



## Effects of localized versus widespread TMD pain on sleep parameters in patients with bruxism: A single-night polysomnographic study



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### ABSTRACT

**Objective:** The purpose of this study was to investigate whether the presence of concomitant widespread pain could influence the polysomnographic characteristics of patients with Sleep Bruxism (SB) and chronic masticatory muscle pain (TMD).

**Methods:** 20 SB/TMD patients (17 women and 3 men) were evaluated according to the RDC/TMD questionnaire; and were divided into two groups according to the absence (Group A) or presence (Group B) of widespread pain. They were evaluated in a one night polysomnography paradigm.

**Results:** Group B had lower sleep efficiency ( $p = 0.034$ ) and higher mean age ( $p = 0.000$ ) than Group A. Self-reported orofacial pain complaints, clinical and emotional aspects (RDC/TMD Axis I and II), and SB PSG parameters were similar in both groups; all patients had masticatory myofascial pain and the pain characteristics were bilateral location (95.0%) and tightness/pressure quality (70.0%).

**Conclusions:** At a single-night PSG, SB/TMD patients with widespread pain presented lower PSG sleep efficiency and higher mean age.

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### 1. Introduction

The prevalence of temporomandibular disorder (TMD)-related jaw pain in the general population is high (5%) and these patients frequently need health assistance (2%) (Goulet, Lavigne, & Lund, 1995). Sleep bruxism (SB) has been considered to be a factor in the onset and perpetuation of pain in TMD, but until now this role has remained unclear (American Academy of Sleep Medicine, 2005; Fernandes, Franco, Siqueira, Gonçalves, & Camparis, 2012). Muscle fatigue has been considered to be one of the causes of pain associated with TMD (Arima, Svensson, & Arendt-Nielsen, 1999; Lobbezoo & Lavigne, 1997). It has been demonstrated that significant levels of post-exercise muscle soreness can be elicited by standardized grinding movements in the masticatory system of healthy subjects (Arima et al., 1999). However, pain associated with bruxism is not a mandatory finding because many subjects who

appear to brux nightly have no masticatory muscle pain (Lobbezoo & Lavigne, 1997). The occurrence of widespread pain, outside the face or head in TMD pain patients is another factor that may influence the experience of facial pain and the development of TMD pain-related disability (John, Miglioretti, LeResche, Von Korff, & Critchlow, 2003).

On the other hand, TMD pain patients complain more of depression and poor sleep quality (Riley et al., 2001); these factors are related to the worsening of the facial pain (Yatani, Studts, Cordova, Carlson, & Okeson, 2002). Indeed, self-reported sleep disturbances and polysomnographic (PSG) sleep continuity disturbances are related to chronic pain (Moldofsky, 2001; Smith & Buenaver, 2007); although frequently, the perception of sleep quality contrasts with PSG sleep performance (Lavigne, Goulet, Zuconni, Morisson, & Lobbezoo, 1999), similar to the phenomenon called paradoxical insomnia (Goulet et al., 1995). Some studies showed that patients with masticatory muscle pain presented 40% fewer bruxism episodes than patients with SB without facial pain, suggesting that patients with pain showed lower levels of sleep bruxism (Lavigne, Rompré, Montplaisir, & Lobbezoo, 1997; Rompré, Daily-Landry, Guitard, Montplaisir, & Lavigne, 2007).

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However, PSG of sleep bruxism patients did not demonstrate sleep architecture alterations (Lavigne et al., 2001) and in general, studies of the polysomnographic characteristics of sleep bruxism and TMD chronic pain are scarce.

Sleep accounts for nearly one third of our lives and is essential for the maintenance of our health and indispensable for the soundness of our minds and emotions (American Academy of Sleep Medicine, 2005). Its influence can clearly be noted after a single bad night's sleep. Studies in the fields of medicine and sleep biology have yielded a body of literature that has improved the comprehension of sleep and its disturbances, its importance in the body's homeostasis (American Academy of Sleep Medicine, 2005) as well as how sleep is associated to the curious act of teeth grinding. From the investigation of dental occlusion, researchers went on to examine orofacial movements such as mastication which led to pinpointing the role of the central nervous system in the rhythmic activity of mastication muscles and sleep bruxism (Lavigne et al., 2007).

Sleep disturbance is a common clinical complaint of several chronic pain disorders (Moldofsky, 2001; Smith & Buenaver, 2007). Some studies have confirmed that sleep continuity parameters are linked to clinical pain severity (Drewes et al., 2000; Göder et al., 2003) or to generalized body pain, like fibromyalgia (Moldofsky, 2001; Roizemblatt, Moldofsky, Benedito-Silva, & Tufik, 2001). There is a lack of studies evaluating sleep continuity disturbance related to specific pain disorders (Smith & Buenaver, 2007), such as TMD and particularly where there is additional pain in other body regions.

In a previous study of SB patients with and without chronic TMD pain, we did not find any statistically significant differences in PSG. However, among those with masticatory myofascial pain, there were more sleep disturbance complaints and in a few patients, signs of altered sleep efficiency (<85%) were observed (Camparis et al., 2006). Interestingly, some of those patients had concomitant pain in regions of the body other than the face or head. Thus, the purpose of this study was to investigate whether the presence of concomitant widespread pain could influence the polysomnographic characteristics of patients with SB and chronic TMD pain.

## 2. Materials and methods

### 2.1. Sample

We selected patients with SB and chronic masticatory muscle pain (17 women and 3 men) from a group of 47 patients who presented SB at a single-night PSG, and who were referred to our Orofacial Pain Team for investigation of orofacial complaints. The final selection was based on the following criteria:

1. Medical record indicates frequent presentation with tooth grinding during sleep that is confirmed by polysomnography in a sleep laboratory. The polysomnographic diagnostic cut-off criteria for sleep bruxism were as follows: a) more than 4 bruxism episodes per hour, b) more than 6 bruxism bursts per episode and/or 25 bruxism bursts per hour of sleep, and c) at least 2 episodes with grinding sounds (Camparis et al., 2006).
2. Chronic facial pain diagnosed using the criteria from the International Association for the Study of Pain (Merskey & Bogduk, 1994).
3. The selected patients were divided in two groups, based on a clinical report of the absence or presence of chronic pain external to the face and head, as follows:

- *Group A*, bruxers with chronic masticatory muscle pain (n = 10);
- *Group B*, bruxers with chronic masticatory muscle pain and concomitant widespread pain (n = 10).

All the patients gave informed consent to procedures approved by the Ethics Committee of the Medical School.

### 2.2. Exclusion criteria

The exclusion criteria were: the use of drugs with action on the central nervous system, lack of posterior occlusal support, the use of an occlusal splint or current orthodontic treatment, fibromyalgia, epilepsy, neuropathic pain, diabetes, insomnia or neurological diseases that could affect motor function.

### 2.3. Clinical evaluation

All the patients received a standardized protocol (Camparis & Siqueira, 2006) administered by the same dentist. It consisted of an interview and systematic evaluation of cervical, cranial, facial, dental and other oral structures with the following specialized diagnostic instruments or exams:

1. A standardized orofacial pain evaluation to obtain details on the following: a) the chief complaint, b) the general orofacial pain characteristics (location, quality, duration, time of pain worsening), c) the presence of headache or additional pain in other body regions (outside the head or face), determined by pain drawings and open questions, and d) the patient's medical history and comorbidities.
2. The Portuguese version of the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) (Pereira Junior, Favilla, Dworkin, & Huggins, 2004).

### 2.4. Sleep and bruxism evaluation

The patients were referred for one full-night polysomnographic recording (Sonolab-Meditron System) to confirm the presence of sleep bruxism and for analysis of the sleep architecture and the presence of sleep disorders. The polysomnography included: electroencephalogram (EEG), utilizing the 10%–20% international system and C3/A2-C4/A1 electrodes; bilateral electrooculograms (EOG); electrocardiogram (ECG); oronasal airflow measurement; pulse oximeter; chest and abdominal movements register; and electromyograms (EMG) of chin/suprahoid, bilateral masseter and anterior tibialis muscles (Carskadon & Rechtschaffen, 2000).

The polysomnographic recording was made in a sound-attenuated and temperature-controlled room with simultaneous audio and video recordings. Prior to recordings, the patients were trained to perform voluntary clenching (to determine patients' maximal intercuspal occlusion), to allow for signal recognition and the calibration of masseter EMG, at three levels: maximum (100%), moderate (>50%) and light (<20%). All patients answered questions about pain during the day before and the night of the exam.

### 2.5. Data analysis

In order to prevent the inclusion of other orofacial motor activities unrelated to bruxism episodes, audio and video recordings were used to observe the patients. Only the EMG potentials of masseter activity with an amplitude of at least 20% of the maximum voluntary contraction were retained for analysis. The EMG events were defined and scored in three different types of episodes: phasic (rhythmic), tonic (sustained), or mixed (both phasic and tonic). A phasic episode corresponded to at least three EMG bursts of 0.25–2.0 s duration, separated by two inter-burst intervals. A tonic episode corresponded to an EMG burst lasting more than 2.0 s (Sjöholm, Lehtinen, & Helenius, 1995). The total number of bruxism episodes and bursts was expressed as an index

per hour of sleep as well as in bursts per episode. The percentage of bruxism episodes with micro-arousals, the total duration of bruxism episodes (s), the percentage of bruxism episodes in each sleep stage and the mean bruxism episode amplitude ( $\mu\text{V}$ ) were also calculated. The sleep parameters were expressed as the total sleep time, sleep efficiency (the cut-off point for severity of poor sleep efficiency is 85%) (American Academy of Sleep Medicine, 2005), REM and non-REM latency, percentage of REM and non-REM sleep stages, number per hour and duration of micro-arousals, number of obstructive apnea events and periodic leg movements per hour. Sleep parameters were scored in 30-s epochs according to a standard method (Rechtschaffen and Kales, 1968). The arousals, periodic leg movements and respiratory events were analyzed by international rules (American Sleep Disorders Association, 1992, 1993; Goulet et al., 1995). The PSG analyses were made by the authors, who were trained for this type of analyses (Camparis et al., 2006).

The statistical analyses were performed using a Chi-square test (Fisher's exact test in cases of small expected frequency) to measure the strength of the associations of the analyzed variables in the two compared groups. The analyzed qualitative variables were obtained from the RDC/TMD self-report, RDC/TMD Axis I and Axis II levels of depression, non-specific physical symptoms and data from the clinical protocol. The Mann-Whitney test was used to compare age and the quantitative variables of bruxism and sleep between the two groups.

The level of significance was 5% and the statistical analyses were performed using SPSS 11.0 for Windows.

### 3. Results

The ages ranged from 22 to 54 years (mean  $32.75 \pm 6.45$  years). There was a statistically significant difference between the mean age ( $p=0.000$ ) of groups A and B, but no statistically significant difference in the distribution of gender ( $p=1.000$ ). The general characteristics of the sample are shown in Table 1.

The pain duration ranged from 1 to 10 years (mean 4.37 years, median 4.00 years) and the intensity of pain (VAS) at the moment of clinical evaluation ranged from 3 to 10 (mean 4.69). The pain characteristics were bilateral location (95.0%) and tightness/pressure quality (70.0%).

The sites of overall body pain reported by Group B patients were: neck and shoulder in 4 (40%), back in 5 (50%), arms in two (20%) and legs in three (30%). All the patients' pain characteristics were of musculoskeletal origin.

Seventeen of the twenty patients reported facial pain complaints during the day before the polysomnographic recording.

#### 3.1. RDC/TMD self-reported symptoms, axis I and II diagnosis

The self-reported RDC/TMD characteristics showed the presence of diurnal tooth grinding/clenching, TMJ clicking, morning stiffness/fatigue, ringing in the ears and uncomfortable bite in both groups. The RDC/TMD axes I and II showed no

statistically significant difference between groups A and B. All results are outlined in Tables 2 and 3.

#### 3.2. PSG sleep bruxism variables (Tables 4 and 5)

Sleep bruxism was analyzed using the following variables: number of episodes per hour of sleep, number of bursts per hour of sleep, number of bursts per episode, total duration of episodes, percentage of episodes in stages 1–4 and REM sleep, percentage of episodes with micro-arousals, maximum voluntary contraction and amplitude of bruxism episodes. No statistically significant differences were found between the two groups for any of these variables.

Patients with widespread body pain (group B) had a lower level of sleep efficiency ( $p=0.034$ ).

### 4. Discussion

Except for age, the present data show that both groups were paired and constituted a uniform sample in relation to the variables studied: a) gender; b) TMD characteristics (RDC/TMD axes I and II) and c) sleep parameters, including those specifically for bruxism, except for sleep efficiency. Most patients in each group were female. This result is in agreement with current scientific literature that shows a higher frequency of women in samples of patients with TMD pain (Camparis & Siqueira, 2006; Huber & Hall, 1990) than men. The characteristics of self-reported orofacial complaints and the temporomandibular disorder diagnosis (Table 2, axis I RDC/TMD) were similar for both groups and all patients had chronic masticatory myofascial pain. The same pattern occurred for RDC/TMD Axis II, which showed that patients presented higher scores of nonspecific physical symptoms and higher frequency of moderate and severe depression than usual, although these trends were not statistically significant between the groups, probably because both had patients with chronic TMD. These findings support published studies documenting more complaints of depression and non-specific physical symptoms in TMD pain patients (Camparis & Siqueira, 2006; De Leeuw, Studts, & Carlson, 2005; Riley et al., 2001). Patients with SB and chronic masticatory muscle pain may self-report a higher frequency of daytime tooth grinding/clenching, when compared with SB patients without pain (Camparis & Siqueira, 2006). Therefore, another aspect to consider is the possible contribution of daytime clenching and stress events to the maintenance of pain (Glaros, Williams, & Lausten, 2005; Van Selms, Lobbezoo, Wicks, & Hamburger, 2004). In the present study, the self-reporting of diurnal tooth grinding/clenching was high, but similar in both groups; most patients had morning stiffness or fatigue (Table 2), without any difference between the groups. The mean pain intensity and mean pain duration were similar in both groups, and for this reason we presented the results for the total sample.

Sleep disturbance complaints are more frequent in patients with chronic pain (Drewes et al., 2000; Smith & Buenaver, 2007), including TMD pain patients (Camparis et al., 2006; Moldofsky,

**Table 1**  
Sample demographic data.

Demographic data	Group A	Group B	Total	p values
Mean age (min.–max.)	26.30 (22–33)	39.20 (28–54)	32.75 (22–54)	0.000*
Women n (%)	8 (85.0)	9 (75.0)	17 (85.0)	>0.05**
Men n (%)	2 (15.0)	1 (25.0)	3 (15.0)	
Total n (%)	10 (100.0)	10 (100.0)	20 (100.0)	

\* Mann-Whitney test.

\*\* Fischer Exact test.

**Table 2**  
Self report and Axis I RDC/TMD characteristics of groups A and B.

	Group A n = 10	Group B n = 10	p values <sup>*</sup>
Diurnal tooth grinding/clenching n (%)	7 (70.0)	8 (80.0)	0.4999
TMJ clicking n (%)	7 (70.0)	6 (60.0)	0.4999
Morning stiffness/fatigue n (%)	8 (80.0)	10 (100.0)	0.2368
Ringing in ears (%)	3 (30.0)	7 (70.0)	0.0894
Uncomfortable/unusual bite (%)	5 (50.0)	7 (70.0)	0.3249
Myofascial pain n (%)	10 (100.0)	10 (100.0)	0.5000
Disc displacement n (%)	1 (10.0)	2 (20.0)	0.5000
Arthralgia n (%)	9 (90.0)	8 (80.0)	0.5000

<sup>\*</sup> Fischer Exact test.

2001; Riley et al., 2001), but PSG studies with TMD patients are scarce, except for those that relate TMD pain in SB patients who showed normal sleep architecture (Camparis et al., 2006; Lavigne et al., 1997, 2001; Rompré et al., 2007). Polysomnographic sleep continuity disturbances are frequent in patients with headache upon awakening (Drewes et al., 2000; Göder et al., 2003). Notably, tension headaches on awakening have been associated with obstructive sleep apnea (Chen & Guilleminault, 2007), but in our data there were no differences between groups with regard to this factor (Table 4) and none of the study subjects exhibited sleep apnea. Thus, it is probable that the lower sleep efficiency observed in Group B patients ( $p=0.034$ ) was influenced by concomitant widespread pain.

**Table 3**  
Axis II RDC/TMD characteristics of groups A and B.

fd	Group A n = 10	Group B n = 10	p values <sup>*</sup>
Chronic pain scale			
Grade I	3	3	0.6857
Grade II	7	5	
Grade III	0	2	
Grade IV	0	0	
Depression			
Normal	3	1	0.2910
Moderate	5	5	
Severe	2	4	
Nonspecific physical symptoms			
Normal	1	0	0.2549
Moderate	5	3	
Severe	4	7	

<sup>\*</sup> Fischer Exact test.

**Table 4**  
Means and standard deviations for sleep variables.

Variables	Group A (n = 10)		Group B (n = 10)		p values <sup>*</sup>
	Mean	s.d.	Mean	s.d.	
Total sleep time (min)	382.25	69.35	412.15	52.46	0.326
NREM latency (min)	13.15	10.78	19.80	14.76	0.496
REM latency (min)	110.80	65.46	98.55	38.09	0.762
Sleep efficiency (%)	89.64	14.27	86.38	9.18	0.034
Stage 1 (%)	2.40	1.86	2.84	0.86	0.447
Stage 2 (%)	58.40	9.36	55.92	4.54	0.650
Stage 3 (%)	3.15	0.74	3.23	0.61	0.909
Stage 4 (%)	18.96	7.94	16.85	5.76	0.762
REM sleep (%)	17.10	3.49	21.16	6.21	0.198
Periodic leg movements (n/h)	0.55	0.50	0.73	0.90	0.848
Obstructive sleep apnea (n/h)	0.65	0.21	1.06	0.75	0.237
Micro-arousals (n/h)	10.27	4.83	9.66	2.71	0.734
Duration of micro-arousals (s)	7.11	0.59	7.18	0.60	0.732

<sup>\*</sup> Mann-Whitney test.

In another study, we did not find a statistically significant difference in sleep architecture between SB patients with and without TMD pain, although SB patients with TMD pain had more complaints of sleep disturbances and trouble falling sleep (Camparis et al., 2006). In that study, the patients with chronic TMD pain were at a mean age of 32 years old. However, in the present study, we observed that SB patients with TMD pain and widespread pain had a higher median age (39.20 y) than the group experiencing pain only in the orofacial area (26.30 y) ( $p=0.000$ ). Thus, the presence of concomitant body pain outside the orofacial area may be due to the older age of group B and, consequently, their poor quality of sleep may be age-related as well. This finding may suggest that young subjects have localized pain, like in group A, and that with aging the patients develop more widespread or diffuse pain (group B). So, the age of the patient is another important issue to be considered at the diagnostic approach to patients with TMD.

Although in this study there was not a control group, in our previous publication (Camparis et al., 2006) we observed that SB patients without TMD had a greater number of episodes and higher duration of bruxism per hour of sleep (average of eight episodes per hour, with average length of 450 s) than the two current groups (Table 4). Sleep bruxism, as a motor jaw activity, may also be modulated by the influence of chronic pain on the motor system (Lavigne et al., 1997; Rompré et al., 2007). These are the main reasons that can explain the lower number of bursts/h and bursts/episode found in the present study. Our findings reinforce the importance of considering the presence of pain outside the orofacial region in TMD pain of SB patients. One needs to remember that chronic pain has a multifactorial etiology and that persistent and chronic pain conditions are associated with prolonged functional changes in the central nervous system (Sessle, 2005). Thus, in the chronic pain patients, factors like central sensitization, neuroplasticity, dysfunction of the inhibitory descend system, and psychosocial abnormalities may be present. On the other hand, patients with sleep bruxism may have peripheral sensitization due to masticatory muscle alterations (Lavigne et al., 1997; Sessle, 2005), and the diffusion and amplification of persistent deep pain may be the result of an increase in descend endogenous facilitation (Ren & Dubner, 2002). Further research is necessary to clarify the interaction between SB, chronic pain and sleep disturbances in patients with TMD.

TMD pain patients are a heterogeneous group and several factors are described to contribute to the onset and perpetuation of TMD, including SB (Goulet et al., 1995; Lavigne et al., 1997; Lobbezoo and Lavigne, 1997), which was similar in both groups of this study, or the presence of pain outside the masticatory system or head (Hagberg, 1991; John et al., 2003; Turp, Kowalski, O'Leary, & Stohler, 1998). TMD may be a comorbidity of patients with fibromyalgia (Dao, Reynolds, & Tanenbaum, 1997); however, fibromyalgia patients were not included in this study. On the other hand, patients with widespread pain in their body can show temporal and spatial summation (Staud, Koo, Robinson, & Price, 2007), and more frequent complaints of sleep disturbance (Moldofsky, 2001; Roizemblatt et al., 2001; Smith and Buenaver, 2007). Thus, clinicians need to be aware that the inefficacy of a TMD treatment can be a consequence of the presence of unknown widespread pain (Raphael and Marbach, 2001). Observations regarding the decreased sleep efficiency in group B should be considered as another possible and important factor at the evaluation of these patients.

The cut-off point for severity of poor sleep efficiency is 85% (American Academy of Sleep Medicine, 2005). In our study, both groups showed sleep efficiency above 85%. However, in group B the sleep efficiency was lower than group A. This is another important

**Table 5**  
Means and standard deviations for bruxism variables.

Variables	Group A (n = 10)		Group B (n = 10)		p values <sup>*</sup>
	Mean	s.d.	Mean	s.d.	
Number of episodes/hour	6.79	2.58	5.70	1.79	0.405
Number of bursts/hour	23.90	9.78	22.20	12.14	0.364
Number of bursts/episode	3.54	1.13	3.88	1.98	1.000
Total duration of episodes (s)	332.06	191.18	315.02	84.34	0.762
Episodes in stage 1 (%)	4.98	4.42	4.13	3.75	0.790
Episodes in stage 2 (%)	64.46	13.47	65.10	12.88	0.880
Episodes in stage 3 and 4 (%)	7.29	6.54	7.69	5.67	0.733
Episodes in REM sleep (%)	23.27	13.75	23.06	12.57	0.940
Episodes with micro-arousals (%)	81.87	11.09	87.97	6.97	0.226
Maximum voluntary contraction ( $\mu$ V)	260.80	159.37	227.10	86.03	0.940
EMG amplitude ( $\mu$ V)	143.66	48.96	144.20	52.48	0.940

<sup>\*</sup> Mann-Whitney test.

finding because it suggests that some SB/TMD subjects with widespread pain had less sleep efficiency, although the sample average was above the cut-off point. There was little difference between the two groups; however, the group with wide-spread body pain was more homogeneous than the other, and a possible reason for the difference in sleep efficiency between groups. In this exploratory study no correction was made for multiple corrections, and this is a limitation that must be considered.

The effects of the different environment and the devices used in the PSG, such as the discomfort of the electrodes, the limitation of movements and the potential psychological consequences due to the patient being observed and evaluated have been mentioned in the literature (Goulet et al., 1995). Some authors performed one-night polysomnography; depending on the quality of sleep observed and the presence of sleep disorders, the exam was either repeated or considered as representative of the patient (Bader, Kampe, & Tagdae, 2000; Sjöholm, Lowe, Miyamoto, Fleetham, & Ryan, 2000). In the present study, one-night polysomnography was carried out for each patient, and the sleep efficiency can be lower in the PSG first night, so this effect is a limitation of our study and needs to be considered with caution.

In conclusion, considering the employed methodology, the sleep parameters were similar for both groups; however, in the patients with widespread pain, sleep efficiency was lower and the mean age of patients was higher. These data reinforce the importance of considering the age and the presence of concomitant pain complaints in several regions of the body at the evaluation of sleep efficiency with TMD pain in SB patients.

#### Conflict of interest

None.

#### Ethical approval

All the patients gave informed consent to procedures approved by the Ethics Committee of the Medical School.

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