Evaluation of muscle activity and bite force in masticatory muscle after massage therapy or occlusal splint in sleep bruxism childhood

Avaliação da atividade muscular e força de mordida em músculos mastigatórios após terapia de massagem ou placa oclusal em crianças com bruxismo do sono

Evaluación de la actividad muscular y la fuerza de la mordida en los músculos masticatorios después de la terapia de masaje o placa oclusal en niños con bruxismo nocturno

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Abstract
Objective: Sleep bruxism (SB) is considered masticatory muscle activities that occur during sleep, which can interfere in stomatognathic system function. When treatment occurs earlier, most of the signs and symptoms can be prevented. However, there are few studies about treatment in early ages. Thus, the present study aimed to evaluate muscle activity and bite force changes after massage therapy (MT) and the use of occlusal splints (OST) for children with SB. Methodology: Forty-eight children were divided into 4 groups after SB diagnosis, according to the American Academy of Sleep Medicine's criteria: Group 1–without bruxism; Group 2–SB, MT treated; Group 3–SB, OST treated for 30 days; Group 4–SB, not treated. Children were submitted to initial and final bite force (BF) evaluations and muscular activity, using a digital dynamometer and BiteStrip®, respectively. The results were computed and statistical analysis performed using SPSS 20.0 program, with a significant level of 95% ($p \leq 0.05$). Results: Significant

differences were statistically found in muscle activity in Group 3 (p = 0.003) and BF in both Groups 2 (p = 0.001) and 3 (p = 0.007). Conclusion: Results indicate that the use of OST led to a reduction in muscle activity and increase on BF in children with SB, whereas MT did not alter muscle activity, but provided an increase on BF in these children. Trial Reference Number (TRN) at *Registo de Ensaios Clínicos Brasileiros (http://www.ensaiosclinicos.gov.br), 13/03/2012, number registration: 543. Funding: FAPESP – 2011/06889-4.*
Keywords: Sleep bruxism; Child; Occlusal splints; Bite force; Myopathies.

Resumo
Objetivo: O bruxismo do sono (BS) é considerado como as atividades dos músculos mastigatórios que ocorrem durante o sono, podendo interferir no funcionamento do sistema estomatognático. Quando o tratamento ocorre mais cedo, a maioria dos sinais e sintomas pode ser prevenida. No entanto, existem poucos estudos sobre o tratamento em idades precoces. Assim, o presente estudo teve como objetivo avaliar as alterações da atividade muscular e da força de mordida após a massagem terapêutica (MT) e o uso de placas oclusais (OST) em crianças com BS. Metodologia: Quarenta e oito crianças foram divididas em 4 grupos após o diagnóstico de BS, de acordo com os critérios da American Academy of Sleep Medicine: Grupo 1 - sem bruxismo; Grupo 2 – BS, tratado com MT; Grupo 3 - BS, OST tratado por 30 dias; Grupo 4 – BS, não tratado. As crianças foram submetidas às avaliações da força de mordida (FM) inicial e final e da atividade muscular, por meio de um dinamômetro digital e BiteStrip®, respectivamente. Os resultados foram computados e a análise estatística realizada no programa SPSS 20.0, com nível de significância de 95% (p ≤ 0,05). Resultados: Diferenças significativas foram encontradas estatisticamente na atividade muscular do Grupo 3 (p=0,003) e FM nos Grupos 2 (p=0,001) e 3 (p=0,007). Conclusão: Os resultados indicam que o uso de OST promoveu redução da atividade muscular e aumento da FM nas crianças com BS, enquanto a MT não alterou a atividade muscular, mas proporcionou aumento do FM nessas crianças. Número de Referência do Ensaio no Registo de Ensaios Clínicos Brasileiros (http://www.ensaiosclinicos.gov.br), 13/03/2012, número de registro: 543. Financiamento: FAPESP - 2011 / 06889-4.
Palavras-chave: Bruxismo do sono; Criança; Placas oclusais; Força de mordida; Miopatias.

Resumen
Objetivo: El bruxismo del sueño (SB) se considera actividades de los músculos masticatorios que ocurren durante el sueño y que pueden interferir en la función del sistema estomatognático. Cuando el tratamiento se realiza antes, la mayoría de los signos y síntomas se pueden prevenir. Sin embargo, existen pocos estudios sobre el tratamiento en edades tempranas. Por lo tanto, el presente estudio tuvo como objetivo evaluar la actividad muscular y los cambios en la fuerza de mordida después de la terapia de masaje (MT) y el uso de férulas oclusales (OST) para niños con SB. Metodología: Cuarenta y ocho niños fueron divididos en 4 grupos después del diagnóstico de SB, según los criterios de la Academia Estadounidense de Medicina del Sueño: Grupo 1: sin bruxismo; Grupo 2: tratado con SB, MT; Grupo 3 – SB, OST tratado durante 30 días; Grupo 4 – SB, no tratado. Los niños fueron sometidos a evaluaciones de fuerza de mordida inicial y final (BF) y actividad muscular, utilizando un dinamómetro digital y BiteStrip®, respectivamente. Los resultados se computaron y el análisis estadístico se realizó mediante el programa SPSS 20.0, con un nivel significativo del 95% (p ≤ 0.05). Resultados: Se encontraron diferencias estadísticamente significativas en la actividad muscular en el Grupo 3 (p = 0,003) y BF en los Grupos 2 (p = 0,001) y 3 (p = 0,007). Conclusión: Los resultados indican que el uso de OST condujo a una reducción de la actividad muscular y un aumento de la LM en niños con SB, mientras que la MT no alteró la actividad muscular, pero proporcionó un aumento de la LM en estos niños. Número de referencia de ensayo (TRN) en el Registo de Ensaios Clínicos Brasileiros (http://www.ensaiosclinicos.gov.br), 13/03/2012, número de registro: 543. Financiamiento: FAPESP - 2011 / 06889-4.
Palabras clave: Bruxismo del sueño; Niño; Ferulas oclusales; Fuerza de la mordida; Enfermedades musculares.

1. Introduction

Sleep and awake bruxism are masticatory muscle activities that occur during sleep (rhythmic or non-rhythmic) and wakefulness (characterised by repetitive or sustained tooth contact and/or by bracing or thrusting of the mandible) (Lobbezoo, 2018). The prevalence of this condition is highly variable. In children aged between 3 to 5 years, it varies between 40·6% according to a systematic review by Manfredini, 2013. Some studies considered that this group age presents greater resistance to muscle fatigue (Ratel, 2008) and a strong association between bruxism and headache, and bruxism and open bite in children has been suggested (Tubel, 2021).

In otherwise healthy individuals, bruxism should not be considered as a disorder, but rather as a behaviour that can be a risk (and/or protective) factor for certain clinical consequences (Lobbezoo, 2018). Psychosocial stress is also associated with the development of oral parafunctions. Anxiety, depression, stress and frustration are common among witch- bruxonams

(Alencar, 2020; Alencar, 2020). Eventually, these parafunctional activities may cause increase of masticatory muscles tone and provoke its intensification (Owczarek, 2020). They may, for example, interfere in bite force (BF) (Castelo, 2007). BF measurement has an important clinical impact, once it can be used to understand the masticatory function of patients and other related symptoms (Huynh, 2007). Measurement occurs with a gnathodynamometer, a device that is widely used to evaluated stomatognathic system disorders.

Another morphological characteristic that should be considered is muscle activity. BiteStrip® is a portable device that evaluates nocturnal activity of mastication muscles that may be related to SB, temporomandibular disorder or other oral-functional changes during sleeping. This device records muscle activity to allow the determination of SB, as well as its frequency, intensity and degree of severity (Gomes, 2014).

Different forms of SB treatment are described, such as psychological methods, drug therapy, massage therapy (MT) and occlusal splints therapy (OST). However, treatment should be individualized, based on the etiological factor identified in each case (Manfredini, 2013). The use of OST for the treatment of bruxism is recommended in the literature in most cases (Murali, 2015). On the other hand, the majority of these studies involve adult patients.

This study aimed to evaluate morphological characteristics in masticatory muscle after MT and OST in SB children.

2. Methodology

Sample - Availability of Data and Materials

This study is a randomized, controlled, clinical trial (Pereira, 2018). It has received approval from the Human Research Ethics Committee of the *Universidade Nove de Julho* (Brazil), process nº 361299, in compliance with Resolution 466/12 of Brazilian National Health Council. All parents/guardians received information regarding the objectives and procedures and signed an informed consent statement authorizing the participation of their children. Children aged from 6 to 10 years old were recruited at the *Universidade Nove de Julho's* Pediatric Clinic School of Dentistry. All the data can be found in a database, available at *Universidade Nove de Julho*.

The inclusion criteria were: mixed dentition phase; first molars in Angle Class I occlusion; dental caries absence; absence of physical motor deficiency reported by parents; or an inappropriate patient's behavior during treatment and/or assessment. The exclusion criteria were: use of medication that could interfere in muscle assessment as antidepressants, analgesics, anti-inflammatories and muscle relaxants; having undergone any type of therapy for bruxism.

The sample size was calculated using researcher's specification that an increase in deviation standard of the responses for which hypothesis would be rejected was p=20%. Considering a maximum significant level of α=0.05 and a minimum test power of 1-β (probability of rejecting H0 when it is false) =0.95, Φ is approximately 2.2. Thus, n$\cong$1.2 and the number of repetitions in each group is 12 individuals (total: 12 x 4=48 individuals). Among the selected children, 36 patients presented bruxism and 12 patients did not.
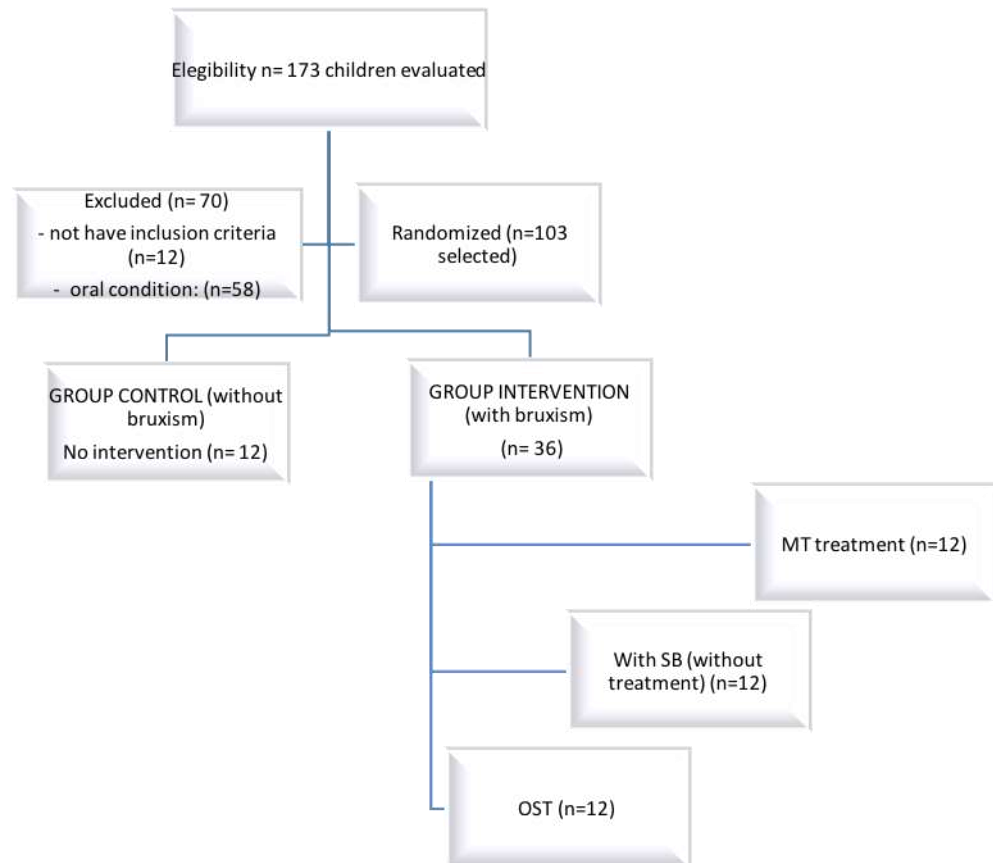
SB diagnosis

SB diagnosis was based on the American Academy of Sleeping Medicine, version 3, criteria: incisor and/or occlusal tooth wear and parents/guardians' reports of teeth clenching or grinding. Others variables were observed, such as presence/absence of clinical signs, as edentate tongue, hyperkeratosis, linea alba in jugal mucosa along the occlusal plane, gingival recession, presence of mandibular and/or maxillary torus, fractures and/or tricus in teeth (Antunes, 2016).

Group division

Volunteers were divided into four groups: Group 1–without SB and no treatment; Group 2–SB submitted to MT; Group 3–SB submitted to OST; and Group 4–SB and no treatment (Figure1). Lots using opaque envelopes containing a determinant number determined the randomization of SB children. All groups were submitted to initial and final BF and muscle activity evaluations.

Figure 1: Flowchart activity, according to CONSORT.

Source: Personal archive.

In Figure 1, the number of evaluated children, exclusion criteria and group divisions are discrimitated. Each group contained 12 participants.

Treatments

Massage therapy (MT)

MT was performed by a calibrated examiner (C.C.B.), who was trained according to the Gomes, 2015 protocol. Volunteers were submitted to MT three times a week during five weeks (15 sessions in total). Sessions had a progressive increase in duration of time for all patients, to improve behavior cooperation. First session lasted 15 minutes. Then, five additional minutes were included to each subsequent session, until reaching 30 minutes. Volunteers were placed in dorsal decubitus in a dental chair with his/her head was supported on headrest. MT was performed on the masseter and temporal muscles in a sliding and kneading way.

Occlusal splint therapy (OST)

Volunteers were submitted to impressions with alginate (Jeltrate Plus-Dentsply) to prepare splints, which were made with acrylic resin (Jet®) (Gomes, 2014). An expander screw was placed on the OSTs, to follow individual growth and development. Children and parents were verbally, and in writing, informed on how to use. OST was utilized during sleeping, eight hours a night for 30 consecutive nights. Adjustments were made once a week to improve device adaptation (Murali, 2015). Furthermore, there were parents' feedbacks reported in all adjustment sessions, regarding the compliance of children and verbal motivational enhancement, in order for them to continue with the therapy until the end of process.

Morphological analysis

Muscle straight–Maximum bite force

BF was determined using a digital dynamometer (DMD, Kratos Equipamentos Industriais Ltda,Cotia,SP,Brazil) adapted for oral conditions. This electronic device is composed of a BF plate with 2mm of diameter, connected to a digital readout. It provides BF values in Newton (N). Volunteers received instructions for training in maximum BF, becoming familiar to device. They were placed with the Camper Plane parallel to ground. Six five-second readings were taken–three on left side and three on right, alternating between sides for each reading, with a one-minute rest interval between readings.

Electromyography

The instrument that was utilized was BiteStrip®. It can analyze contractions greater than 30% of maximum. Equipment parameters were calibrated by C. C. B. This device produces a classification categorized into four scores, depending on event numbers quantified in a five-hour period (A or L=less than 30 events; B=31 to 60 events; C=61 to 100 events; D=more than 100 events). All volunteers were instructed to use BiteStrip® during one sleep night at the beginning and at the end of the study. Parents/guardians were orientated regarding left temporal muscle location and the use of the device, following manufacturer's instructions.

Statistical analisys

Data were computed and submitted to statistical tests using the SPSS 20.0 program, with significance level set at 5% ($p \leq 0.05$). After determination of normal data distribution, variance analysis (ANOVA) complemented by Tukey's test were used for comparisons among groups and repeated-measures ANOVA were used when paired measures were analyzed.

3. Results

Forty-eight children aged from 6 to 10 years were evaluated in present study (mean age: 7.38; standard deviation: 0.815). Boys accounted for 58.3% of sample ($n=28$) and girls accounted for 41.7% ($n=20$).

Mean initial BF was 22.605 KgF (SD=2.625) and was not significantly associated with gender ($p=0.432$) or age ($p=0.414$). In intra-group of BF analysis, statistically significant differences were found between initial and final evaluations in Group 2 and 3, with a BF increase in both groups ($p=0.001$ and $p=0.007$, respectively). No significant differences were found in other groups. In inter-group analysis, a statistically significant difference among groups was found between initial and final evaluations ($p=0.034$) and a statistically significant difference was found between Groups 1 and 3 ($p=0.044$).

According to muscle activity (BiteStrip®), 8.3% of volunteers presented score 0 or L, 14.6% exhibited mild activity (score A), 37.5% exhibited moderate activity (score B) and 39.6% exhibited severe activity (score C). Volunteers classified either without or with mild activity had been allocated to Group 1 (Table 1).

A statistically significant reduction in muscle activity between initial and final evaluations was found in Group 3

(*p=0.003*) (Table 2). The inter-group analysis results are described in Table 3.

A significantly lower initial and final muscle activity was found in Group 1 in comparison to the other groups (*p<0.001*). A statistically significant difference in muscle activity was also found between Groups 3 and 4 (*p=0.02*) (Table 3).

Table 1: Muscle activity analysis by Bitestrip®, according to gender, age and groups.

		A*	L*	B	C	Total	
Gender	♂	3	3	10	12	28	p=0.709
	♀	1	4	8	7	20	
Age	6	1	1	2	2	6	
	7	1	4	9	8	22	
	8	2	2	5	7	16	p=0.960
	9	0	0	2	2	4	
	10	0	0	0	0	0	
Group	1	4	7	1	0	12	
	2	0	0	7	5	12	P<0.001
	3	0	0	5	7	12	
	4	0	0	5	7	12	

Source: Authors.

In Table 1, it can be stressed that volunteers classified either without or with mild activity had been allocated to Group 1, the one without SB.

Table 2: BF intergroups. Change in bite force (KgF) in different groups.

Group	Initial measure	SD	Final measure	SD	p
1	23.176	1.528	23.239	3.446	0.951
2	21.642	2.304	24.203	1.521	0.001*
3	22.752	3.311	27.376	5.974	0.007*
4	22.852	3.064	23.526	2.316	0.611

SD standard deviation; * statistical significance (repeated-measures ANOVA). Source: Personal archive.

In Table 2, the significant reduction in muscle activity between initial and final evaluations in Group 3 (OST group) can be highlighted.

Table 3: Inter-group comparisons of changes in bite force (KgF).

Groups	Initial	Final
1. 2. 3 and 4	p=0.521	p=0.034*
1 and 2	p=0.494	p=0.920
1 and 3	p=0.979	p=0.044*
1 and 4	p=0.990	p=0.998
2 and 3	p=0.735	p=0.172
2 and 4	p=0.679	p=0.970
3 and 4	p=1.00	p=0.068

- Statistical significance (ANOVA and Tukey's post hoc test). Source: personal archive.

In Table 3, it is shown that significantly lower initial and final muscle activity was found in Group 1 (without SB) in comparison to the other groups and a statistically significant difference in muscle activity was also found between Groups 3 (OST) and 4 (no treatment).

4. Discussion

Investigations on SB in children have increased in literature due to its impact in other developmental problems, such as respiratory issues, dental wear, dental caries, and malocclusion (Yoshida, 2016). SB prevalence was reported in 21.0% children (n=1263) by Tachibana, 2016. The authors have also observed that the prevalence in the group aged 5–7 years (27.4%) was the highest one. Considering this significant prevalence, it is important to conduct SB diagnosis correctly. There are some studies that defend diagnosis with polysomnography as a methodology to assess SB, also considering it as a gold standard (de Siqueira, 2017; Serra-Negra, 2016). However, this assessment is not practicable in children. Parents have an important role in SB diagnosis in children, especially because they are the first ones who recognize main signs and symptons, such as grinding of teeth (Ristrepo, 2016). Polysomnography protocols, that are used in adults, have been tested in children, but not successfully (Gomes, 2015). Therefore, more studies are required in order for polysomnography to become useful in SB children investigation, otherwise, parents' report continues to be an available form of assessment.

Straight muscle

The present study showed an increase in BF in Groups 2 and 3. This result reinforces the importance of early diagnosis and treatment. MT and OST are described in literature as options to SB treatment, in all ages (Mesko, 2017; Hirai, 2017; Kobayashi, 2012). When patients received no treatment, there were no significant alterations in BF (Castelo, 2007). Besides, Kobayashi, 2012 observed that a higher BF in children with SB meant better masticatory performance (Kobayashi, 2014). In addition, results obtained from correlation between BF and age corroborate to literature (Mello, 2016).

SB kinesiology

Results showed that 8.3% of volunteers presented a score A and 14.6% presented Score L. Score B represents 37.5%, and 39.6% presented Score C. A statistically significant reduction in muscle activity between initial and final evaluations was found in Group 3 (p=0.0003), which was submitted to OST. In contrast, adults submitted to the same therapy had no significant influence on electromyographic activity of the masseter or anterior temporal muscles (Mesko, 2017). Age is a variable that could be associated to structural and functional alterations in stomatognathic system muscles (Martins, 2015).

In intragroup analysis, a statistically significant reduction in muscle activity between initial and final evaluations was found in Group 3 (p=0.03). A low muscle activity was reported in literature after OST in young adults (Williamson, 1993). A significantly lower muscle activity was found in Group 1 in comparison to other groups (p<0.001), which means even after treatment, SB children present a muscle activity higher than those who do not have SB. It might have happened because treatment was not dedicated to a primary cause, such as sleeping apnea or daytime problematic behaviors (Yoshida, 2016).

In intergroup analysis, a stastiscally significant difference in muscle activity was also found between Groups 3 and 4 (p=0.02). Therefore, OST was a treatment that improved kinesiological characteristics of the muscle in question.

5. Conclusion

The present study concluded that OST led to a reduction in muscle activity and an increase in BF in children with SB, whereas MT did not alter muscle activity, but provided a BF increase in these children. This research reinforces the need for more clinical trials in this area, in order to achive adequate diagnosis and treatment for children with SB.

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