Published online: 2019-10-15

Effect of Occlusal Splints on the Temporomandibular Disorders, Dental Wear and Anxiety of Bruxist Children

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ABSTRACT

Objectives: To evaluate the effectiveness of occlusal splints to reduce the signs and symptoms of temporomandibular disorders (TMD), dental wear and anxiety in a group of bruxist children.

Methods: All of the subjects were 3 to 6 years old, had complete primary dentition, class I occlusion and were classified as bruxist according to the minimal criteria of the ICSD for bruxism. For each child, anxiety was evaluated with the Conners' Parent Rating Scales (CPRS). The TMD were evaluated using the RDC/TMD. The dental wear was processed in digital format with Mat Lab® and Lab view® software to determine its size and form. The children were randomized into an experimental (n=19) and a control (n=17) group. The children in the experimental group used rigid bite plates for a two-year period, until mixed dentition. Afterwards, the CPRS and the RDC/TMD were applied again and dental casts were taken. Comparisons of the variables regarding dental wear, signs and symptoms of TMD and anxiety before and after treatment among the groups were analyzed using the t-test, the Wilcoxon rank sum test and the Mann-Whitney test.

Results: The subjects in the experimental group showed no statistically significant difference regarding anxiety levels and dental wear when compared with the control group. The signs and symptoms of TMD were not reduced except for the deviation in mouth opening.

Conclusions: The use of rigid occlusal bite plates was not efficient in reducing the signs of bruxism as a whole but did reduce the deviation in mouth opening. (Eur J Dent 2011;5:441-450)

Key words: Bruxism; Rigid occlusal bite plates; TMD; Dental wear; Anxiety.

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INTRODUCTION

Bruxism cannot be considered normal, even during the primary or mixed dentition stages.[1] However, it is not considered a pathology during childhood until structural damage of the stomatognathic system (muscles, teeth, mucosas and TMJ) is seen,[1] although harmful effects on parafunction have been described in the permanent dentition when bruxism develops early.[2]

The etiology of bruxism has been defined as multifactorial.[3] It is mainly regulated centrally, not peripherally.[4] This means that oral habits,[5] temporomandibular disorders (TMD),[6-9] malocclusions,[10,11] hypopnoea,[12,13] high anxiety levels[14] and stress,[15,16] among others[17] could influence the peripheral occurrence of bruxism. These factors act as motion stimuli to the central nervous system, which reacts with an alteration in the neurotransmission of dopamine,[18-20] and the result is the clenching or grinding of the teeth.

The association between bruxism and TMD in children is strongly supported,[21-23] and the existence of an association between TMD and anxiety, depression and stress has been examined previously.[24] However, none of these studies demonstrated the causality of the relation between the psychological factors and TMD.[25]

The prevalence of sleep bruxism is difficult to estimate, because quite often, the subjects are unaware of having the disorder.[26,27] There is no reported gender difference, and it is more frequent in children, with a decline over advancing age.[26] The symptoms recognized in children can persist into adulthood.[28]

Although the frequency of bruxism and its effects during childhood, there are only a few studies that have reported any treatments during this stage,[29] especially in dentistry. The available controlled clinical trials are not enough to sustain a therapy for infantile bruxism.

Some authors have shown that when anxiety is treated, either with psychological techniques[2] or with drugs,[30] the symptoms of bruxism decrease. However, controversy does exist regarding the effectiveness of pharmacology for the treatment of bruxism,[31] although this approach has not been used in children. Longitudinal studies are necessary to evaluate the long-term results of psychological therapies to reduce bruxism, even in children.

The most common treatment for bruxism in dentistry is the rigid occlusal splint. However, well-controlled clinical studies are not available in the literature for the treatment of bruxism in children with this device.

Thus, the objective of the present study was to evaluate the effectiveness of occlusal splints in reducing the signs and symptoms of bruxism, such as temporomandibular disorders, dental wear and anxiety in a group of children.

MATERIALS AND METHODS

A prospective, long-standing, randomized controlled clinical trial was performed. The children were patients from Salud Sura (a clinic of the colombian private health service) and CES Sabaneta (clinic of the CES University Dental School). All of the subjects were required to be healthy and have normal facial morphology, complete primary teeth, an absence of other types of oral habits, a presence of dental wear and no history of trauma.

The subjects were matched for age between the experimental and control group. Matching for gender was not possible due to the number of subjects. The sample size was calculated with a confidence of 95% and a statistical power of 80%. Sixteen subjects were required in each group to make the comparisons. The formula to calculate the sample size was the following:

$n = P_1(1 - P_1 + P_2(1-P_2) / (P_1-P_2)^2 \cdot f(æ,ß)$

where:

P_1: proportion in the control group.

P_2: Proportion in the experimental group.

f (æ,ß): Changes according to æ,ß.[32]

P_1 and P_2 were extracted from a controlled trial performed in bruxist adults using occlusal splints

The exclusion criteria were skeletal malocclusions confirmed with cephalometric X-rays[33,34] and dental malocclusions confirmed with dental casts. Reports of respiratory diseases or the presence of mouth breathing were also reasons to exclude patients from the study.

The children had complete primary dentition, an acceptable facial morphology (no malformations or deformation of the face, such as any type of cleft lip or palate), a straight or mesial step molar relationship, a class I canine relationship, an overjet between 0-2 mm, an overbite between 1-3 mm and showed a Definitely Positive Behavior according to the Frankl scale.

The parents were asked to sleep with the children for at least two weeks, and all the children exhibited the minimal criteria of the International *Classification of Sleep Disorders* (ICSD)[35] for sleep bruxism:

1. The children's parents indicated in an interview with one of the examiners that the occurrence of tooth-grinding or tooth-clenching during sleep was noted at least once during the night for at least five nights in a two week period.

2. No other medical or mental disorders (e.g., sleep-related epilepsy) were present.

3. Other sleep disorders (e.g., obstructive sleep apnea syndrome) were absent.

Initially, 45 children were evaluated and nine were excluded. Two children developed early mixed dentition during the observation time. Another four children changed their address and didn't inform the investigators. Three of the children had definitively bad behavior according to Frânkl scale. Finally, the data of 36 patients were analyzed.

The selected subjects were randomly distributed to the control (n=17) and experimental groups (n=19) with the Epitable module® by EpiInfo 6.04.

The children in the experimental group used the hard plate for a two-year period. The procedures, the possible discomforts and risks as well as the possible benefits were all explained to the patients involved and their parents, and the parents' written informed consent was obtained prior to the investigation.

All examinations were recorded before and two years after the use of the occlusal splint in the experimental group. All the children were evaluated once a month to make sure the occlusal splint was being used and adequately programmed (as described below). Examinations of the dental health of each patient were also performed.

The upper and lower dental arches of all subjects were reproduced from alginate impressions cast in dental stone with a standardized technique.

The dental wear of all of the casts was drawn, acquired in digital format and processed automatically. The technique used to analyze it has been previously reported.[36] The size and shape of the dental wear was calculated for each dental cast.

The size of the dental wear was quantified through its area (mm^2) and perimeter (mm), and the shape was calculated by the form factor (D Factor),[30] which is non-dimensional. The last two measurements were used to calculate the format of objects without geometrical shapes.

For the D factor, the following ratio was used:

D factor $= \frac{\sqrt{a}}{p}$ where a is the area [mm^2] and p the perimeter [mm].

Conners' Parent Rating Scale (CPRS)

The Conners' Parent Rating Scale (CPRS) is a popular research and clinical tool for obtaining parental reports of childhood behavior problems. The revised CPRS (CPRS-R)[37] has norms derived from a large representative sample of North American children and uses confirmatory factor analysis to develop a definitive factor structure. CPRS-R has an updated item content to reflect recent knowledge and developments pertaining to childhood behavior problems. Exploratory and confirmatory factor-analytic analysis revealed a seven-factor model including the following factors: cognitive problems, oppositional, hyperactivity-impulsivity, anxious-shy, perfectionism, social problems, and psychosomatic abnormalities. The psychometric properties of the revised scale appear adequate as demonstrated by good internal reliability coefficients (Cronbach's alpha=0.70), a high test-retest reliability (Pearson's r = r=0.83, [37] and an effective discriminatory power. The factor analysis of anxiety was the only one extracted for this study.

The questions are applied to the parents rather than the children, as indicated by the instructions of the test, and the researchers did not participate in the questioning process

Research diagnostic criteria RDC/TMD

The research diagnostic criteria for temporomandibular disorders (RDC/TMD) have been developed for scientific evaluation of TMD and are available to researchers and clinicians. The RDC/TMD were developed by a team of international clinical research experts gathered together (with NIDCR support) to develop an operationalized system for diagnosing and classifying RDC/TMD, based on the best available scientific data, within the context of a biopsychosocial model. Its reliability values ranged from good to excellent for the RDC/TMD clinical examination of children and adolescents.[38,39]

The objective of the present study was not to diagnose specific diseases of the TMJ, but to evaluate the effects of the hard plate on the signs and symptoms of TMD. This is the reason why a complete RDC/TMD diagnosis was not obtained in this investigation. The clinical examination in this study was based upon the RDC/TMD Axis I booklet, which is an updated version of the original publication and involves the clinical assessment of the following TMD signs and symptoms.

Pain site: present pain was evaluated as ipsilateral or contralateral pain that was provoked by

clinical examination of the masticatory muscles and/or jaw function.

Mandibular range of motion (mm): jaw opening patterns were determined. The vertical range of motion (extent of active unassisted opening without the occurrence of pain) and the extent of mandibular lateral and protrusive movements without pain were evaluated.

The mandibular deviation was not included in the RDC/TMD, but was assessed as well, measuring the midline in a closed position and in maximum aperture. The difference between these two measurements was registered. All of the measurements were performed with a millimeter flexible acetate ruler (ETM scale®).

TMJ sounds: clicking, grating and crepitus sounds were palpated during lateral, vertical and protrusive movements of the mandible and were registered as a whole.

Muscle and joint palpation for tenderness: assessments of extra- and intra-oral masticatory and related muscles (20 sites) were performed by bilateral palpation for tenderness and pain. The four sites of the TMJ were also examined by bilateral palpation. Self-reported TMD pain in this investigation was based upon the subjects' responses to two questions: (i) do you have pain in your temples, face, temporomandibular joint (TMJ) or jaws once a week or more? (ii) do you have pain when you open your mouth wide or chew once a week or more? The test–retest reliability of 0Æ83 was previously found for these two questions in another study.[40] The whole questionnaire of the RDC/TMD was not used because the questions were not easy to answer for the 8- and 9-year-old children.

Fabrication of the bruxism plate

The rigid occlusal splints were made and programmed according to Bennett, Okeson JP[42] and Lunden TF[43] (Figure 1). Simultaneous and symmetric contact points were obtained in maximum intercuspation. The plate was polished to remove any irregularities. Indications for its use were given to the patients' parents; they were informed that it had to be used at least 14 hours each day.

Each child visited the dental clinic of CES University every month. Two years after use of the plate was initiated, control casts were taken to evaluate all of the measures described above. The patients used the rigid occlusal splint until the beginning of their mixed dentition.

Error of method

Standardizations of the examiners and calibration of all of the techniques to evaluate the children regarding the clinical examination were made on 12 subjects different from the ones included in the investigation. The intratester (ICC> 0.9 2-way ANOVA) and intertester error (Kappa > 0.7) were not statistically significant.

Standardizations of the examiners to evaluate anxiety levels were made on 12 subjects different from the ones included in the investigation. The Intratester and intertester error was not statistically significant (ICC> 0.9 and Kappa > 0.8).

The 12 subjects underwent repeated clinical exams with two standardized examiners to assess the RDC/TMD. Interexaminer and intraexaminer reliability was assessed for clinical examination and questionnaire items. Reliability values ranged from acceptable to excellent for the RDC/TMD and the two questions (ICC > 0.81 and Kappa > 0.77). The dental wear was traced only by one investigator (ICC>0.7).

Statistical analysis

All of the data were analyzed with SPSS 11.0® for Windows (SPSS Inc. Headquarters, Chicago, Illinois USA) Distributions were tested using the Shapiro-Wilk test. The data were compared using the Wilcoxon rank-sum test, the Student's t-test, or the Mann-Whitney test. For all tests, the significance was set at 95% (P<.05).

RESULTS

All of the children were 36 to 48 months old at the beginning, with a mean age of 40.3 months for the experimental group and 41.4 months for the control group, with no statistical differences between the groups. After treatment, the mean age was 64.6 months, with a range between 60 and 72 months.

The studied variables were statistically homogenous at the beginning of the study, which means that the two groups (experimental and control) were comparable (Table 1). However, a great variability in the size of the dental wear was observed for both groups.

When the three parameters of dental wear

were analyzed, the dental wear of the experimental group did not present a statistically significant increase after the intervention with occlusal splints compared with the initial values of the same group. However, all of the values were higher after the intervention for both the experimental and the control groups except for the D factor in the experimental group, which presented a lower value (more regular form of the dental wear) (Table 2). When those values after the use of the plates were compared between the experimental and control groups, no statistically significant differences were found.

At the beginning of the study, all of the parents indicated the presence of sleep bruxism in the children, as it was part of the inclusion criteria. After the use of the rigid occlusal splints, 20% of the parents of the children included in the experimental group answered no when they were asked about the occurrence of nocturnal bruxism in their children; while in the control group, 15.38% of the parents answered "no" to this question. This difference was not statistically significant (P=0.078).

The anxiety level at the end of the study was significantly reduced in the experimental and control groups (Table 2), which means that the treatment did not have any effect. When the measurement of anxiety was compared between the experimental and control groups after treatment (Table 3), the value was not statistically significant.

The experimental group presented a reduction in the deviation in mouth opening after treatment (Table 4) compared with the measurements made before treatment (Table 5). The reduction was statistically significant when it was compared with the value obtained from the control group (Table 5).

The signs and symptoms of TMD presented statistically significant reductions when the initial and final phases were compared between the experimental and control groups (Table 2). When the control and experimental groups were compared after the treatment (Table 3), the values were not statistically significant.

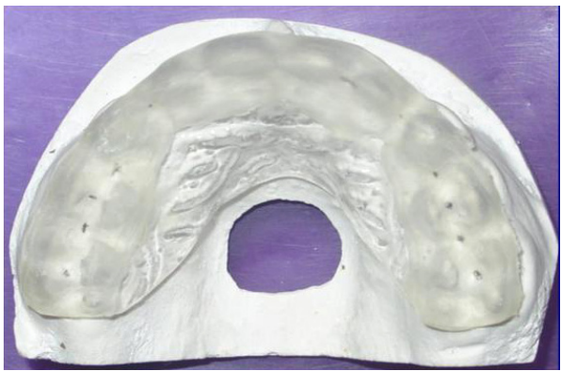

Figure 1. Programmed rigid occlusal splint.

Table 1. Comparison of dental wear, anxiety levels and TMD signs and symptoms before the use of the hard plate between the experimental and the control groups.

	Experimental		Control		
	Mean	SD	Mean	SD	P value
Area of dental wear (mm)	19.55	12.80	17.80	8.91	0.19*
Perimeter of dental wear (mm)	37.00	31.83	37.39	17.07	0.40**
D Factor	13.35	2.51	10.91	2.51	0.59*
Anxiety (CPRS)	0.80	0.11	0.78	0.15	0.67*
Number of signs and symptoms of temporomandibular Disorders (RDC/TMD)	4	1.77	3	1.42	0.16*

Table 2. Comparison of dental wear, anxiety levels and TMD signs and symptoms before and after the intervention in the control and experimental groups.

	Experimental			Control		
	Before	After	P value	Before	After	P value
Area of dental wear (mm)	19.55	26.60	0.990**	17.80	22.68	0.77**
Perimeter of dental wear (mm)	37.00	56.01	0.981**	37.39	47.39	0.90**
D Factor	13.35	10.91	0.121**	10.91	14.07	0.17**
Anxiety level (CPRS)	0.80	0.40	0.001 *	0.78	0.19	0.01 *
Number of signs and symptoms of temporomandibular disdisorders (RDC/TMD)	4	2	0.001 *	3	2	0.50 *

* Wilcoxon

** Student's t-test

DISCUSSION

The effectiveness of rigid occlusal splints to control dental wear and reduce anxiety and TMD signs and symptoms in children[44] with bruxism was tested. Although there are investigations into several treatments for bruxism in children, there is still a lack of evidence to support diagnostic and therapeutic options for bruxism in children.

Thus far, the most reliable method to diagnose sleep bruxism in children is based on the reports by the parents or children´s guardians. The problem of using this reporting method is that most children do not sleep in close enough proximity to their parents; so the parents are not always aware of their children's episodes of bruxism. This study attempted to eliminate this bias, as all of the par-

Table 3. Comparison of dental wear, anxiety levels and TMD signs and symptoms after the intervention between the control and experimental groups.

	Experimental		Control		
	Mean	SD	Mean	SD	P value
Area of dental wear (mm)	26.60	18.12	22.68	9.67	0.33*
Perimeter of dental wear (mm)	56.01	32.13	47.39	21.43	0.55*
D Factor	10.91	1.97	14.07	0.78	0.16*
Anxiety level (CPRS)	0.40	0.36	0.19	0.25	0.17**
Number of signs and symptoms of temporomandibular Disorders (RDC/TMD)	2	1.11	2	1.75	0.37**

* Mann-Whitney test

** Wilcoxon rank-sum test.

Table 4. Comparison of the temporomandibular disorders evaluated with the RDC/TMD before the intervention in the experimental and control groups.

Measurement	Experimental	Control	P value
Clinical examination			
Number of subjects with pain on jaw movement	3	4	0.62**
Mean of range of mouth opening (mm) (active unassisted opening)	41	42.5	0.07*
Mean of deviation in mouth opening (mm) (additional measurement is not part of the RDC / TMD)	3.5	3.6	0.40*
Number of subjects with joint sounds (clicks and crepitation are not differentiated)	2	2	0.18**
Number of subjects with extra-oral muscle tenderness	3	4	0.17**
Number of subjects with intra-oral muscle tenderness	2	3	0.07**
Questions			
Number of subjects with pain in temples, face, temporomandibular joint (TMJ), or jaws once a week or more	1	2	0.07**
Number of subjects with pain when opening the mouth wide or chewing once a week or more	0	0	0.98**

Table 5. Comparison of the temporomandibular disorders evaluated with the RDC/TMD after the intervention in the experimental and control groups.

Measurement	Experimental	Control	P value
Clinical examination			
Number of subjects with pain on jaw movement	3	2	0.52**
Mean of range of mouth opening (mm) (active unassisted opening)	43	42	0.08*
Mean of deviation in mouth opening (mm). (additional measurement not part of the RDC / TMD)	2.5	3.6	0.04*
Number of subjects with joint sounds. (clicks and crepitation are not differentiated)	2	1	0.26**
Number of subjects with extra-oral muscle tenderness	4	5	0.21**
Number of subjects with intra-oral muscle tenderness	2	3	0.07**
Questions			
Number of subjects with pain in temples, face, temporomandibular joint (TMJ), or jaws once a week or more	1	2	0.07**
Number of subjects with pain when opening the mouth wide or chewing once a week or more	0	0	0.98**

* t-test

** Wilcoxon rank-sum test

ents were asked to sleep with their children for at least two weeks before starting the measurements. On the other hand, the minimal criteria of the *International Classification of Sleep Disorders* (ICSD) require occurrence report of tooth-grinding or tooth-clenching during sleep by the parents. The limitation was that day-time bruxism was not considered.

In adults, the subjects can describe their anxiety characteristics and how anxious they feel; they can even write about and classify their anxiety.[45] The anxiety state is also a prominent factor in the development of bruxing behavior in children.[46] However, studying anxiety in children is more difficult. Most of the children involved do not understand the concept of anxiety or know how it feels to be anxious. As stated previously, the occlusal splints have a placebo effect[53] that has been proven to reduce anxiety.[47]

Although there are self-applied scales to measure anxiety in children,[48] it is important to quantify the children's anxiety through their parents or guardians. Certain questions posed to the parents and even to the teachers can define the anxiety status of the children[49] better than the children's own opinion of their anxious state. The CPRS have been shown to measure anxiety as defined by the DSM IV.[50] Indeed, the CPRS has been used as a gold standard when comparing other scales to measure anxiety in children[51] and has been used before to evaluate anxiety-associated to bruxism in children.[45]

Other instruments, such as questionnaires for parents including the Child Stress Scale and scales assessing neuroticism and responsibility from the pre-validated Big Five Questionnaire for Children, have been used to evaluate the emotional state of the bruxing child.[52] Unfortunately, the results of these instruments only can be interpreted by psychologists.

The rigid occlusal splint is a common treatment for bruxism in adults; it is economical, light and easy to use, among other characteristics. This treatment aims to reduce the parafunctional activity of the muscles, inducing their relaxation, and to raise the vertical occlusal dimension, reduce the pressure over the TMJ, protect the teeth from attrition and wear, allow the centric position of the condyle, give diagnostic information and cause a placebo effect.[44,53,54] However, it is difficult to compare the present findings to reports in the literature because there is not enough scientific evidence to support or refute the use of rigid hard plates during the primary dentition stage.

Only one previous study evaluated the use of the rigid occlusal plate in bruxist children with complete temporal dentition.[44] However, that investigation did not standardize the selection criteria of the patients, and the children only used the occlusal splint for a two-month period time, which is not enough to change the muscular reflex. It is necessary to use and follow any oral device affecting the muscle's reflexes for at least two years;[55] the muscular reflexes altered during bruxism do not change permanently before that time. If those reflexes continue to be present, then other signs and symptoms of TMD could not be avoided, as every single part of the craniofacial complex belongs to a system in which any alteration in any structure could affect the others. Additionally, the previously mentioned study[44] did not present tables or graphics to adequately compare their results to ours or to follow their methodology.

The number of subjects in each group considered in this investigation was not enough to establish comparisons regarding sex. Other studies[56-58] have presented homogeneous gender distributions in the study groups so that this variable was controlled for when tooth wear was studied, and no differences were reported between the males and females.

When early treatment of any kind of habit is established, it is vital to have the collaboration of both the patients and their parents. Even though evaluating the motivation of the children and their parents to use the hard plates was not an objective of the present research, it is meaningful to mention that in this study, the rigid plates were well-accepted by both patients and parents. Perhaps participating in this kind of study reduced the anxiety of both the children and the parents. Anxiety is not always positively related to stress,[59] but anxiety has been observed in bruxist patients.[14,26,28]

Bruxing adults have been reported to be prone to stress and to present headaches, clenching, and pain in the neck, back, throat or shoulders.[16] Anxiety and tense personality during childhood could be predictors of the early development of bruxism.[45]

The relationship of bruxism with TMD signs and symptoms in children is strongly supported,[21,60]

and the existence of an association between TMD signs and symptoms and anxiety, depression and stress has been investigated previously.[23] However, a reduction in TMD signs and symptoms when the bite plate was used was not established in this study.

Furthermore, the objective of the present study was not to diagnose specific diseases of the TMJ, but to evaluate the effect of the hard plate on the signs and symptoms of TMD. Therefore, a complete RDC/TMD diagnosis was not obtained in this investigation. There are reports of the RDC/TMD being used in children as young as 10 years of age,[24,45] and it is a common tool to evaluate the signs and symptoms of TMD. However, further studies are necessary to assure that the RDC/TMD is completely reliable for use in children who are 8–9 years of age.

CONCLUSIONS

The rigid occlusal bite plates were not efficient in reducing the signs of bruxism as a whole but did reduce the deviation in mouth opening.

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