Nonfunctional Tooth Contact in Healthy Controls and Patients with Myogenous Facial Pain

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Aims: *To investigate how often healthy controls and patients with myogenous masticatory pain have wake-time nonfunctional tooth contact, whether the frequency of nonfunctional tooth contact differs between genders or between weekdays and weekends, and whether it is influenced by stress levels.* ***Methods:*** *The study was performed on 24 subjects: 15 controls and 9 patients with myogenous facial pain. Before data collection the subjects were trained to ascertain their ability to feel correctly whether their teeth were in contact or apart. Subsequently, for 10 days the subjects were alerted by means of a radio wave–activated wrist vibrator approximately every 20 minutes (8:00 AM to 10:00 PM) in order to report whether the teeth were in contact. Subjects also completed 2 stress assessment questionnaires, the Perceived Stress Scale (PSS) and the short version of the Trier Inventory for Assessment of Chronic Stress (TICS-S).* ***Results:*** *There was a significantly higher frequency of wake-time nonfunctional tooth contact in myogenous pain patients than in controls (median of 34.9% and range of 26.5% to 41.3% for patients; median of 8.9% and range of 2.3% to 14.3% for controls;* P *< .001). In both groups the frequency of nonfunctional tooth contact did not significantly differ among the various days or between the genders. The patients had significantly higher PSS scores and reported having experienced more stressful situations in the dimensions "social overload" and "overextended at work" than the controls. However, PSS and TICS-S scores were not correlated with the frequency of nonfunctional tooth contact for either group.* ***Conclusions:*** *Myogenous pain patients had nearly 4 times more nonfunctional tooth contact during wake time than controls.* J OROFAC PAIN 2007;21:185–193

Key words: bruxism, ecological momentary assessment, tooth clenching, tooth contact

It is believed that clenching during wake time may play a role in the etiology of the myoarthropathies of the masticatory system (MAP), ie, temporomandibular disorders (TMD), especially myogenous TMD. Indeed, studies often have described an association between wake-time clenching and MAP symptoms.[1–6] One study reported that MAP patients seem to keep their teeth in contact more often than non-MAP patients,[7] a finding reported also in an epidemiologic, questionnaire-based study.[6] Lastly, it has been recently reported that 50% to 60% of patients with masticatory myalgia habitually keep the teeth in contact during wake time.[8,9]

Occlusal parafunction during wake time and sleep bruxism differ in character and may have different causes. Thus, the 2 behaviors should be considered separately. Wake-time parafunction is normally not associated with tooth grinding such as that observed in sleeping patients; it consists mainly of tooth clenching.[10] Wake-time parafunction is probably a more relevant risk factor for myogenous masticatory pain than sleep bruxism because it is accompanied by long-lasting muscle contractions that under experimental conditions may elicit muscle pain even if performed at low intensity.[11,12]

Surveys on wake-time tooth clenching were based on retrospective self-reports. All self-reports are prone to recall errors, as subjects may be unaware of their teeth being in contact and/or they may not be able to recall this situation when asked to report it later in time.[13–16] In addition, self-reports only allow, at best, an estimation as to whether subjects clench their teeth. They do not provide information on how often occlusal parafunction or simply nonfunctional tooth contact occurs during wake-time periods. To address the concerns of recall errors, a technique called ecologic momentary assessment (EMA) or experience sampling methodology has been developed. This method allows moment-by-moment data to be collected in the natural environment. Thus, the immediate recall of momentary phenomena minimizes reliance on recall and attention biases. The validity of the EMA technique for behavioral assessment is well established.[15] It has already been used to study tooth clenching in healthy subjects and MAP patients.[2,7,17] In these studies, patients were alerted by means of a pager on average every 2 hours during 1 week. Upon being alerted they completed a questionnaire asking, among other questions, about the presence and intensity of tooth contact. The results indicated that MAP patients engaged more often in tooth clenching than normal subjects.[7,17] The limits of this approach were a low number of alerts per day, relatively few days of recording, and a cumbersome method of data collection (questionnaire). Therefore, the present investigators designed an alerting and monitoring device that was easy to carry and allowed a shorter response time as well as the collection of a much larger number of data points over a longer observational period in order to obtain a more accurate picture of the subjects' behavior.

The goals of this study were to investigate how often healthy controls and patients with myogenous masticatory pain have wake-time nonfunctional tooth contact, whether the frequency of nonfunctional tooth contact differs between genders or between weekdays and weekends, and whether it is influenced by stress levels.

Materials and Methods

Subjects

The study was performed on 15 controls (10 women and 5 men; median age, 30 years; range, 19 to 49 years) and 9 patients with myogenous facial pain (6 women and 3 men; median age, 35 years; range, 18 to 67 years). Gender and age distribution did not significantly differ between the 2 groups (Mann-Whitney test, $P > .05$).

The controls were recruited among friends (5), research laboratory staff (3), and dental staff (4 nurses, 2 students, and 1 dentist) and were examined by 2 independent and calibrated dentists according to the clinic protocol. The controls had to be in good general health and free of signs and symptoms of MAP. Maximum opening had to be > 40 mm, protrusion and laterotrusion > 7 mm, and endfeel normal. Signs such as a slight tenderness in ≤ 3 masticatory muscles in response to palpation and soft but pain-free joint clicking were not criteria for exclusion. In addition controls had to be free of neck and shoulder pain and feel that their teeth fit comfortably together.

The patients, who were referred to the clinic for treatment of orofacial pain, were also examined clinically by the dentists in order to select only patients with a diagnosis of myogenous pain according to the Research Diagnostic Criteria for TMD (RDC/TMD).[18] The criteria were *(1)* a report of pain in the jaw, temples, face, preauricular area, or inside the ear at rest or during function and *(2)* tenderness to palpation of 3 or more of the 14 examined muscle sites, with at least 1 tender point on the painful side. In case of discrepancy in the diagnosis (1 case), a third dentist checked the patient, and a diagnosis was reached by consensus.

Exclusion criteria were a previous MAP therapy (only for the controls; 3 patients reported conservative therapy), wearing dental prostheses, psychiatric or neurologic disorders, and the use of drugs affecting the central nervous system. In addition, since it is unknown whether sleep bruxism is associated with wake-time tooth clenching, subjects with that condition were excluded. Thus, any subject with severe tooth wear, crown height reduction, shiny spots on restorations, masseter muscle hypertrophy, or grinding sounds recently reported from sleep partners was excluded.

The study protocol was approved by an institutional review board. All subjects signed an informed consent form prior to the investigation.

Clinical Examination

The clinical examination included measurement of active and passive maximum opening; active protrusion and laterotrusion; palpation and auscultation of the TMJ area; and palpation of the masticatory muscles. In contrast to the RDC/TMD, only 7 muscle sites per side were examined, viz, the anterior, medial, and posterior portion of the temporal muscle; the insertions of the temporal and medial pterygoid muscles; and the superficial and the deep masseter muscle. The lateral pterygoid muscle was not palpated, as it is inaccessible to palpation.[19,20] Pressure palpation was standardized at 10 N/cm^2 for extraoral muscles and 5 N/cm^2 for the joints and the intraoral sites.[18] A muscle was considered tender to palpation if the subject reported pain on palpation or the palpation elicited blinking or a withdrawal reflex.

Recording Devices

In order to establish how often each subject kept the teeth in contact, a microprocessor-controlled recorder was constructed. The recorder activated by radio waves a wrist-vibrator, which alerted the subject to check whether the teeth were in contact. The device allowed the subject to choose among the following reply options: teeth not in contact, teeth in contact, speaking, swallowing, and chewing. If the subject did not enter an answer within 32 seconds, "no reply" was recorded. The recorder was programmed to alert the subjects approximately every 20 minutes from 8:00 AM to 10:00 PM. To avoid habituation and to prevent any anticipatory behavior, the recorder was programmed to add or subtract a random interval (0 to 9 minutes) to the preselected times. Thus, the subject received randomly occurring alerts 43 times per day.

Stress Assessment

Each subject filled out 2 stress-assessment questionnaires: the German translation of the Perceived Stress Scale (PSS) and the German short version of the Trier Inventory for Assessment of Chronic Stress (TICS-S), which have good internal consistency and construct validation.[21–23] The PSS[24] measures the degree to which a situation is appraised as stressful. It is a 14-item self-report instrument with a 5-point scale (0 = never, 1 = almost never, 2 = sometimes, 3 = fairly often, 4 = very often). The TICS-S, which is derived from the second revision of TICS,[25] is a 30-item self-report scale for the assessment of chronic stress in various dimensions: "Work overload," "Social overload," "Overextended at work," "Lack of social recognition," "Work discontent," "Social tension," "Performance pressure at work," "Performance pressure in social interactions," "Social isolation," and "Worry propensity." The subjects assessed on a 5-point rating scale how frequently (never, rarely, sometimes, often, or very often) they had experienced specific stressful situations during the previous 3 months.

In addition, the subjects had to report daily difficulties in using the recorder and/or whether the use of the device, which alerted the subject approximately every 20 minutes, disturbed them in their daily activities, for instance, during work, sports, or social activities.

Experimental Protocol

Before data collection, the subjects were informed about the goal of the study but were kept blind about a possible association between the habit of keeping the teeth in contact and facial pain. In addition, patients were told that the additional information was necessary to improve the diagnosis. Furthermore, the subject's ability to feel correctly whether the teeth were in contact was validated before the beginning of the recording session. For this, the interocclusal space was continuously recorded by means of a Hall Effect sensor (HAL-805, MICRONAS) attached to a spectacle-frame and a magnet fixed to the mandibular incisors. A tone signal was randomly activated, and the subject had to record whether teeth were in contact. The accuracy of the response was checked by measuring the interocclusal distance. This procedure was repeated 20 times in 3 different series during the same day. A subject was considered to have answered correctly when more than 95% of the answers of the 3 series were correct, and the last series also had more than 95% correct answers. All subjects achieved these goals within the 3 series.

Thereafter, the patient was instructed how to handle the recorder and the wrist vibrator. He or she was given the stress questionnaires, with brief instructions on how to fill them out, and asked to return the materials at the end of the 10th recording day. Originally, the intent was to record tooth contacts for 10 consecutive days starting on a Friday or Saturday (4 weekend days and 6 weekdays). However, for different reasons 5 patients could not follow this schedule. These patients recorded tooth contacts on nonconsecutive days—4 weekend days and 6 weekdays during a 2-week period.

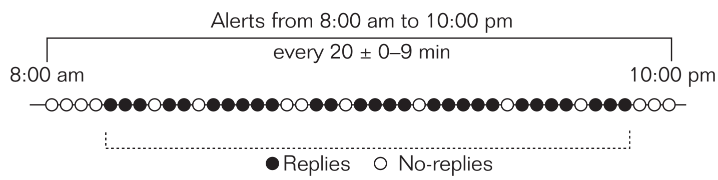

Fig 1 Illustration of determination of the number of replies. The solid line represents 43 alerts between 8:00 AM and 10:00 PM, and the dotted line represents the number of replies to alerts from the first reply to the last reply. All replies and no-replies are illustrated.

Data Analysis

The subjects returned the recorder and the questionnaires/reports after the last recording day. All alerts within the recording period, 8:00 AM to 10:00 PM, were counted starting from the first reply to the last one, ie, all alerts occurring before the first reply and after the last one were discarded (Fig 1). This was done because the lack of reply was mostly due to the fact that the subject went to sleep before 10:00 PM or woke up after 8:00 AM on weekends. The number of no-replies was determined by subtracting the number of replies from the number of alerts. The frequency of nonfunctional and of functional tooth contact was expressed as a percentage of the total number of replies to the counted alerts, whereas the number of no-replies was expressed as a percentage of all alerts.

A power analysis with an α value of .05 of the data of the first 9 subjects indicated a power of 100%. Nonetheless, the sample size was increased in order to provide normative data.

Nonparametric statistical tests were used because the control data were not normally distributed. As the frequency of nonfunctional tooth contact did not vary significantly during the 10 days (Friedman test, $P > .05$), the mean values were averaged over the 10 recording days, and the group median value was calculated. The Mann-Whitney test was used to analyze whether there were any differences between controls and patients as well as between the controls working in the dental field (dental students, nurses, and a dentist) and those naive to dental issues (friends and laboratory technicians). The Wilcoxon signed rank test analyzed whether the frequency of nonfunctional tooth contact differed between weekdays and weekend days. For this test the frequencies were averaged over the weekdays and weekend days, respectively.

As the number of male and female subjects within each group was small, the frequency of nonfunctional tooth contact was pooled for each gender and analyzed with the Mann-Whitney test. The Spearman's correlation coefficient analyzed whether the frequency of no-replies correlated with that of nonfunctional tooth contact within each subject and also estimated whether the number of nonfunctional tooth contacts decreased over the 10-day period. This was assessed only for those subjects with 10 consecutive recording days starting on Saturday. The degree of association between the frequency of nonfunctional tooth contact and PSS scores as well as the scores for single TICS-S dimensions was also assessed by means of the Spearman's correlation coefficient. Differences in the PSS and TICS-S scores between the 2 groups were evaluated by means of the Mann-Whitney test. A significance level of $P < .05$ was set and corrected according to Bonferroni in the case of repeated tests. The statistical tests were performed by means of the statistical package SPSS for Windows v. 12.0.01 (SPSS).

Results

Myogenous pain patients had significantly more often nonfunctional tooth contact (median 34.9%) than healthy controls (median 8.9%; Mann-Whitney test, $P < .001$; Table 1 and Fig 2). The statistical distribution of the nonfunctional tooth contacts of the controls were skewed toward zero, while that of the myogenous pain patients was more symmetrical. There was no overlap between the statistical distributions of the 2 groups (Fig 2), which is expressed by a power of 100%, ie, a zero β error. The frequency of nonfunctional tooth contact did not differ significantly between the genders (women: median 13.5%; men: median 11.1%;

Table 1 Frequency of Nonfunctional Tooth Contact, Functional Tooth Contact (During Chewing and Swallowing), and No-Replies in Controls and Myogenous Pain Patients

	Controls (n = 15)		Patients (n = 9)			
	Median	Range	Median	Range	U*	*P**
Nonfunctional tooth contact	8.9	2.3–14.3	34.9	26.5–41.3	0.00	< .001
Functional tooth contact (chewing and swallowing)	9.2	5.4–23.3	10.9	6.1–23.3	60.0	.655
No-replies	9.7	1.2–31.0	13.2	2.8–33.7	57.00	.531

*Mann-Whitney test.

Mann-Whitney test, $P > .05$). Furthermore, there was no significant difference between controls with or without knowledge of dentistry (Mann-Whitney test, $P > .05$). Neither the control nor the pain group exhibited any difference in the frequency of nonfunctional tooth contact between weekdays and weekend days (Wilcoxon signed rank test, $P > .05$). Taking into consideration only those controls and myogenous pain patients with 10 consecutive recording days starting on Saturday, the frequency of nonfunctional tooth contact did not change over the 10 days (nonsignificant Spearman correlation coefficients).

The frequency of functional tooth contact, ie, contact during chewing or swallowing, was similar between the 2 groups (median 10.9% versus median 9.2%; Mann-Whitney test, $P > .05$; Table 1).

The subjects responded to at least 242 (max 422) of the total 430 alerts during the 10 days (median, 89.1%; range, 66.3% to 98.8%). The frequency of no-replies did not differ between the controls and the myogenous pain patients (Mann-Whitney test, $P > .05$; Table 1). The overall median of no-replies was 10.9% (range, 1.2% to 33.7%). No significant association (Spearman) was found between the frequency of no-replies and the frequency of nonfunctional tooth contact among all subjects; Spearman's rho varied between 0.575 and 0.455.

The patients had significantly higher mean PSS scores than the controls (patients: median 31, range 8 to 42; controls: median 20, range 6 to 27; Mann-Whitney test, U = 20.0, $P = .005$). With respect to the TICS-S scores, the myogenous pain patients reported that they had experienced stressful situations significantly more often over the past 3 months in the "social overload" (patients: median 7; controls: median 3) and the "overextended at work" dimensions (patients: median 4; controls: median 2; Mann-Whitney test, $P < .05$; Table 2). Neither the PSS scores nor the single TICS-S dimension scores correlated significantly with the frequency of nonfunctional tooth contact for either the controls or the patients (Spearman's rho of –0.022 and –0.100, respectively; $P = .939$ and $P = .798$, respectively; 2-tailed).

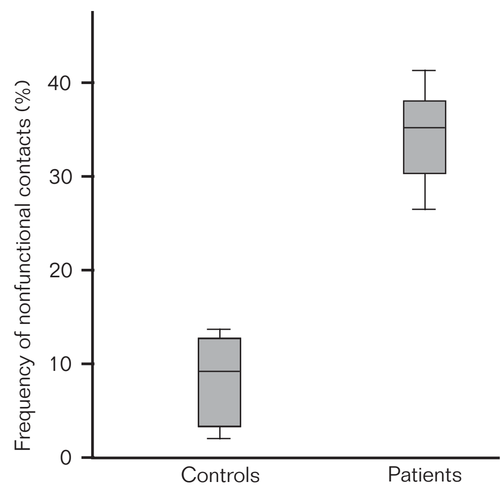

Fig 2 Frequency of nonfunctional tooth contact in patients and controls. Medians, quartiles, and extreme values (bars).

Overall, the subjects did not encounter difficulties in operating the recorder, and the device only slightly disturbed some of the subjects in their daily activities. One third of the subjects were "not at all disturbed" and one half were only "slightly disturbed." The experiment was more intrusive only when subjects were engaged playing sports.

Table 2 Median Values and Range of the 10 Dimension Scores of the TICS-S in Controls and Myogenous Pain Patients

	Controls (n = 15)		Patients (n = 9)			
Item	Median	Range	Median	Range	U*	*P**
Work overload	5	1–10	8	3–9	49.0	.261
Social overload	3	0–7	7	0–9	18.5	.003
Overextended at work	2	0–4	4	0–9	26.0	.012
Lack of social recognition	3	0–11	6	0–9	45.0	.175
Work discontent	3	0–7	5	0–10	44.0	.158
Social tension	4	1–5	4	0–10	44.0	.155
Performance pressure at work	7	0–12	6	1–11	64.5	.857
Performance pressure in social interactions	5	1–10	5	1–8	56.5	.509
Social isolation	3	0–6	3	0–8	51.5	.334
Worry propensity	5	0–9	7	0–11	38.5	.081

*Mann-Whitney test.

Discussion

The myogenous pain patients had significantly more nonfunctional tooth contact during the 10 days than healthy controls. More importantly, the distribution of nonfunctional tooth contact did not overlap between the 2 groups. The large difference in the statistical distributions of the study was not related to the fact that some of the controls had some knowledge of dentistry and therefore may have known that teeth normally should not be in contact, because nonfunctional tooth contact was not less frequent in those controls involved in dentistry than in controls naive to dental issues. Thus, the study has high external validity despite the low sample size. In addition, the frequency of tooth contact did not decrease over the 10 recording days. This indicates that the subjects did not learn to keep the teeth apart, ie, there was no evidence for an intervention effect of recording.

All 15 controls and the 9 MAP patients had nonfunctional tooth contact throughout the day, and the frequency of tooth contact did not differ between men and women. This means that healthy subjects also have a habit of keeping their teeth in contact to some extent. This is in agreement with a study believed to be the only other study using a similar technique to record the frequency of wake-time tooth contact. [7] However, that study reported a much higher frequency of nonfunctional tooth contact than the present study, with an overlap in the statistical distributions of nonfunctional tooth contact between patients and controls. Moreover, in that study the number of nonfunctional tooth contacts was significantly increased only in patients with both myofascial pain and arthralgia and not in subjects with only myofascial pain.[7] Nonetheless, the results of these 2 EMA studies contradict previous questionnaire surveys indicating that only approximately 20% of the general population admit to clenching their teeth when awake and that women are more aware of wake-time clenching than men.[26–28] The general unawareness of keeping the teeth in contact or in clenching best explains the difference between these results and the retrospective collection of data. Thus, these EMA studies indicate that retrospective studies based on questionnaires have a limited reliability for assessing wake-time clenching and corroborate previous findings showing that retrospective coping or behavioral assessments are inaccurate.[15,29]

Emotional stress might play a role in the etiology of wake-time tooth clenching,[27,30–32] and masticatory muscles may be active during stressful events.[31–36] The PSS and TICS-S questionnaires were used to evaluate the subjects' chronic emotional stress during the prior 30 days and past 3 months. Results showed that myogenous pain patients had significantly higher overall stress levels over the past 3 months than healthy subjects in the dimensions of "social overload" and "overextended at work" as well as significantly higher PSS stress scores in the last 30 days. However, the PSS stress scores did not correlate with the frequency of nonfunctional tooth contact in either group. In addition, the frequency of tooth contact on weekdays did not differ significantly from that recorded on weekends. Thus, any conclusion on an association between stress level and nonfunctional tooth contact during wake time is premature.

Episodic or acute myogenous pain episodes are likely precipitated by muscle fiber lesions caused by muscle overload or by low-level, long-lasting tooth clenching.[11,12] During low-level contractions, specific motor units may be continuously active so that they become overloaded.[37] Continuously active motor units have been found in the trapezius muscle when subjects were working with a computer mouse over a 30-minute period.[38] Motor unit territories in the human masseter are focally distributed and are related to anatomic compartments.[39] This has been shown to provide an anatomic substrate for selective regional motor control of the masseter.[40–43] As a consequence it is possible that selected muscle areas are contracted for longer periods, leading to muscle fiber lesions and therefore to pain through nociceptor sensitization during parafunctional activity, such as keeping the teeth in contact.

The finding that myogenous pain patients more often keep the teeth in contact could support the hypothesis that wake-time tooth clenching is an etiologic cofactor for myogenous masticatory pain. Further support for this hypothesis is the clinical experience that the advice to relax and to keep the teeth out of contact often leads to pain remission. However, a questionnaire-based study[44] on habit-reversal treatment did not show that the total number and frequency of oral habits decreased significantly in successfully treated myofascial pain patients, and another study,[45] also using a questionnaire, showed a decrease in oral habits (not only tooth clenching and grinding) that was short of reaching significance. These 2 studies suggest that the treatment success of the habit-reversal therapy was not due to a decrease in tooth-contact frequency. This is not surprising, as symptom reduction with several therapies, such as biofeedback and occlusal splints, is not strongly related to the changes of the parameters at which the therapy is aimed, ie, decrease in electromyographic activity or a change in occlusion.[46,47] Also, the results of the present study did not show a difference in the frequency of nonfunctional tooth contact between women and men, a finding that is not consistent with the higher prevalence of myogenous masticatory pain in women than in men. This inconsistency could be due to a higher susceptibility of women to muscle pain after prolonged muscle contraction. Indeed, muscle pain in women has been reported to occur after prolonged chewing.[48]

This study has several limitations. The first limitation was the recording of nonfunctional tooth contact at discrete time points and without an electromyographic or occlusal force recording. The duration of tooth contact and the degree of muscle contraction are therefore unknown. Thus, the data provide evidence that the patients more often had the teeth in contact, but not for how long or that they clenched. The second limitation is inherent to the method used and thus is typical of EMA assessments, ie, the inability to check directly the correctness of the replies. Thus, a validation study should be carried out with a more sophisticated method. However, the accuracy of the subject's feeling that the teeth were in contact or apart was tested before the study, and a very high match between answers and the actual tooth contact condition was found. Thus it can be assumed that the subjects replied correctly when asked to report whether the teeth were in contact or apart. In addition, the experiment lasted 10 days, providing a large number of replies, and the maximum delay allowed for replying was short (32 seconds) to eliminate the possibility of inaccurate recall. Also the proportion of alerts that resulted in no-replies was quite low (overall median of 10.9%) and did not differ significantly between the 2 groups. This indicates good subject compliance in accordance with the findings of previous EMA studies (details in Stone et al[15]). That the subjects had to provide only a reply, that they were not alerted by a beeper but by a vibrator (which does not disturb the environment), and that the device was user friendly certainly contributed to this good compliance. Patients may have had a tendency to be more accurate in replying to the alerts than controls, which could also partly explain the results. To see whether patients overestimated the number of nonfunctional tooth contacts, we also assessed the frequency of functional tooth contacts that did not differ between patients and controls. Thus, despite the methodologic shortcomings, the present investigators are confident that the results have good external validity. In particular, the large number of replies in the present study allowed for a representative estimate of the true value of the phenomenon in the natural environment.

The recording device was easy to carry during the daytime. In addition, the user interface was intuitively understood by the subjects. Indeed, the diaries demonstrated that the majority of the subjects encountered few or no problems. Furthermore, the recording protocol did not particularly interfere with the subjects' daily activities: one third of the subjects were "not at all disturbed" and one half was only "slightly disturbed." The only times in which the experiment was more intrusive was when subjects were engaged in a sports activity. These observations indicate that the method is promising for the collection of data on wake-time occlusal parafunction in larger samples.

Conclusions

Myogenous pain patients had nearly 4 times more nonfunctional tooth contact during wake time and higher stress levels than controls. The frequency of nonfunctional tooth contact did not correlate with the stress level.

Acknowledgments

The authors thank Dr Gilles Lavigne and Dr Donald Seligman for their critical review of the manuscript. This work was entirely supported by the standard financial plan of the University of Zürich.

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