

Can Concomitant Masticatory Muscle Contraction Interfere with Temporomandibular Joint Arthralgia Evaluation?

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Aims: To investigate the effect of masticatory muscle contraction on the pressure pain threshold (PPT) of the lateral pole of the temporomandibular joint (TMJ) in patients with TMJ arthralgia and in asymptomatic individuals. **Methods:** A total of 72 individuals divided into two groups (group 1: patients with unilateral TMJ arthralgia [n = 36]; group 2: control group, asymptomatic individuals [n = 36]) were compared. The PPT of the lateral pole of the TMJ with and without concomitant masticatory muscle contraction was determined using a digital algometer in both groups. Paired and independent Student *t* test were used to compare the data within and between groups, respectively. A 5% significance level was used for all tests. **Results:** Higher TMJ PPT values with concomitant masticatory muscle contraction were found in both groups ($P < .001$). The amount of increase in PPT with contracted muscles was not significantly different between groups ($P = .341$), but the TMJ arthralgia group had significantly lower PPT values than the control group regardless of muscle contraction status ($P < .001$). **Conclusion:** Concomitant masticatory muscle contraction significantly increased the PPT of the lateral pole of the TMJ in relation to relaxed muscles, regardless of the presence of arthralgia. *J Oral Facial Pain Headache* 2021;35:72–76. doi: 10.11607/ofph.2759

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Temporomandibular disorders (TMD) are the second major cause of orofacial pain, characterized by disorders that affect the muscles of mastication and the temporomandibular joint (TMJ).¹ TMJ pain is usually related to inflammation.^{2,3} Arthralgia is inflammation of the joint capsule and/or of the TMJ synovial lining, generating pain and sensitivity.^{1–3} Arthralgia corresponds to 35.2% of TMD diagnostics, being predominantly unilateral (26.6%) with no preference for sides.⁴ Increased pain with jaw function, painful tenderness to manual palpation, and decreased pressure pain threshold (PPT) in the TMJ area are common features of TMJ arthralgia.^{2,5} PPT is the point at which a patient feels that the increasing pressure exerted on an area has become unpleasant or painful.⁶

The most used test for clinical arthralgia diagnosis is the digital palpation of joint sites (lateral pole and/or posterior attachment), which allows identification of painful areas that can replicate the patient's main complaint.⁷ This procedure has a sensitivity of 0.89 and a specificity of 0.988. A very well trained and calibrated palpation is extremely important to avoid incorrect diagnoses of arthralgia, since even healthy individuals report pain depending on palpation pressure.⁸ A PPT value of 1.36 kgf/cm² has been determined as the most appropriate for discriminating asymptomatic TMJ individuals from those with moderate to severe TMJ arthralgia.⁵

The main instruments for TMD diagnosis—the Research Diagnostic Criteria for TMD (RDC/TMD) and the Diagnostic Criteria for TMD (DC/TMD)—recommend that palpation should be performed only on relaxed muscles.^{7,9} A recent study showed that performing palpation with the masticatory muscles contracted can increase the PPT, leading to a false negative diagnosis of myofascial pain.¹⁰ However, the interfer-

ence of concomitant muscle contraction during TMJ palpation for clinical diagnosis of arthralgia has not been previously addressed. This understanding can influence the TMJ physical examination. Therefore, the aim of the present study was to investigate the effect of masticatory muscle contraction on the PPT of the lateral pole of the TMJ. The null hypothesis was that there would be no differences in the PPT of the lateral pole of the TMJ with or without concomitant masticatory muscle contraction in individuals with TMJ arthralgia or in asymptomatic individuals.

Materials and Methods

Sample and Ethics

This cross-sectional study was approved by the Research Ethics Committee of the Bauru School of Dentistry, University of São Paulo, Bauru, Brazil (CAAE: 88592018.0.0000.5417/no. 2.725.838). All individuals were informed about the research purpose and signed a free informed consent form. This study was conducted following the Helsinki Declaration and the recommendations of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.¹¹

The sample size calculation was performed using G*Power 3.1.9.2 software.¹² The following parameters were considered: a test power of 0.8, a significance level of 0.05%, and an effect size of 0.6. The sample size was calculated at 72 individuals equally divided into two groups: group 1 was composed of 36 patients (28 women, 8 men, mean age 34.41 ± 15.13 years) with only unilateral TMJ arthralgia; and group 2 (control group) was composed of 36 asymptomatic individuals (28 women, 8 men, mean age 31.13 ± 10.02 years) with no TMJ arthralgia. The individual was considered the unit of observation. The study design and sample formation were based on a previous investigation that studied the impact of masticatory muscle contraction on the diagnosis of myofascial pain.¹⁰

The sample was obtained from Brazilian individuals over 18 years of age seeking regular dental treatment (control group) or presenting with a pain complaint in the TMJ area at the Bauru School of Dentistry, Orofacial Pain Clinic, between September 2018 and June 2019. All clinical examinations were made by a single examiner (R.L.P.). The patients were then allocated into one of the groups based on the clinical examination according to the parameters and criteria established by the official Portuguese version of the RDC/TMD Axis I.⁷ Individuals were excluded if they had any pain different from arthralgia, such as myofascial pain; if they had any previous surgical intervention in the TMJ; had systemic conditions such

as fibromyalgia, osteoarthritis, or an autoimmune arthritis like rheumatoid arthritis or any degenerative joint disease; used removable dental prostheses; were undergoing orthodontic treatment; or were in continuous use of medications such as analgesics and anti-inflammatory drugs.

Algometry Examination (PPT Determination)

The PPT recording procedure was performed using a digital algometer (model DDK-20, Kratos). This algometer has a 1-cm² flat circular-shaped tip at one end that was used to apply pressure perpendicular to the lateral pole of the studied TMJ. The pressure application rate was previously calibrated with a stopwatch and set at approximately 0.5 kgf/cm²/second. Throughout the test, the individual's head was firmly supported by the operator's hand. The device used in the present study has a button that the patient was asked to press at the very beginning of a pain sensation. Therefore, the subject had full control in determining the moment when the applied pressure became painful, with no interference from the examiner. The procedure was fully explained to each patient before the examination. It was emphasized that the purpose of the study was to measure the PPT, not pain tolerance. The PPT was reached when the subject felt the pressure begin to turn into pain.⁵

In patients, the TMJ with arthralgia was defined as the test side. In healthy controls, the dominant side was defined as the test side. First, TMJ PPT measurement was performed with masticatory muscles in a relaxed state, followed by measurement in a contracted state. The determination of muscle status was made by clinical observation: The muscles were considered in a relaxed state when the patient was at rest, with the lips sealed, without any dental contact, and muscles were considered in a contracted state when the patient was clenching their teeth with maximum clinical muscular contraction.¹⁰ For every individual, each measurement (contracted and relaxed) was performed three times (with a 2-minute interval between tests), and the average value was considered for analysis.

Statistical Analysis

All data were expressed as mean \pm SD and were assessed for normal distribution with the Kolmogorov-Smirnov test. To compare the mean values of the TMJ PPT between concomitant contracted and relaxed muscles within each group, paired Student *t* test was used. Additionally, to compare the mean value of the TMJ PPT between groups, independent Student *t* test was used. A 5% significance level was used for all these tests. Data were analysed using SPSS Statistics version 25.0 software (IBM).

Table 1 Within-Group Comparison of TMJ Pressure Pain Threshold (PPT) Values with Masticatory Muscles in the Relaxed and Contracted States in TMJ Arthralgia Patients (Group 1)

Group 1	<i>P</i> ^a	Mean ± SD PPT (kgf/cm ²)	<i>P</i> ^b
Relaxed muscles	.200 ^a	1.078 ± 0.244	< .001 ^b
Contracted muscles	.180 ^a	1.398 ± 0.318	

^aKolmogorov-Smirnov test showed that the variable followed a normal distribution (*P* > .05).

^bThe difference was statistically significant according to paired Student *t* test (*P* < .05).

Table 2 Within-Group Comparison of TMJ Pressure Pain Threshold (PPT) Values with Masticatory Muscles in the Relaxed and Contracted States in Healthy Controls (Group 2)

Group 2	<i>P</i> ^a	Mean ± SD PPT (kgf/cm ²)	<i>P</i> ^b
Relaxed muscles	.120 ^a	1.976 ± 0.428	< .001 ^b
Contracted muscles	.098 ^a	2.331 ± 0.474	

^aKolmogorov-Smirnov test showed that the variable followed a normal distribution (*P* > .05).

^bThis difference was statistically significant according to paired Student *t* test (*P* < .05).

Results

Kolmogorov-Smirnov test showed that all studied variables were normally distributed (*P* > .05). Paired Student *t* test showed that concomitant muscle contraction produced a significant increase in TMJ PPT values when compared to relaxed muscles (*P* < .001) for both groups (Tables 1 and 2). Although in group 2 the amount that the PPT increased with muscle contraction was higher than in group 1, no significant differences were found (*P* = .341; Table 3).

Also, independent Student *t* test showed that patients with arthralgia (group 1) had significantly lower TMJ PPT mean values when compared to the control group (group 2) regardless of the muscle contraction status (*P* < .001).

Discussion

To the best of the authors' knowledge, this is the first study to evaluate the influence of concomitant muscle contraction status on TMJ PPT determination in patients with TMJ arthralgia and asymptomatic individuals. Muscle contraction caused a significant increase in PPT of the lateral pole of the TMJ in both groups (*P* < .001). Therefore, the null hypothesis was rejected.

The male:female ratio in the present sample was 3.5:1. This prevalence is not surprising, since women tend to seek TMD treatment more often than men.¹³ Also, a recent systematic review and meta-analysis showed that the risk of developing TMD increases by more than two times in women.¹⁴ Additionally, arthralgia is more common in women than in men.¹⁵ This predilection is possibly related to estrogen, which is believed to increase inflammatory hyperalgesia in the TMJ area in addition to having peripheral/central action in the modulation of pain and influencing the sensitization of the trigeminal system,¹⁶ but this discussion is not within the scope of the present study.

Table 3 Between-Group Comparison of the Difference in TMJ Pressure Pain Threshold (PPT) Between Contracted and Relaxed Muscles in Each Group

	<i>P</i> ^a	Mean ± SD difference (kgf/cm ²)	<i>P</i> ^b
Group 1	.111 ^a	0.319 ± 0.180	.341
Group 2	.106 ^a	0.355 ± 0.129	

^aKolmogorov-Smirnov test showed that the variable follows a normal distribution (*P* > .05).

^bIndependent Student *t* test.

Muscle contraction significantly increased the TMJ PPT mean values for both groups. However, these findings were even more significant for group 1 (TMJ arthralgia), since the TMJ PPT value with masticatory muscles in the contracted state (1.398 ± 0.318 kgf/cm²) was higher than the recently suggested cut-off value of 1.36 kgf/cm² (with 89.66% specificity and 70% sensitivity) for clinical TMJ arthralgia diagnosis.⁵ These results imply that performing the TMJ palpation examination with concomitant masticatory muscle contraction may lead to a false negative diagnosis of TMJ arthralgia, an undesirable situation when dealing with a condition that has an important impact on quality of life.¹⁷

One apparent explanation for the increased TMJ PPT with contracted muscles is the activation of descending inhibitory pathways by exercise-induced hypoalgesia (EIH). EIH is characterized by elevations in pain thresholds and tolerances, as well as reductions in pain intensity ratings during and following exercises.¹⁸ The physiologic mechanisms of EIH remain not fully understood; presently, the interactions between the opioid and endocannabinoid systems and between the opioid and serotonergic systems seem to be responsible for the EIH.¹⁹ Both aerobic and isometric exercises have been shown to produce

EIH.²⁰ Masticatory muscle contraction (an isometric exercise) is able to evoke EIH, as reflected in the increased facial pain thresholds.²¹

Although human descending pain inhibition, when assessed by the conditioned pain modulation (CPM) paradigm, is usually impaired in TMD pain patients, including those with TMJ arthralgia,²² the mechanisms explaining EIH appear to be at least partly independent of CPM.¹⁹ This could explain why the group of patients had increased TMJ PPT even in the presence of TMJ arthralgia. No significant differences were found between the amount of PPT increase with contracted muscles, regardless of the presence of TMJ pain (0.319 ± 0.180 kgf/cm² and 0.355 ± 0.129 kgf/cm² for groups 1 and 2, respectively). This result is in accordance with a previous study where tooth clenching until exhaustion was able to activate EIH, with similar magnitude between TMD myalgia patients and pain-free women, suggesting no deficiency of EIH in women with TMD.²¹ The increase of TMJ PPT with contracted muscles may also be explained by another hypothesis, such as the blocking of pain signals through presynaptic inhibition or by reducing or preventing the pain signal from reaching a conscious level that could be generated by muscle contraction.¹⁰

As expected, the present findings agree with clinical studies that demonstrated smaller PPT values in patients with TMJ arthralgia when compared to asymptomatic individuals.^{2,5} Regardless of muscle contraction status, the patients had lower PPT values than the controls. The well-established inflammatory process and the hyperalgesia phenomenon can probably explain this fact.^{1,2,5}

Performing a comprehensive physical examination is essential for obtaining a correct diagnosis, as well as for the establishment of adequate management strategies.⁹ The results of the present study substantiate the recommendations of TMD diagnosis instruments accepted worldwide (RDC/TMD and DC/TMD) to perform TMJ palpation with muscles in the relaxed position. The actual results, however, should be analyzed with caution, since the present study has the limitation of being monocentric and without gender pairing. Additionally, no electromyography was performed to evaluate the tonicity of the muscles; the determination of the muscle's contraction state was determined by clinical observation,¹⁰ which can also be considered a limitation. Also, the duration of the EIH effect was not measured since the TMJ PPT after muscle contraction was not measured at any time, so there is no indication of how long the wait should be before performing the clinical examination after masticatory muscle contraction.

Further studies associated with electromyography and with gender-paired samples are suggested

to improve the sensitivity and specificity of clinical examinations and the comprehension regarding the involvement of muscle contraction status in the examination of TMD conditions.

Conclusions

The concomitant masticatory muscle contraction significantly increased the PPT of the lateral pole of the TMJ in relation to relaxed muscles, regardless of the presence of arthralgia.

Key Findings and Clinical Implications

Concomitant masticatory muscle contraction significantly increased the PPT of the lateral pole of the TMJ in relation to relaxed muscles. The present results suggest that performing the TMJ palpation examination with concomitant masticatory muscle contraction may lead to a false negative diagnosis of TMJ arthralgia.

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Author contributions: R.L.P.: study concept and design, clinical examinations, data collection, data analysis, manuscript preparation; G.D.T.C.: data collection, data analysis, manuscript preparation, L.R.B.: subcoordinator, study concept, revision of manuscript, P.C.R.C.: coordinator, study concept and design, data analysis, revision of manuscript.

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