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Painful temporomandibular disorders and central sensitization: implications for management—a pilot study

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Abstract. The objective was to investigate the presence of cutaneous allodynia and hyperalgesia in the trigeminal and extra-trigeminal areas, as a surrogate for central sensitization (CS), in women with a painful temporomandibular disorder (TMD) and without other painful conditions. Painful TMDs, depression, and non-specific physical symptoms (NSPS) were classified according to the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD). The amount of pain in the trigeminal and extra-trigeminal areas was determined using a visual analogue scale (0–100 mm) after the application of a vibrotactile stimulus and assessment of the pressure pain threshold (PPT). Statistical tests (Fisher's, χ^2, and Mann–Whitney) were performed, with a significance level of 5%. The sample comprised 45 women (mean age 37.5 years; 16 with a painful TMD) who were free of any headache, fibromyalgia, or other painful condition. Painful TMD was associated with higher pain sensitivity and lower PPT values in the trigeminal ($P < 0.01$) and extra-trigeminal regions ($P < 0.01$). The presence of depression contributed significantly to increased pain sensitivity. The presence of hyperalgesia and allodynia in both the trigeminal and extra-trigeminal regions among women with a painful TMD indicated the presence of CS. Changes involving the central nervous system should be considered during the evaluation and management of patients with a painful TMD.

Key words: temporomandibular joint disorders; central nervous system sensitization; hyperalgesia.

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Temporomandibular disorders (TMD) represent a cluster of conditions involving the structures of the masticatory system. The most frequent symptoms include pain in the masticatory muscles and/or the temporomandibular joint (TMJ), TMJ sounds, and limited or asymmetric mandibular movements.[1] The prevalence of TMD ranges from 21.5% to 51.8% in different studies,[2,3] being approximately twice as common in women as in men.[3]

The presence of pain and the reduced pressure pain threshold (PPT) in structures related to the TMD can be explained by peripheral sensitization (PS),[4] characterized by a reduction in threshold and amplification in responsiveness of nociceptors.[5] Local factors such as trauma, parafunctional activity, and surgical procedures can cause local inflammation and ischemia, increasing the nociceptive input restricted to the site of tissue injury. This can then evolve, inducing a sensitization of higher-order neurons, which characterizes a central sensitization (CS) process.[6]

CS is an important aspect in the pathophysiology of various types of chronic musculoskeletal pain, including TMDs.[7] It is characterized by hyperexcitability and an expansion of the nociceptive second-order neuron receptive fields, reduction of the activation threshold, and prolonged neuronal discharge.[8] Clinically, CS can be evidenced by an increased and prolonged responsiveness to noxious stimuli (hyperalgesia) and the perception of pain following a non-painful stimulus (allodynia).[8] These phenomena may explain the presence of sensitivity and pain in another area of the body observed in patients presenting a painful TMD,[4] featuring centrally mediated pain.[9]

Previous studies have demonstrated the presence of cutaneous allodynia, hyperalgesia, and therefore CS in patients with a painful TMD.[10] Nevertheless, TMD patients frequently present painful comorbidities such as primary headaches[11] and fibromyalgia,[12] conditions that may involve the presence of CS. Only a few studies have investigated the presence of cutaneous allodynia and hyperalgesia in TMD patients with no other persistent painful conditions.[13] Furthermore, the presence of fibromyalgia, primary headaches, and emotional disorders are potential confounders in the association between allodynia, hyperalgesia, and painful TMDs.[14]

The identification of the presence of CS is of high clinical relevance to choosing treatments not limited to peripheral approaches and capable of producing analgesia by normalizing the hyperexcitable central neural activity.[12] It is also important to predict the development of severe postoperative and persistent pain.[15] Osteoarthritis patients with high levels of comorbid centrally-mediated symptoms, for example, showed severe pain and increased analgesic requirements after total knee arthroplasty in the early postoperative period. Moreover, these patients seemed to be at higher risk of persistent pain and showed low satisfaction regarding pain relief after surgery.[16]

Therefore, the aim of this study was to verify the presence of CS, manifested as trigeminal and extra-trigeminal cutaneous allodynia and hyperalgesia, in a controlled sample of women presenting with a painful TMD who were free of headaches, fibromyalgia, and other chronic painful conditions.

Patients and methods

A cross-sectional study was conducted involving a sample of women presenting with a painful TMD, identified among individuals seeking treatment for orofacial pain. To be included in the painful TMD study group, individuals had to present a joint, muscle, or mixed painful TMD, according to the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) Axis I.[17–19] The control group comprised women who were free of any orofacial pain seeking routine dental care, with neither a current nor a past history of painful TMD or other forms of chronic orofacial pain. Consecutive individuals aged between 20 and 65 years were enrolled, considering the following exclusion criteria: (1) total absence of natural teeth (even using conventional complete dentures); (2) partial absence of teeth with no use of a fixed or removable prosthesis; (3) abnormal cognitive function and communication skills; (4) current daily use of pain medication; (5) presence of any headache, fibromyalgia, or other chronic painful condition.

The local research ethics committee approved this study, and informed consent was obtained from each participant (patients and controls).

Study protocol

Two trained researchers (R1 and R2) conducted the evaluations. R1 conducted the interview and clinical examination, and applied the RDC/TMD Axis I and II criteria.[17–19] R2, who was blinded to the individual's pain status, applied the psychophysical and algometry tests. The sequences of the assessments and the areas of evaluation were determined randomly.

The socio-demographic data, main complaint, pain characteristics, dental examination, and medical history were assessed through an interview and clinical examination. The TMD diagnoses and differential diagnosis with other orofacial pain conditions were made according to the American Academy of Orofacial Pain (AAOP) diagnostic criteria.[1]

RDC/TMD Axis I criteria were used to classify the TMD into group I (myofascial TMD), group II (TMJ disc displacement), or group III ((a) arthralgia, (b) osteoarthritis, or (c) osteoarthrosis). Women classified as presenting group I and/or group IIIa or IIIb were included in the painful TMD group. Individuals who fulfilled the criteria for group II or no TMD were classified as controls.

The RDC/TMD Axis II criteria were applied to assess the grade of depression and somatization (non-specific physical symptoms (NSPS)). Depression and NSPS were individually classified as normal, moderate, or severe. For the analyses, the moderate and severe categories were grouped together, and both depression and NSPS were treated as dichotomous variables (no depression/depression; no NSPS/NSPS).

Psychophysical test—vibrotactile stimulation

The vibrotactile stimulus was applied using an electric toothbrush, a validated method for the assessment of pain sensitivity and CS for screening purposes.[7] Following the previously validated method,[7] an electric toothbrush with a brush head of 1 cm in diameter, with 22 tufts of bristles and approximately 50 polished bristles per tuft was used (Braun – Oral-B). The brush head moves in a rotational direction at a frequency of 5 Hz. The bristles were positioned perpendicular to the skin with 1 lb of pressure for 30 s. Researcher R2 calibrated the pressure applied immediately before and then after the application of the stimulus, using an electronic scale.[7]

The stimuli were applied bilaterally at the lateral pole of the TMJ, mid-masseter, and anterior temporal muscles, and also in the ventral region of the forearms, following the same protocol. The pain or unpleasantness (if any) evoked by the vibrotactile stimuli was assessed using a 100-mm visual analogue scale (VAS). At each point the participant was required to estimate the pain at the initial moment of vibrotactile stimulus application (0 s), and after 15 s, 30 s (when the stimulus was interrupted), and 60 s (30 s after cessation of the stimulus).[7]

The resultant right and left pain figures were added for each point stimulated in the trigeminal area (lateral pole of the TMJ, mid-masseter, and anterior temporal muscles) to obtain the total trigeminal region pain. The same was done for the extra-trigeminal area: the resultant right and left pain figures for the ventral area of

the forearms were added to obtain the extra-trigeminal region pain. For each individual, the trigeminal and extra-trigeminal region pain scores were plotted separately against time and connected with a line. The area under the line was calculated and used as the amount of pain experienced by the individual over time following the vibrotactile stimulation.[7]

Pressure pain threshold (PPT)

The PPT evaluation consisted of measuring the PPT bilaterally in the central region of the anterior temporal muscle, midmasseter, lateral pole of the TMJ, and the lateral epicondyle following a protocol described previously.[20] Researcher R2 was trained for a total of 15 h in the application of a constant pressure of approximately 0.5 kg/cm^2/s. The pressure was applied with the tip of the device positioned perpendicular to the skin. A rubber disk with 1 cm^2 of surface was fixed on the tip to prevent any skin injury. A digital metronome (Korg, model A-30) with a frequency of 1 Hz was used in all tests to ensure a standard speed of application of the compression force in kilogram-force (kgf).[20] During the evaluations, the volunteers were in a comfortable sitting position and received instructions to keep the masticatory muscles relaxed. The investigator provided manual resistance contralateral to the point of pressure application to stabilize the head. The volunteer verbally communicated the perception of the pain onset, and the pressure was immediately interrupted. This procedure was repeated three times at each point with a 5-min interval between the applications.[20] The PPT for each point was obtained by calculating the mean of these three PPT values. The values of the right and left sides were then added to obtain the final PPT figures for the temporal muscle, masseter, TMJ, and epicondyle.

Statistical analysis

Descriptive statistics were used to summarize all measurements. Fisher's test and the χ^2 test were applied to compare proportions. The mean values and standard deviation (SD) of the amount of pain experienced (pain intensity plotted against time) for the trigeminal and extra-trigeminal regions were calculated. Since the data did not adhere to a normal distribution, the Mann–Whitney test for independent samples was performed to compare the mean pain ratings and the PPT in the trigeminal and extra-trigeminal regions of the control group compared with the painful TMD group. The sample was also stratified according to the presence or not of depression and NSPS to compare the mean pain between groups. Pearson's correlation test was performed to explore the correlation between the amount of pain in the trigeminal region and the PPT in the same region. Results were considered statistically significant at a P-value of <0.05.

Results

The total sample comprised 45 women with a mean age of 37.5 years (SD 15.3 years). Sixteen of these women had a painful TMD (35.6%) and 29 were free of any orofacial pain (controls, 64.4%). On average, individuals presenting a painful TMD reported that the pain had occurred for the first time 60.8 months ago (SD 71.3 months), varying from 5 months to 240 months. Among them, eight (50%) presented myofascial pain associated with an articular TMD (group I plus group IIIa or IIIb), five (31.3%) were classified as presenting a painful articular TMD (only group IIIa or IIIb), and three (18.8%) were classified as having a myofascial TMD (group I) (RDC/TMD Axis I). The control group comprised 15 women (51.7%) with no TMD and 14 women (48.3%) presenting TMJ disc displacement with no pain (group II only) (RDC/TMD Axis I).

The characteristics of the sample according to the presence of painful TMD are described in Table 1. The mean age and educational level did not differ significantly between the two groups. Regarding marital status, most of the women in the control group were single (58.6%), while among those with a painful TMD most were married (75%) ($P = 0.01$).

Figure 1 shows the total amount of pain for the trigeminal and extra-trigeminal regions (right plus left side) at each evaluation time point (0, 15, 30, 60 s) experienced by the individuals during the vibrotactile test. Compared to the control group, the painful TMD group presented significantly higher mean pain in both the trigeminal and extra-trigeminal region at all assessment time points.

Table 2 displays the total amount of pain experienced in the trigeminal and extra-trigeminal regions resulting from the vibrotactile stimulation, comparing the control and painful TMD groups. In comparison with the control group subjects, individuals with a painful TMD presented higher values in both the trigeminal region (36.9 vs. 12; $P = 0.003$) and extra-trigeminal region (10.5 vs. 3.4; $P = 0.009$).

The sample was stratified according to the presence of depression (RDC/TMD Axis II) to compare the total amount of pain experienced between the groups in both regions (Table 3). Among individuals free of depression, those with a painful

Table 1. Characteristics of the sample according to the presence of a painful TMD.

	Controls ($n = 29$)	Painful TMD ($n = 16$)	Total ($n = 45$)	P-value
Age (years), mean (SD)	35.1 (15.7)	41.8 (13.9)	37.5 (15.3)	$P = 0.104$[a]
Educational level, *n* (%)				5.03 ($P = 0.081$)[b]
Elementary	6 (20.7%)	6 (40%)	12 (27.3%)	
High school	7 (24.1%)	6 (40%)	13 (29.5%)	
College	16 (55.2%)	3 (20%)	19 (43.2%)	
Total	29 (100%)	15 (100%)	44 (100%)	
Marital status, *n* (%)				$P = 0.01$[c]
Single	17 (58.6%)	2 (12.5%)	19 (42.2%)	
Married	9 (31.0%)	12 (75%)	21 (46.7%)	
Widowed	1 (3.4%)	1 (6.3%)	2 (4.4%)	
Divorced	2 (6.9%)	1 (6.3%)	3 (6.7%)	
Total	29 (100%)	16 (100%)	45 (100%)	

TMD, temporomandibular disorder; SD, standard deviation.
[a] Mann–Whitney test for independent samples.
[b] χ^2 test.
[c] Fisher's exact test.

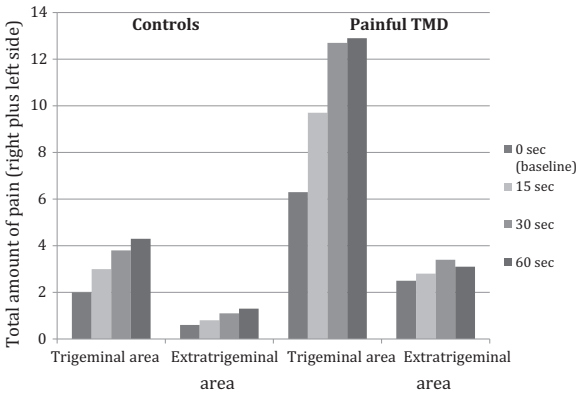

Fig. 1. Total amount of pain in the trigeminal and extra-trigeminal regions at each time point (0, 15, 30, 60 s) during the vibrotactile test, for the control group and painful TMD group.

TMD presented significantly higher values for the trigeminal ($P = 0.002$) and extra-trigeminal regions ($P = 0.001$) than the control group subjects. Conversely, among individuals classified with some grade of depression, although greater pain sensitivity was found among the individuals with a painful TMD than in the controls in both regions (trigeminal: 38.5 vs. 23.6; extra-trigeminal: 13.1 vs. 8), these differences did not reach statistical significance ($P = 0.400$ and $P = 0.661$).

The same evaluation was performed after stratification of the sample according to the presence of non-specific physical symptoms (NSPS, RDC/TMD Axis II) (Table 4). It was found that the differences in mean pain intensity were not significant when comparing the control and painful TMD groups among those with no NSPS (trigeminal: $P = 0.216$; extra-trigeminal: $P = 0.139$) and among those with NSPS (trigeminal: $P = 0.083$; extra-trigeminal: $P = 0.201$).

Table 2. Total amount of pain experienced by individuals presenting a painful TMD and controls following vibrotactile stimulation of the trigeminal and extra-trigeminal regions.

	Number	Total amount of pain, mean (SD)	
		Trigeminal area	Extra-trigeminal area
Controls	29	12 (24.5)	3.4 (8.7)
Painful TMD	16	36.9 (41.7)	10.5 (14.5)
Total	45	20.9 (33.5)	5.9 (11.5)
P-value[a]		0.003	0.009

TMD, temporomandibular disorder; SD, standard deviation.
[a] Mann–Whitney test for independent samples.

Table 3. Total amount of pain experienced by individuals presenting a painful TMD and controls following vibrotactile stimulation of the trigeminal and extra-trigeminal regions, according to the presence of depression (RDC/TMD Axis II).

	Number	Total amount of pain, mean (SD)	
		Trigeminal area	Extra-trigeminal area
Free of depression			
Controls	20	6.8 (14)	1.4 (3.2)
Painful TMD	6	34.3 (40.8)	6.2 (2.6)
Total	26	13.1 (24.9)	2.5 (3.7)
P-value[a]		0.002	0.001
Depression			
Controls	9	23.6 (37.6)	8 (14.4)
Painful TMD	10	38.5 (44.4)	13.1 (18.1)
Total	19	31.4 (40.9)	10.7 (16.2)
P-value[a]		0.400	0.661

TMD, temporomandibular disorder; RDC/TMD, Research Diagnostic Criteria for Temporomandibular Disorders; SD, standard deviation.
[a] Mann–Whitney test for independent samples.

Interestingly, among individuals presenting NSPS, although not significant, the mean pain intensity was higher in the painful TMD group than in the control group (trigeminal: 40.5 vs. 12.3; extra-trigeminal: 11.1 vs. 3.3).

Regarding the PPT test, the values were significantly lower among subjects with a painful TMD compared to controls for all trigeminal (temporal: $P = 0.008$; masseter: $P = 0.046$; TMJ: $P = 0.021$) and extra-trigeminal regions ($P = 0.024$) (Table 5).

Pearson's test was used to study the correlations between the amount of pain related to the vibrotactile stimulation and the mean PPT in the same region. A significant negative correlation was found for both the trigeminal (Pearson correlation = −0.408; $P = 0.005$) and extra-trigeminal regions (Pearson correlation= −0.353; $P = 0.017$), indicating that the higher the pain intensity, the lower the PPT for the same area.

Discussion

Evidence was found of increased pain sensitivity in women presenting a painful TMD. Among these women, most were married. A higher prevalence of married women among individuals presenting chronic pain has been reported before.[21] In a large population study, among women presenting different types of chronic pain, 47.9% were married. Moreover, in that sample, the single marital status was a protective factor in chronic pain for women.[21] The physical and psychological effects of chronic pain influence and are influenced by interpersonal relationships and marital relationships specifically.[22] When a patient's spouse is unable to provide social, instrumental, or emotional support, the person with chronic pain may experience higher levels of pain and dysfunction.[23] This increased pain sensitivity in both trigeminal and extra-trigeminal areas in women presenting a painful TMD with no headaches points to a higher risk of cutaneous allodynia and hyperalgesia, suggesting the existence of CS, associated with the presence of a painful TMD.

People with chronic TMD pain are more likely to experience changes in their central processing of external stimuli within the structures innervated by the trigeminal nerve, resulting in lower sensory thresholds.[24] This can be evidenced by changes in measures of the pressure pain threshold[25] and the perception of vibrotactile stimulation[9] in TMD pain patients.

Quantitative sensory testing (QST) is a group of methods used to assess the positive and negative sensory signals in order

Table 4. Total amount of pain experienced by individuals presenting a painful TMD and controls following vibrotactile stimulation of the trigeminal and extra-trigeminal regions, according to the presence of non-specific physical symptoms (RDC/TMD Axis II).

	Number	Total amount of pain, mean (SD)	
		Trigeminal area	Extra-trigeminal area
Free of NSPS			
Controls	20	11.8 (28.1)	3.5 (10.1)
Painful TMD	2	12.1 (7.16)	6.6 (1.5)
Total	22	11.9 (26.8)	3.7 (9.6)
P-value[a]		0.216	0.139
NSPS			
Controls	9	12.3 (14.8)	3.3 (5)
Painful TMD	14	40.5 (43.6)	11.1 (15.5)
Total	25	29.5 (37.4)	8 (12.9)
P-value[a]		0.083	0.201

TMD, temporomandibular disorder; RDC/TMD, Research Diagnostic Criteria for Temporomandibular Disorders; SD, standard deviation; NSPS, non-specific physical symptoms.
[a] Mann–Whitney test for independent samples.

to identify the neural mechanisms and somatosensory disorders involved in the mechanisms of pain. This represents an appropriate method to quantitatively measure sensory gain, like allodynia.[26] A positive pain response to an individual QST modality is suggestive of sensitization (in the absence of signs or symptoms that explain obvious peripheral reasons for increased sensitivity).[27] Vibrotactile stimulation using an electric toothbrush has proven to be a reliable and valid QST method to evaluate CS in the orofacial region of individuals with a painful TMD. It is considered a multimodal stimulus, since it allows the evaluation not only of the dynamic mechanical allodynia, but also thermal and punctuate mechanical allodynia.[7]

The data from this study showed that women with a painful TMD were more sensitive to pain than those who were free of orofacial pain, suggesting the involvement of peripheral and central mechanisms, including hyperexcitability of the central nociceptive neurons and/or dysfunction of endogenous pain regulatory systems.[28] Previous studies have demonstrated an association between painful TMDs and cutaneous allodynia[4,9] in both trigeminal and extra-trigeminal regions.[4,13] Also, a lower PPT has been found in patients with painful TMDs in the local painful areas, as well as in distant pain-free areas.[4,25] The significant negative correlation between the pain sensitivity related to the vibrotactile stimulation and the mean PPT was expected. Changes in the functional properties of the neurons that occur during CS processes are sufficient to reduce the pain threshold, increase the magnitude and duration of responses to noxious inputs, and permit usually innocuous stimuli to generate pain sensations.[12]

Hyperalgesia and allodynia have been considered clinical markers of CS.[8] While primary hyperalgesia is related to tissue damage or inflammation increasing the excitability of nociceptors, secondary hyperalgesia, defined as an increased sensitivity to noxious stimuli beyond the site of tissue injury, is related to changes within the central nervous system and with the presence of CS.[8] Moreover, central enhancements of excitability and their sensory consequences are critically dependent on the presence of a persistent input from the nociceptors. This indicates a crucial role of the afferent drive in the generation and maintenance of allodynia.[29] It is well established that both mechanisms are implicated in the pathophysiology of painful TMDs.[8]

The nociceptive inputs from the masticatory muscle or TMJ could lead to the activation of the trigeminal nucleus caudalis.[30] Furthermore, the presence of proinflammatory factors in the TMJ could be another form of sensitization.[29] It has also been suggested that a general hyperexcitability in central nociceptive processing is part of the pathophysiology of TMDs, which could explain the greater sensitivity to pain in multiple body areas in TMD patients.[9,28]

Besides the higher risk of CS, individuals with a painful TMD, like those with other painful chronic conditions, also present a higher risk of comorbid psychological disorders.[31] These aspects can contribute to the onset and perpetuation of the pain.[32] Depression seems to interfere with the central modulation of the pain response,[33] and when deficits occur in these areas, the modulation of signals from the body are disturbed, leading to a more intense experience of pain.[34] Furthermore, depression induces stress and increases the production of proinflammatory cytokines,[35] which may increase pain.[2]

Previous studies have shown the association between the presence of NSPS (somatization) and painful TMDs.[2,31,35] The levels of these symptoms reflect distress arising from perceptions of bodily dysfunction. Muscle pain, discomfort, and anxiety symptoms are the possible components of these conditions.[36] In contrast, although in the present study a higher mean pain intensity was found in women with a painful TMD and NSPS compared with the other groups, the differences did not reach statistical significance. It is hypothesized that the absence of significant differences when comparing the groups in the present sample is due to the limited sample size.

The results of this study are consistent with the involvement of CS in women with a painful TMD. These findings emphasize the need for a better understanding of the pathophysiology of TMDs, especially the chronic forms, considering the presence of CS. Understanding the endogenous mediators and factors that contribute to sensitization might provide a better understanding of how acute pain progresses to a chronic physiological pain state. Blocking these receptors might attenuate or prevent acute pain and improve or even reverse a chronic pain condition.[37] Furthermore, the ability to readily differentiate people with increased sensitization could enhance the diagnostic precision of

Table 5. Pressure pain threshold (PPT) in kilogram-force for the trigeminal and extra-trigeminal regions, among individuals presenting a painful TMD and controls.

	PPT (kgf), mean (SD)		*P*-value[a]
	Controls ($n = 29$)	Painful TMD ($n = 16$)	
Trigeminal region			
Temporal	4.9 (2.4)	3.2 (1.3)	0.008
Masseter	3.9 (2)	2.7 (1.1)	0.046
TMJ	4.0 (2.1)	2.6 (1.1)	0.021
Extra-trigeminal region			
Epicondyle	8.5 (4.6)	5.2 (2.6)	0.024

TMD, temporomandibular disorder; SD, standard deviation; TMJ, temporomandibular joint.
[a] Mann–Whitney test for independent samples.

painful conditions, contributing to improved prognostics regarding chronic pain treatments and the pain experienced by patients during the postoperative period.[38] The presence of CS before surgery may be a significant contributing factor to postoperative pain.[16]

The strengths of this study include the fact that the sample was free of any headache, fibromyalgia, and other chronic painful conditions that could interfere with pain sensitivity. As demonstrated in the literature, the presence of fibromyalgia and migraine in people with TMDs is associated with an increase in TMD pain intensity and duration.[39] Additionally, since migraine is highly associated with cutaneous allodynia, it would be an important confounder in the association between TMD and cutaneous allodynia. Finally, the same researcher (LBC) conducted all of the psychophysical tests, improving the accuracy.

The main limitation of this study is that the sample included only women. Since the frequency of TMDs is higher in women, to compose a gender-paired sample would be a difficult task.[1] Also, the sample was relatively small; this was particularly due to the high prevalence of comorbid conditions such as migraine.[10,11] Another limitation is the fact that there was a diversity of sub-diagnoses among the patients with a painful TMD (muscle pain, joint pain/disc disorders, or a combination of muscle pain and joint pain/disc disorders), which implies different treatment approaches. According to Lorduy et al., there is a significant association of myofascial TMDs with symptoms of CS syndromes.[40] However, in this study the focus was placed on the pain phenomenon, which is similar regarding the central process independent of the pain source (muscle or joint). Nevertheless, further studies should be performed to investigate the relationship between CS and each subtype of TMD, which will require larger samples.

Individuals presenting TMDs may be in need of a variety of treatments to address an assortment of different conditions besides the TMD. When a chronic painful TMD is identified, the patient should be screened for the presence of CS and specific measures should be taken to improve the prognostic of any procedure, especially the surgical approaches.

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Competing interests

All authors declare no competing interests.

Ethical approval

The Research Ethics Committee of Araraquara Dental School (Sao Paulo State University, Brazil) approved this study (CAAE 15636913.6.0000.5416).

Patient consent

Informed consent was obtained from each participant.

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