, there was a significant increase (from 33% to 86%) in the percentage of ICC values classified as excellent for symptomatic and maintenance of the percentage (93%) in symptom-free children (Tables 4a to 4d).

The CV of the 3 measurements obtained on the same day by rater 1 did not exceed 19% for the symptomatic children and 18% for symptom-free children (n = 16) (Table 3). The CV of the measurements obtained by rater 2 did not exceed 17% of variation for either group (Table 3). The CV of the 2 final measurements obtained on the same day by both raters was also calculated. The CV values between measurements did not exceed 20% for rater 1 or 13% for rater 2 for the symptomatic children; they did exceed 17% for rater 1 or 14% for rater 2 for the symptom-free children (Table 3).

Intrarater and Interrater Agreement Regarding the PPT Values Obtained on Different Days

In the symptomatic group, the mean ICC values of the mean of 3 consecutive measurements obtained on different days by the same rater were excellent for 8 sites, moderate for 5 sites, and poor for 2 sites, and in the group of symptom-free children the mean ICC values were excellent for all sites except for the left lateral TMJ, for which they were moderate. Regarding interrater agreement, the mean ICC values were excellent for 10 sites and moderate for 5 for the symptomatic group and excellent for all but 1 site for the symptom-free children (1 left TMJ obtained a moderate mean ICC value; Table 5).

The intra- and interrater agreements for PPT values were also determined based on the last 2 measurements obtained on different days. For the symptomatic group, the mean ICC value of intrarater agreement was poor for 3 sites, moderate for 4 sites, and excellent for 8 sites; for the symptom-free children, the mean ICC values were moderate for 2 sites and excellent for 13 sites. Thus, discarding 1 measurement did not have a significant impact on the percentage of sites with ICC values classified as excellent (53% with either 2 or 3 measurements used; Tables 4a to 4d). However, for the symptomatic children, there was a reduction in the level of interrater agreement when the mean of 2 consecutive measurements was considered; the percentage of sites with ICC values classified as excellent fell from 66% to 26%. Discarding 1 measurement did not have a significant impact on the percentage of sites with ICC values classified as excellent (93% versus 100%).

The intermeasurement CV of the PPT values based on the mean of 3 consecutive measurements was higher in the symptomatic group (intrarater evaluation, n = 14) both during the first session and the second session held 1 week later. For the data collected by rater 1, the CV values between measurements decreased in both groups after 1 week. For the symptomatic children, the CV values between measurements did not exceed 19% of variation and for the symptom-free children the CV did not exceed 17% of variation (Table 5).

Discussion

In the present study, there was excellent intrasession agreement for most of the sites evaluated for both raters and groups, and excellent intra- and interrater agreement for evaluations conducted on different days only for the symptom-free individuals. Few studies[1,6,23] have detected differences in intra- and interrater agreement of PPT values in TMD patients or in community cases that report orofacial pain compared to symptom-free individuals. These findings agree with Ohrbach and Gale,[6] who evaluated the correlation between the PPT values obtained on the same and on different days in a group of adults with myogenic TMD. These authors obtained excellent correlation levels for the intrasession evaluations in both groups and in different sessions only for the control group.

On the other hand, for adult patients with myogenic TMD and control volunteers, Reid et al[1] determined the intrasession and intersession agreement of the mean of 3 consecutive measurements of PPT. In contrast to the results obtained in the present study, these authors did not detect differences in the levels of correlation for intra- and intersession values for either group.

The present results indicate differences in the reproducibility of PPT values between individuals reporting pain and symptom-free individuals that may be related to instability of signs and symptoms in patients with pain conditions.[6] However, in contrast to the studies conducted by Ohrbach

Table 5 ICCs and CVs of Evaluations 1 Week Apart for PPT Values and Intrarater and Interrater Agreement Obtained on Different Days for the Mean of 3 Consecutive Measurements and the Mean of the Final 2 Measurements of Each Session

	Symptomatic children				Symptom-free children			
	Intrarater (n = 14)		Interrater (n = 13)		Intrarater (n = 16)		Interrater (n = 16)	
	Mean ICC	1st CV	2nd CV	Mean ICC	Mean ICC	1st CV	2nd CV	Mean ICC
Mean ICC and CV values of the mean of 3 consecutive measurements								
Right								
Masseter								
Origin	0.82	9.7	12.7	0.77	0.85	11.9	10.2	0.89
Belly	0.90	13.3	12.5	0.74	0.93	10.5	12.5	0.89
Insertion	0.71	17.4	11.5	0.53	0.93	15.2	12.5	0.92
Temporalis								
Anterior	0.68	12.8	8.5	0.75	0.92	11.7	12.5	0.92
Middle	0.73	18.1	12.5	0.81	0.93	13.1	10.6	0.93
Posterior	0.76	11.2	13.3	0.87	0.91	10.5	10.3	0.92
TMJ	0.46	12.7	10.0	0.79	0.79	14.2	12.3	0.93
Thenar region	0.79	11.8	9.8	0.88	0.91	16.7	13.5	0.88
Left								
Masseter								
Origin	0.71	14.7	10.3	0.57	0.94	13.0	10.8	0.89
Belly	0.86	16.4	12.5	0.85	0.92	15.0	10.8	0.85
Insertion	0.94	13.2	13.7	0.84	0.91	14.7	11.6	0.86
Temporalis								
Anterior	0.82	13.3	10.6	0.79	0.88	15.8	9.8	0.91
Middle	-0.49	11.5	12.8	0.66	0.87	14.2	10.7	0.92
Posterior	0.87	13.3	13.9	0.86	0.92	12.3	10.3	0.83
TMJ	-0.28	11.5	9.5	0.79	0.49	11.6	12.7	0.75
Mean ICC and CV values of the mean of the 2 final consecutive measurements								
Right								
Masseter								
Origin	0.76	8.8	10.8	0.68	0.83	11.4	10.3	0.87
Belly	0.80	11.3	7.5	0.68	0.93	9.5	11.5	0.88
Insertion	0.82	14.6	9.3	0.61	0.88	11.6	9.2	0.90
Temporalis								
Anterior	0.58	9.9	5.6	0.74	0.94	11.5	13.3	0.91
Middle	0.38	12.9	10.1	0.71	0.91	11.3	9.4	0.91
Posterior	0.73	17.1	12.5	0.84	0.92	8.1	8.4	0.90
TMJ	0.41	9.5	7.7	0.78	0.71	12.0	11.9	0.87
Thenar region	0.76	16.4	8.7	0.68	0.83	13.2	12.0	0.87
Left								
Masseter								
Origin	0.63	9.6	7.9	0.40	0.95	12.1	13.1	0.88
Belly	0.84	11.1	10.0	0.73	0.90	11.0	10.2	0.86
Insertion	0.89	13.3	7.6	0.83	0.89	15.2	7.7	0.89
Temporalis								
Anterior	0.76	15.5	13.4	0.64	0.89	12.1	8.7	0.88
Middle	0.28	13.6	9.7	0.54	0.87	8.9	8.2	0.92
Posterior	0.87	14.5	10.3	0.86	0.92	9.5	8.6	0.84
TMJ	–0.27	11.2	16.4	0.72	0.52	8.3	10.2	0.77

and Gale[6] and by Reid et al,[1] the present sample was a sample of children reporting orofacial pain related to TMD. One can argue that the lower levels of agreement in the symptomatic group in the present study may also be related to rater errors during the procedure for obtaining PPT. However, the excellent intra- and interrater agreement regarding most of the sites evaluated in the symptom-free children do not support this view.

Only 1 study was found in the literature in which the intra- and interrater agreement of the PPT values was determined for the evaluation of structures of masticatory system in children.[23] The authors detected just moderate levels of intra- and interrater agreement in the last 2 PPT measurements. These findings are in partial agreement with the results of the present study, since at least 54% (n = 8) of the sites evaluated showed excellent ICC levels for intrarater agreement and 27% (n = 4) showed excellent ICC levels for interrater agreement in the symptomatic group (Table 5). However, the previous study[23] did not verify differences in the values of agreement between children with and without TMD, and the data were obtained with a group of adolescents rather than children.

An increase in or maintenance of the levels of intrarater agreement for measurements performed on the same day was observed for both groups when the first of 3 measurements was discarded. On the other hand, for measurements obtained on different days, there was a reduction in the percentage of sites classified with excellent ICC values specifically for interrater agreement for the symptomatic group. Nussbaum and Downes[20] demonstrated an increase in ICC values when they compared the last 2 measurements to the last 3 measurements both in intrasession and intersession evaluations for palpations of the brachial biceps muscle of healthy volunteers. This behavior can be explained by the fact that the PPT values obtained in the first series of consecutive measurements are usually higher than those obtained in the subsequent measurements, a fact probably related to an effect of nociceptor sensitization.[15]

The procedure of discarding the first PPT measurement obtained led to lower ICC values for interrater agreement on different days for the symptomatic group. The greater variability among repeated PPT measurements in those children was not sufficient to lead to significant differences in CV values (in the analyses based on the difference between means); however, the variability did lead to changes in the levels of agreement. Thus, in longitudinal studies involving the PPT on different days, specifically by different raters, the use of the mean of 3 consecutive measurements may lead to a reduction of PPT value variability in children reporting pain, particularly in studies involving different examiners. The results suggest that the determination of changes in PPT values over time permits a reliable correlation of these values with real changes in the clinical picture.

The procedure of discarding the first of the 3 consecutive measurements increased or maintained the ICC values for the symptom-free children for the evaluations performed on the same day. Such a procedure did not change the ICC values for measurements obtained on different days in the symptom-free children and reduced them for the children who reported pain; specifically, the ICC for interrater agreement was reduced.

The results of the present study document that algometry can be a reliable tool for the evaluation of pain threshold in the masticatory structures of children.

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References

1. Reid KI, Gracely RH, Dubner RA. The influence of time, facial side, and location on pain-pressure thresholds in chronic myogenous temporomandibular disorder. J Orofac Pain 1994;8:258–265.
2. Dworkin SF, LeResche L (eds). Research Diagnostic Criteria for Temporomandibular Disorders: Review, criteria, examinations and specifications, critique. J Craniomandib Disord 1992;6:301–355.
3. Kosek E, Ekholm J, Nordemar R. A comparison of pressure pain thresholds in different tissues and body regions. Scand J Rehab Med 1993;25:117–124.
4. Fredriksson L, Alstergren P, Kopp S. Absolute and relative facial pressure-pain thresholds in healthy individuals. J Orofac Pain 2000;14:98–104.
5. Farella M, Michelotti A, Steenks MH, Romeo R, Cimino R, Bosman F. The diagnostic value of pressure algometry in myofascial pain of the jaw muscles. J Oral Rehab 2000; 27:9-14.
6. Ohrbach R, Gale EN. Pressure pain thresholds, clinical assessment, and differential diagnosis: Reliability and validity in patients with myogenic pain. Pain 1989;39:157–169.
7. Chung SC, Um BY, Kim HS. Evaluation of pressure pain threshold in head and neck muscles by electronic algometer: Intra-rater and inter-rater reliability. Cranio 1992;10:28–34.
8. Murphy GJ, Mckinney MW, Gross WG. Temporomandibular-related pressure thresholds: A model for establishing baselines. Cranio 1992;10:118–123.

9. Goulet JP, Clark GT. Clinical TMJ examination methods. J Calif Dent Assoc 1990;18:25–33.
10. Dworkin SF, LeResche L, DeRouen T. Reliability of clinical measurements in temporomandibular disorders. Clin J Pain 1988;4:89–99.
11. Fischer AA. Pressure algometry over normal muscles. Standard values, validity and reproducibility of pressure threshold. Pain 1987;30:115–126.
12. Duarte MA, Goulart EMA, Penna FJ. Limiar de dor e idade na infância e adolescência. J Pediatr (Rio J) 1999;75:244–248.
13. Rollman GB, Lautenbacher S. Sex differences in musculoskeletal pain. Clin J Pain 2001;17:20–24.
14. Chesterton LS, Barlas P, Foster NE, Baxter GD, Wright CC. Gender differences in pressure pain threshold in healthy humans. Pain 2003;101:259–266.
15. Isselèe H, De Laat A, Lesaffre E, Lysens R. Short-term reproducibility of pressure pain thresholds in masseter and temporalis muscles of symptom-free subjects. Eur J Oral Sci 1997;105:583–587.
16. Brown FF, Robinson ME, Riley JL, Gremillion HA, McSolay J, Meyers G. Better palpation of pain: Reliability and validity of a new pressure pain protocol in TMD. Cranio 2000;18:58–65.
17. Antonaci F, Sand T, Lucas GA. Pressure algometry in healthy subjects: Inter-examiner variability. Scand J Rehabil Med 1998;30:3–8.
18. List T, Helkimo M, Falk G. Reliability and validity of a pressure threshold meter in recording tenderness in the masseter muscle and the anterior temporalis muscle. Cranio 1989;7:223–229.
19. Silva RS, Conti PCR, Lauris JRP, Silva ROF, Pegoraro LF. Pressure pain threshold in the detection of masticatory myofascial pain: An algometer-based study. J Orofac Pain 2005;19:318–324.
20. Nussbaum EL, Downes L. Reliability of clinical pressure-pain algometric measurements obtained on consecutive days. Phys Ther 1998;78:160–169.
21. Hogeweg JA, Kuis W, Oostendorp RAB, Helders PJM. The influence of site of stimulation, age, and gender on pain threshold in healthy children. Phys Ther 1996;76:1331–1339.
22. Metsahonkala L, Anttila P, Laimi K, et al. Extracephalic tenderness and pressure pain threshold in children with headache. Eur J Pain 2006;10:581–585.
23. Wahlund K, List T, Dworkin SF. Temporomandibular disorders in children and adolescents: Reliability of a questionnaire, clinical examination, and diagnosis. J Orofac Pain 1998;12:42–51.
24. LeResche L. Epidemiology of temporomandibular disorders: Implications for the investigation of etiologic factors. Crit Rev Oral Biol Med 1997;8:291–305.
25. Franck LS, Greenberg CS, Stevens B. Pain assessment in infants and children. Pediatric Clin North Am 2000;47:487–512.
26. Alamoudi N, Farsi N, Salako NO, Feteih R. Temporomandibular disorders among school children. J Clin Pediatr Dent 1998;22:323–329.
27. Castelo PM, Gavião MB, Pereira LJ, Bonjardim LR. Relationship between oral parafunctional/nutritive sucking habits and temporomandibular joint disorders in primary dentition. Int J Paediatr Dent 2005;15:29–36.
28. Sonnesen L, Bakke M, Solow B. Temporomandibular disorders in relation to craniofacial dimensions, head posture and bite force in children selected for orthodontic treatment. Eur J Orthod 2001;23:179–192.
29. Thilander B, Rubio G, Pena L, Mayorga C. Prevalence of temporomandibular disorders and its association with malocclusion in children and adolescents: An epidemiologic study related to specified stages of dental development. Angle Orthod 2002;72:146–154.
30. Bonjardim LR, Gavião MBD, Carmagnani FG, Pereira LJ, Castelo PM. Signs and symptoms of temporomandibular joint disorders in children with primary dentition. J Clin Pediatr Dent 2003;28:53–58.
31. Dworkin SF, LeResche L, DeRouen T, Von Korff M. Assessing clinical signs of temporomandibular disorders: Reliability of clinical examiners. J Prosthet Dent 1990;63:574–579.
32. LeResche L, Mancl LA, Drangsholt MT, Saunders K, Von Korff M. Relationship of pain and symptoms to pubertal development in adolescents. Pain 2005;118:201–209.
33. Mohl ND. Standards for testing new diagnostic strategies for temporomandibular disorders. In: Fricton JR, Dubner R. Orofacial Pain and Temporomandibular Disorders. New York: Raven Press, 1995.
34. Fonseca DM, Bonfate G, Valle AL, Freitas SFT. Diagnóstico pela anamnese da disfunção craniomandibular. Rev Gaucha Odontol 1994;42:23–28.
35. Poletto PR, Gil Coury HJC, Walsh IAP, Mattielo-Rosa SM. Correlação entre métodos de auto-relato e testes provocativos de avaliação de dor em indivíduos portadores de distúrbios osteomusculares relacionados ao trabalho. Rev Bras Fisioter 2004;8:223–229.
36. Jensen K, Andersen HO, Olesen J, Lindblom U. Pressure-pain threshold in human temporal region. Evaluation of a new pressure algometer. Pain 1986;25:313–323.
37. Fredriksson L, Alstergren P, Kopp S. Pressure pain thresholds in the craniofacial region of female patients with rheumatoid arthritis. J Orofac Pain 2003;17:326–332.
38. Visscher CM, Lobbezoo F, Naeije M. Comparison of algometry and palpation in the recognition of temporomandibular disorder pain complaints. J Orofac Pain 2004;18:214–219.
39. Wong DL, Baker CM. Pain in children: Comparison of assessment scales. Pediatr Nurs 1988;14:9–17.
40. Schall R. Estimation in generalized linear models with random effects. Biometrika 1991;78:719–727.
41. Snedecor GW, Cochran WG. Statistical Methods, Sixth Edition, Iowa: The Iowa State University Press, 1972.
42. Fleiss JL, Levin B, Paik MC. Statistical Methods for Rates and Proportions, ed 3. Hoboken, NJ: John Wiley & Sons, 2003.