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Head posture and dental wear evaluation of bruxist children with primary teeth

A. L. VÉLEZ*, C. C. RESTREPO*,†, A. PELÁEZ-VARGAS*,†,‡, G. J. GALLEGO*,†, E. ALVAREZ*, V. TAMAYO†,§ & M. TAMAYO*,† **CES University, Medellín, Colombia, †CES-LPH Research Group, Medellín, Colombia, ‡Universidad Nacional de Colombia – Sede Medellín, Colombia, §FUMC, Medellín, Colombia*

SUMMARY The aim of the present study was to compare the head position and dental wear of bruxist and non-bruxist children with primary dentition.

Methods: All the subjects had complete primary dentition, dental and skeletal class I occlusion and were classified as bruxist or non-bruxist according to their anxiety level, bruxism described by their parents and signs of temporomandibular disorders. The dental wear was drawn in dental casts and processed in digital format. Physiotherapeutic evaluation and a cephalometric radiograph with natural head position were also performed for each child to evaluate the cranio-cervical position for the bruxist group ($n = 33$) and the control group ($n = 20$). The variables of the two groups were compared, using the Student *t*-test and Mann–Whitney *U*-test.

Results: A more anterior and downward head tilt was found in the bruxist group, with statistically significant differences compared with the controls. More significant dental wear was observed in the bruxist children.

Conclusions: Bruxism seems to be related to altered natural head posture and more intense dental wear. Further studies are necessary to explore bruxism mechanisms.

KEYWORDS: bruxism, head, posture, dental wear

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Introduction

The aetiology of bruxism has been defined as multifactorial (1). It is mainly regulated centrally, not peripherally (2). This fact means that oral habits (3), temporomandibular disorders (TMD) (4–7), malocclusions (8, 9), hypopnoea (10), high-anxiety levels (11) and stress (12), among others (13) could influence the peripheral occurrence of bruxism. These factors act as a molar stimulus to the central nervous system, which reacts with an alteration in the neurotransmission of dopamine (14, 15) and the result is the clenching or grinding of the teeth.

During early infancy, children react to the habits of their parents, such as smoking, alcohol and the use of psychoactive drugs among others (16). These habits are risk factors involved in acquiring bruxism (17), thus they have to be evaluated to make a reliable diagnosis of the parafunction.

Bruxism not only affects the masticatory muscles, but also all the muscles of the cranio-facial complex, shoulders and neck (18). These structures share innervations through the trigemino-cervical complex, which is conformed by the upper cervical and trigeminal nerves (18). Also, anatomically, the axes for the excentric movements of the mandible and cervical column concur in the occiput (19). These connections cause the jaw position to influence the activity of the cervical muscles (20) and the neck inclination to influence the bilateral sternocleidomastoid activity (21).

If the masticatory system, neck and shoulders are anatomically and physiologically connected and bruxism affects all the above described structures, it might be possible that the head position and the homeostasis of the cranio-cervical system could be affected when a parafunction occurs, so the head posture could be different between bruxist and non-bruxist subjects.

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The head posture could be affected by the skeletal (22) and dental occlusion (23, 24). During the mixed dentition, the dental occlusion changes (25), so the head posture could be affected (26). In the primary teeth period, the arch dimensions seem to be stable (27, 28), so if there are changes in the head and cervical column posture, these might be due to other factors besides changes in occlusion, for example, the occurrence of oral parafunctions.

The available evidence-based dentistry is still not enough to support the multifactorial diagnosis of bruxism, especially in children. Historically, the background of bruxism has been confined to the visual examination of dental wear (1, 4) and the reports of grinding by parents.

The difference between normal and pathological dental wear has been previously described in the mixed dentition with digital analysis (29). Dental wear produced by bruxism is characterized by a plane surface with a central zone that sometimes reaches the dentine, surrounded by enamel zones (30). Waltimo *et al.* (31) found that the most common dental facets in adults are those with a horizontal shape that indicates the occurrence of a grinding pattern rather than a clenching pattern of bruxism.

There are sophisticated methods to measure the dental wear related to bruxism (29, 32–36), but other factors contributing to parafunction, such as body posture, have not been measured together with the dental wear, to gain a better understanding of the peripheral multifactorial aetiology of bruxism.

The aim of the present study was to compare the head posture and dental wear of bruxist and non-bruxist children with primary dentition.

Materials and methods

A case–control study was performed. The procedures, possible discomforts or risks, as well as possible benefits were fully explained to the participant patients and their parents, and written informed consent from their parents was obtained prior to the investigation.

Subjects

Participating children were selected from Susalud (a clinic of the Colombian Private Health Service) and CES Sabaneta (Clinic of the CES University Dental School). All the subjects (bruxist and non-bruxist) were required to be healthy, with normal facial morphology, complete primary teeth, absence of other types of oral habits, presence of dental wear and with no history of trauma.

The sample size was calculated with a confidence of 95% and a statistical power of 80%. The number of subjects required in each group to make the comparisons was 20.

Inclusion and exclusion criteria

The exclusion criteria were skeletal malocclusions confirmed with cephalometric X-rays (37, 38) and dental malocclusions confirmed with dental casts. The reports of respiratory diseases, presence of mouth breathing and functional alterations in the body posture were also reasons to exclude patients from the study. Asymmetry in children's legs or any other mobility alteration that could generate changes in head posture due to anatomically detectable reasons were also exclusion criteria.

An evaluation of the temporomandibular joint (TMJ) was performed on all the children together with a questionnaire and a clinical examination, according to Bernal and Tsamtsouris (39).

Children's anxiety was measured using the Conners' Parents Rating Scales (40) (CPRS). Both instruments, Tsamtsouris and Bernal and CPRS had been previously used to diagnose bruxism in children (16).

Children were included in the bruxist group ($n = 33$) when their anxiety level was above 0·75% according to the CPRS, presented two or more signs of TMD according to Bernal and Tsamtsouris and fulfilled the American Academy of Sleep Medicine (AASM) (41) criteria for sleep bruxism:

1 The children's parents indicated the occurrence of tooth-grinding or tooth-clenching during sleep.
2 No other medical or mental disorders which could account for abnormal movement during sleep were present (e.g., sleep-related epilepsy).
3 Other sleep disorders (e.g., obstructive sleep apnoea syndrome) were absent.

All children not fulfilling the above criteria were included in the control group. If children fulfilled the 2nd and 3rd criteria of the AASM, they were excluded from the control group.

Seventy-two children were initially evaluated and 53 were finally included in the study, 33 in the bruxist group and 20 in the control group. Eleven subjects were excluded because they presented exfoliating movements of the primary teeth or appearance of eruption of permanent molars. Three presented skeletal malocclusions in the cephalogram, three were excluded by difficulties in their behaviour during the required initial procedures, one presented functional scoliosis, one showed leg asymmetry and one presented cerebral palsy.

All the children were 3–6 years old. In the bruxist group, the mean age was 56·70 ± 7·22 months, while for the non-bruxist children it was 55·20 ± 7·89 months. As can be observed, with regard to their chronological age the groups were homogeneous.

Techniques

The risk factors to acquire TMD were assessed by questioning those in charge of the children, using the questionnaire of the Bernal and Tsamtsouris test. The clinical evaluation of TMD included the auscultation of TMJ sounds, the palpation of discontinuous condylar movement, measurement of the maximum opening of the mouth and deviation of the mandible during opening.

The physiotherapeutic evaluation (42) was performed to exclude any possible anatomical disturbance of the cervical column that could affect the head posture or the craniofacial growth of the studied children. The test included a questionnaire to ask the parents about family history that could indicate possible alterations in the body posture of the subjects. Then, the real and apparent measurements of the legs were taken with the subjects in supine position with a standardized technique. The examination also included impression of the plantar foot with the child in bipedestation over a non-sliding surface. With this procedure, the feet track of the subject was copied. Additionally, photographs of the front, back and both sides' views of each child were taken. The data obtained in the physiotherapeutic examination were analysed separately by two different physiotherapists at different moments to detect abnormalities or asymmetries.

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 the casts was drawn, acquired in digital format and processed automatically. The technique to analyse dental wear was previously reported (29). The size and shape of the dental wear were calculated for each dental cast.

The size of the dental wear was quantified through its area (mm^2) and perimeter (mm) and the shape by the roundness and the form factor (D factor) (29), which are non-dimensional. The last two measurements were used to calculate the format of objects without geometrical shapes (29).

For D factor, the following ratio was used:

$$D \text{ factor} = \frac{\sqrt{a}}{p}$$

where a is the area (mm^2) and p the perimeter (mm).

Each X-ray was taken with an Orthophos Plus Ceph* for lateral cephalograms. The machine was vertically adjustable; it had a standardized focus – film distance of 190 cm and a distance from the film to the medial plane of 10 cm. The subject stood up without fixation in orthoposition after balancing forward and backward three times, with the teeth together and the lips in rest, looking to a light in a mirror, located perpendicular to the eyes of the child. This position made sure that the head and the neck were in natural position. The exposures were taken at 60–80 kv and 32 mAs. A vertical 0·5 mm wide wire was put in front of the cassette to register the perfect vertical line (VV).

The technique used to take the lateral cephalogram was the natural head posture, described previously by different authors (43). It is a reproducible technique (44–46) and allows the clinician to evaluate the natural position of the cervical vertebras and the inclination of the cervical column and head posture.

Afterwards, the lateral cephalograms were scanned and traced digitally according to Solow and Tallgren (43), in a dark room, using a MATLAB 5·3† program. Based on the vertical reference, a horizontal line (HOR) was traced perpendicular to the vertical one. These two lines were the references to calculate the angles between head and neck in the cephalogram. All the measurements to evaluate the head and cervical column posture can be seen in Fig. 1.

The following angles were measured to analyse the head and cervical column posture:

- Angle between tangent (CVT) to the cervical vertebra (cv4ip) and VV: the wider the angle, the more relevant the kyphosis of the cervical column.

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*Sirona Co, Alemania, Long Island City, NY, USA.

†MathWorks, Inc., Natick, MA, USA.

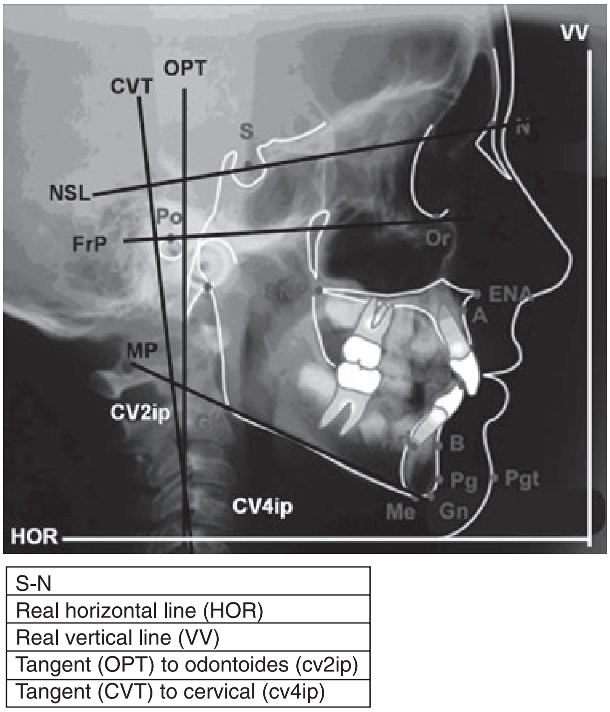

Fig. 1. Cephalometric analysis.

- Angle between CVT and HOR: the narrower the angle, the more significant the anterior tilt of the head.
- Angle between the tangent (OPT) to odontoides (cv2ip) and VV: the wider the angle, the more relevant the kyphosis of the cervical column.
- Angle between OPT and HOR: the narrower the angle, the more relevant the anterior tilt of the head.

The examiners evaluating the condition of bruxism/non-bruxism were not aware who performed the physiotherapeutic evaluation and who analysed the dental wear and the X-ray images.

Error of method

Standardizations of the examiners and calibration of all the techniques to evaluate the children regarding the clinical examination, TMD and anxiety level were made on 12 subjects different from those included in the investigation. The Intra-tester and intertester error was not statistically significant (ICC >0·9 and Kappa >0·7).

A calibration of the X-ray technique and a standardization of the digital tracing of the cephalogram were also performed. The tracing of the cephalogram was standardized between two investigators with 10 X-rays, scanned and traced three times each by each of the two investigators. To determine the intra-tester and inter-tester reliability, the intra-class correlation coefficient was applied (ICC >0·6).

The dental wear was traced only by one investigator whose intra-class error was not statistically significant (ICC >0·7).

Statistical analysis

Univariant and bivariant analysis were performed for each variable, using frequencies and mean values. The bivariant analysis was carried out using Student's t-test, or Mann–Whitney U-tests, depending on the normality of the variables distribution. Distributions were tested using the Shapiro–Wilk test.

Results

The non-bruxist group was composed of nine girls and 11 boys, while in the bruxist group there were 14 girls and 19 boys. In both groups there were more boys: 55% and 58% respectively for each group (Table 1).

The four outcome parameters of dental wear were compared between the bruxist and non-bruxist groups (Table 2). There was no statistically significant difference for the shape (roundness and D factor) of the dental wear between the bruxist and the non-bruxist children ($P > 0{\cdot}05$). The size of dental wear (area and perimeter) showed higher values in the case of bruxist children ($P < 0{\cdot}05$) for both the upper and lower arches. The only measurement that was not statistically significant regarding the size of the dental wear was the perimeter in the upper arch ($p = 0{\cdot}058$) (Table 2). The localization of dental wear in the bruxist group was mainly in the anterior zone (incisive) (82·4%), while for the control group it was in the molars (73·56%).

The head posture of the bruxist children was found to have a statistically more significant anterior and downward tilting of the head, when compared with the control group. The OPT_HOR angle was wider in the

Table 1. Gender distribution of both groups in this study

Sex	Bruxist	Non-bruxist
Female	14 (42)	9 (45)
Male	19 (58)	11 (55)
Total	33	20

Values in parentheses are percentage.

Table 2. Comparison between dental wear measurements in bruxist and non-bruxist children

Criteria	Diagnosis	*n*	Mean ± s.d.	*P*-value
Upper arch roundness of dental wear	Bruxist	33	0·12 ± 0·07	0·341
	Non-bruxist	20	0·14 ± 0·13	
Lower arch roundness of dental wear	Bruxist	33	0·17 ± 0·26	0·788
	Non-bruxist	20	0·15 ± 0·09	
Upper arch *D* factor of dental wear	Bruxist	33	11·18 ± 1·98	0·310
	Non-bruxist	20	10·59 ± 2·18	
Lower arch *D* factor of dental wear	Bruxist	33	10·52 ± 2·60	0·086
	Non-bruxist	20	9·15 ± 3·00	
Upper arch area of dental wear (mm^2)	Bruxist	33	33·24 ± 20·52	**0·004**
	Non-bruxist	20	20·26 ± 10·45	
Lower arch area of dental wear (mm^2)	Bruxist	33	20·23 ± 13·92	**0·003**
	Non-bruxist	20	11·22 ± 6·82	
Upper arch perimeter of dental wear (mm)	Bruxist	33	59·35 ± 30·54	0·058
	Non-bruxist	20	44·47 ± 19·86	
Lower arch perimeter of dental wear (mm)	Bruxist	33	45·42 ± 27·01	**0·008**
	Non-bruxist	20	29·42 ± 15·23	

Significance $p < 0·05$.
Bold figures indicate a significance of $p < 0.01$.

Table 3. Comparison of the cervical column posture between bruxist and non-bruxist children

Variable	Diagnosis	*n*	Mean (angles) s.d.	*P*-value
CVT_HOR	Bruxist	33	82·99 ± 4·98	0·000
	Non-bruxist	20	87·17 ± 2·04	
OPT_HOR	Bruxist	33	82·20 ± 6·15	0·001
	Non-bruxist	20	86·34 ± 2·36	
CVT_VV	Bruxist	33	7·01 ± 4·98	0·000
	Non-bruxist	20	2·83 ± 2·04	
OPT_VV	Bruxist	33	7·80 ± 6·15	0·001
	Non-bruxist	20	3·66 ± 2·36	

control group, while the CVT_HOR measurement presented lower values in the bruxist children. (Table 3).

The cervical column also showed statistically more significant kyphotic position in the bruxist group with wider CVT_VV and OPT_VV angles (Table 3).

Discussion

Bruxism is considered to be a parafunctional behaviour that has a multifactorial aetiology (47–50). In the present work, dental wear was more significant in the bruxist group. However, it must not be taken as the only sign to diagnose this parafunctional activity.

Some studies in the literature have left aside factors related to the parafunction that give important information regarding the aetiology of bruxism in the central and peripheral nervous system (1), such as body and cervical column positions (51). There are no specific measurement methods or criteria to diagnose bruxism (52), but as it has a multifactorial aetiology (53), the study of its associated factors (54) could lead to an accurate diagnosis of the parafunction. The diagnosis of bruxism, as it was performed in this study, should be multifactorial and include the associated peripherally factors, such as the analysis of the dental wear digitally, evaluation of the TMD and alterations in anxiety levels.

In this study, dental wear present in bruxist and non-bruxist children was used to compare the size and shape differences of dental wear between the two groups. It was found to be more significant in the bruxist group, being located mainly in the incisive zone. These findings agree with other studies (29), which had previously correlated wear of the incisives with bruxism (55). There are reports (31) in adults of the horizontal form of dental wear when the teeth grind. In this investigation, no differences were found regarding the shape of the dental wear between bruxist and non-bruxist subjects. However, the studied teeth here were deciduous, whose enamel hardness is higher than that in the permanent dentition [primary enamel has a mean hardness of 4·88 ± 0·35 GPa (56). In the permanent dentition, the hardness of the normal enamel is 3·66 ± 0·75 GPa (57)], so the shape of wear could be more uniform, as it is more difficult to wear it out (56).

High anxiety levels have been previously reported as closely associated with bruxism (58). The anxiety state is a prominent factor in the development of bruxing behaviour in children (58). Indeed, some authors have shown that when the anxiety is treated, either with psychological techniques (16) or with drugs (59), the signs of bruxism decrease. Bruxist children studied in the present research had high anxiety level and they were found to present anterior head posture when compared with the non-bruxist group. Although there are reports of anxiety affecting the body posture (60), a specific head tilt in an anxiety state has not been previously reported.

Oral parafunctions, especially bruxism, have a significant association with TMD (54, 61), even in children (54). The objective of the present investigation was not to seek an association of TMD with head posture. However, controversy does exist regarding the relationship between TMD and head posture. Some authors support it (62, 63), but their methodology is not good enough to establish the relationship between TMD and anterior head posture in children. Some of them used a stethoscope to detect only TMJ sounds (62), leaving aside other TMD that are not audible. Others used the Helkimo's index (64), whose measurements of the muscle tenderness and pain are not reliable in children (63). However, other authors have better evidence to conclude about the poor relationship between TMD and head posture (65, 66).

Bruxism is mainly centrally regulated, not peripherally regulated (2, 4). Alterations in body position have been identified and described in the literature, as one of the peripherical factors that could initiate the parafunction (67, 68), while in the central nervous system, the partial hypoxia (69) has been defined as one of the factors that could generate the failure in the neurotransmission of dopamine (15).

The oral airway resistance increases with modest degrees of head and neck flexions in healthy adult humans (70), while in healthy infants, hyperflexion of the head has been shown to affect the airflow, airway patency and pulmonary mechanisms (71, 72). Additionally, sleep bruxism has been correlated to hypopnoea (10) and increasing airway patency (69). In this work, more anterior and downward head postures and kyphotic necks were found in the bruxist group, with hyperflexion of the head posture. These characteristics could affect the airflow in the bruxist children and could be part of the aetiology of their parafunction. Now, the question is whether physiotherapeutic therapies applied aiming at changing head posture could work as a therapeutic option for bruxist children.

Anterior and downward head postures, like those found in the bruxist children in this study, make the masticatory muscles be more hypertonic (73). This finding coincides with the muscular signs found by other authors (74), when the parafunction is exacerbated.

This study did not explore the relationship between mandibular rotation and the head posture, because we would have needed a bigger sample to match the children for malocclusions class I, II and III. However, observations of past studies (51, 74) indicate that anterior and downward head postures affect the mandibular position.

The results of the present research showed that if the parafunction has a multifactorial aetiology, then the diagnosis and the treatment has to be multifactorial as well.

Conclusions

The head postures found in the bruxist group were more anterior and downward than those found in the control group.

It is always important to make a multifactorial diagnosis of the parafunction to establish the individual causes of bruxism in each case and determine the best therapeutic alternative for each subject.

Further work is required to understand whether head postures are causes or consequences of bruxism.

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Correspondence: Claudia Restrepo, Calle 3 No. 43 B. 48 Apto 202. Medellín, Colombia.
E-mail: martinezrestrepo@une.net.co