Original Article

Sensitivity of Brux Checker® in Grinding Bruxer

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Abstract

Untreated bruxism can cause pathologic consequences to the components of the masticatory system leading to unnecessary treatments that are often complicated and costly. However, the damage could be prevented if the condition is diagnosed earlier. Bruxism patients with asymptomatic or mild jaw symptoms usually refused to admit that they grind their teeth. Therefore, a reasonably priced tool with high sensitivity that is comfortable to wear would be beneficial for early screening or diagnosing sleep bruxism. The aim of this clinical study is to investigate Bruxcore Plate (Brux Checker®) accuracy to diagnose sleep bruxism in known cases. Forty-four sleep bruxism participants with clear evidence of bruxofacets on the intraoral appliance were enrolled. Results showed that Brux Checker® had a sensitivity of 84.1% after one night of application and a sensitivity of 100% on four consecutive nights. In conclusion, at least four nights of Brux Checker® wearing is recommended for sleep bruxism diagnosis.

Keywords : Diagnostic sensitivity, Grinding bruxer, Intraoral device, Oral parafunction, Sleep bruxism

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Introduction

Bruxism is a repetitive jaw-muscle activity characterized by clenching or grinding of the teeth and/or bracing or thrusting the mandible. Bruxism has two distinct circadian manifestations: it can occur during sleep (indicated as sleep bruxism) or during wakefulness (indicated as awake bruxism).[1] Awake bruxism is a semi-voluntary bite often associated with stress about daily life or work.[1] Sleep bruxism (SB) is medically defined by the International Classification of Sleep Disorders, 3rd edition (ICSD-3) as a sleep-related movement disorder characterized by teeth grinding or clenching associated with an excessive sleep arousal activity.[2] Bruxism has been reported to be caused by forces that are transmitted during tooth contact for 20 minutes or more than two hours of tooth contact.[3]

Bruxism is a common condition. Studies showed the self-reported prevalence of 8-16% in the general adult population with similar numbers in males and females. Bruxism begins about one year after deciduous incisors appear in the oral cavity. A survey of children and adolescents found bruxism rates between 14-20% and tended to

decrease when they got older.[4] In particular, only 3% of bruxism was found in adults over 60 years of age. However, it should be considered that many older patients wearing dentures could still have bruxism. In addition, several psychotropic medications taken by the elderly could aggravate the bruxism condition.[5,6]

The etiology of bruxism is multifactorial; however, the exact cause is still unknown. There is an assumption that there may be four factors.[1,7] 1) Pathophysiological factors and the central nervous system such as genetics, neurochemicals disrupt the balance of nerve impulses in the basal ganglia, causing a disturbance in dopamine transmission similar to Parkinson's disease or brain injuries and diseases. 2) Psychosocial factors: daytime teeth grinding is associated with psychosocial conditions, especially stress.[8] 3) Factors related to drugs: drugs affecting the dopaminergic system such as amphetamine, nicotine, serotonin ecstasy, alcohol, caffeine, tobacco, selective serotonin reuptake inhibitors, benzodiazepines.[8] 4) Physical factors such as the anatomical structure of the jaw, face and oral cavity.[8]

The cause of bruxism is controversial, but it can be separated into teeth grinding while conscious and while sleeping with different disease factors. Awake bruxism can be determined by accumulated daily stress.[9] The occurrence of muscle spasms associated with sleep bruxism caused by the central nervous system and may be related to shallow sleep, also known as slight arousal (micro-arousal).[10]

Several methods were used to evaluate bruxism. A questionnaire could be a useful tool in assessing this condition. The advantage of questionnaires is being able to collect data among large populations efficiently, but the disadvantage is underestimation or overestimation in bruxism patients. Many of them could not identify themselves as bruxers, especially those who sleep alone. Thus, the questionnaire was limited in terms of accuracy.[5,11,12] Clinical examination, one of the most common methods for bruxism assessment, could be performed by looking for signs and symptoms of bruxism in the patient's oral cavity, such as wear facets, scalloped tongue and linea alba buccalis. However, these signs and symptoms should not be used in the clinical diagnosis of bruxism alone.[13-17] Measurement of muscle function or electromyography (EMG) is considered close to the standard of sleep laboratory testing.[5] However, the disadvantage involves other confounding factors that may cause interpretation error due to other orofacial movements, such as swallowing, sneezing, or coughing during sleep or sleepwalking.[5]

The gold standard for sleep bruxism evaluation is Polysomnography (Sleep laboratory), which is the most accurate but costly. Therefore, an inexpensive tool or test to diagnose bruxism with specificity, sensitivity, and accuracy that increases patient incorporation in using will benefit dentists and patients in assisting the assessment of bruxism. The assessment of bruxism by using oral devices can be divided into the following two groups:

1. Observation wear facets type:

1.1 Occlusal Splint: The result is assessed from the wear facets on the appliance.[18,19]

1.2 Bruxcore Plate (Brux Checker®): The Brux Checker® is used to clinically diagnose bruxism that facilitates to record and evaluate a patient's parafunctional activity patterns. It presents the wear marks of static and dynamic occlusal contacts, the identification of physiological or unphysiological tooth contacts, and the classification and differentiation of the dynamic occlusal scheme. The assessment of these patterns in the context of occlusion diagnostics enables the development of a precise, personalized treatment plan for each patient based on their respective current bruxism pattern.[20]

It is fabricated with a 0.51 mm thick polyvinyl chloride color-coated plate (Table 1), that is shaped according to the patient's dental anatomy, using a vacuum pressure machine.[20]

Table 1 *Demonstration of physical, chemical, mechanical and biological properties of Brux Checker® (SCHEU DENTAL GmbH, 2019)*[21]

Properties	Guideline	Value
General properties		
Form	-	Solid
Colour	-	Transparent film with a red paint layer
Odour	-	Odourless
Density	ISO 1183	1.33 g/cm^3
Water absorption after 24 h at 23°C	ISO 62 Method 1	-
Mechanical properties		
Tensile strength	ISO 527	> 42 MPa
Flectional strength	ISO 527	-
Impact strength 23°C	ISO 179	600 KJ/m^2
Notched 23°C	ISO 179	-
Yield strain	ISO 527	-
Yield stress	ISO 527	-
Elasticity	DIN 53377	+/- 4%
Elongation at tear	ISO 527	-
E-modulus	ISO 527	-
Hardness Shore D	DIN 53505	~ 78
Thermal properties		
Vicat softening point	ISO 306 / Verfahren B/50	74°C
Thermoform resistance	ISO 75	55°C
Continuous stress temperature	ISO 75	55°C
Biological properties / Biocompatibility		
The material has been tested on biocompatibility according to DIN EN ISO 10993		

Similar to an occlusal splint, the result is positive when wear facets appear after use, According to the recommendation of Prof. Sadao Sato, after one night use enabled the diagnosis of bruxism.[21,22,23]

2. Measurement of bite force type: Intra-splint force detector (ISFD) is an instrument that measures the bite force of bruxism when teeth come into contact with the tool.[24]

Even though there is a lack of standardized indications for scoring and evidence supporting its validity, the results obtained from these instruments may not reflect the current state of bruxism because of the variety of bruxism at night. The findings may not be the bruxism results and could be the disturbances associated with recording methods.[25-27] Owing to the convenience and practicality, the oral appliance has become increasingly common for bruxism assessment. Patients with bruxism may not know or refuse that they are bruxers. Therefore, inexpensive tools with high sensitivity like oral appliances are suitable for diagnosing this group of patients. This research focused on studying Bruxcore Plate (Brux Checker®)'s sensitivity test in diagnosing bruxism in known sleep bruxism patients and determining the relationship between sex, age range, and instrument (Brux Checker®) sensitivity.

Materials and method

Study design: This research was modeled as human experimental research.

Sample size calculation and Sampling method

The sample size was calculated based on the Brux Checker® determination to indicate bruxism in 80%

of patients with bruxism, 90% confidence interval, and sensitivity of Brux Checker® was equal to 0.8 ± 0.1 based on sample size for a descriptive study with dichotomous variable. Total of 44 participants were required. A random sampling method used systematic random sampling by dividing the sample into males and females and selecting from the pool within three months.

Inclusion criteria

1. Thai people between the ages of 18 - 60 years with at least two pairs of occluded posterior teeth on each side.
2. Patients who had been treated for bruxism by using an intraoral appliance in Michigan splint or flat plane stabilization splint design in which the material was heat-cured clear acrylic resin, and showing wear facets from bruxism.

Exclusion criteria

1. Having sore teeth, gums, or symptoms of periodontal disease in the past six months.
2. Parafunction of the jaw muscles resulting from other sleep disorders, medical or neurological disorders, drug or substance abuse.
3. Allergy to polyvinyl chloride and acid red 51 food coloring.

Brux Checker® fabrication and Data collection

Upon passing the inclusion criteria, participants were instructed to photograph the wear facets on the occlusal splint to confirm being the true bruxer. Then the alginate impression was taken to fabricate a dental model with dental stone. The dental model was then sent to a laboratory to construct the Brux Checker® from the polyvinyl chloride plate using vacuum pressure machine (Bio Star®). (Fig. 1) Brux Checker® was given to the participant for familiarity and observation of allergic reactions to polyvinyl chloride and acid red 51 food coloring for ten minutes. (Fig. 2) Then the participant was instructed to wear Brux Checker® at bedtime and observe for the number of nights when the wear marks on Brux Checker® first appeared. Once the recording was completed, the participant inserted the Brux Checker® on the dental model or in the box to prevent tearing and sent it back to the researcher. (Fig. 3)

Figure 1 *Finished Brux Checker®*

Figure 2 *Wearing a Brux Checker® in the subject; 2a in frontal view, 2b in occlusal view*

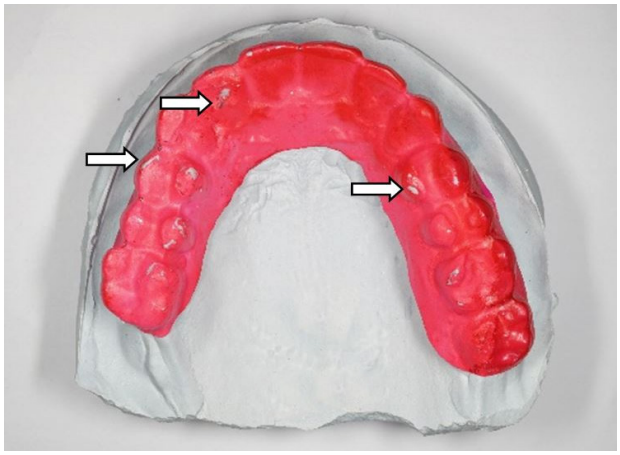

Figure 3 *Brux Checker® with wear marks*

Data analysis

The information gathered and the nominal scale data, such as sex, age range, the number of participants with wear marks on the first night and the number of nights wearing the Brux Checker® until the wear marks appeared were distributed into groups. The sensitivity of the Brux Checker® for each night was calculated based on the number of samples who reported the presence of the wear marks on the Brux Checker® after the first night of wearing it as well as the other subsequent nights that the wear marks initially appeared. The relationship between gender and Brux Checker®'s sensitivity and age range and Brux Checker®'s sensitivity were determined using Chi-square association statistics and the Fisher's Exact Test.

The study was accredited by the Human Research Ethics at the Faculty of Dentistry and Faculty of Pharmacy Mahidol University No. MU-DT/PY-IRB2018/053.140.

Results

The frequency distribution data obtained from 44 participants was analyzed in four categories: gender, age range, the presence of wear marks on the Brux Checker® on the first night, and the presence of wear marks on the Brux Checker® on other nights by using descriptive analysis. According to these data, there were 10 males (22.7%) and 34 females (77.3%). Based on the age range, there were 11 participants with the ages between 18 to 24 years old (25%) and 33 participants at the ages ranging from 25 to 60 years old (75%). (Table 2)

Table 2 *Demonstration of numbers of the participants classified by gender, age range, and the presence of wear marks on the Brux Checker® on the first night*

N = 44	Independent variable	Participants N (%)	Wear marks on the first night N (%)
Gender	Male	10 (22.7 %)	9 (20.45 %)
	Female	34 (77.3 %)	28 (63.64 %)
Age range	18 – 24 yrs.	11 (25 %)	8 (18.18 %)
	25 – 60 yrs.	33 (75 %)	29 (65.91 %)

In this study, the wear marks presented on the Brux Checker® after the first night use were found in 37 participants of which the sensitivity was 84.1%. The numbers of the positive results detected after the second and third nights were increased to three participants per night and equaled to 6.8% and were consistent with the cumulative sensitivity of 90.9% and 97.7%, respectively. On the fourth night, all participants had positive results with 100% of cumulative sensitivity. (Table 3)

Table 3 *Demonstration of the frequency of the participants with wear marks presented on the Brux Checker® from the 1st to 4th night*

Night with wear marks presented	Numbers of participants with positive wear marks N (%)	Cumulative sensitivity (%)
1st night	37 (84.1 %)	84.1
2nd night	3 (6.8 %)	90.9
3rd night	3 (6.8 %)	97.7
4th night	1 (2.2 %)	100

The expected ideal sensitivity of the diagnostic tool should approach 1. In this study, the sensitivity after using Brux Checker® for one night was 0.841 or 84.1%.

The results of Fisher's Exact Test of the data with frequency less than 5 in 1 cell of 2x2 table of total data set, revealed no significant correlation between gender, or age range and detected wear marks on the Brux Checker® used on the first night with *p*-value > 0.05 and = 0.341, respectively. (Tables 4 and 5)

Table 4 *Demonstration of the correlation between gender and detected wear marks on the Brux Checker® used on the 1st night, p-value > 0.05*

Count		Wear marks on the 1st night		Total
		Positive	Negative	
Sex	Male	9	1	10
	Female	28	6	34
Total		37	7	44

Table 5 *Demonstration of the correlation between age range and detected wear marks on the Brux Checker® used on the 1st night, p-value = 0.341*

Count		Wear marks on the 1st night		Total
		Positive	Negative	
Age range	18 – 24 yrs.	8	3	11
	25 – 60 yrs.	29	4	33
Total		37	7	44

Discussion

While the authors expected to have the sensitivity of the diagnostic tool approaching or equaling to 1 or 100%, the sensitivity of Brux Checker® was as high as 84.1% after one night of use. However, the sensitivity was 100% after four nights of use. This can be due to the variable force of teeth grinding of individuals during the week which can lead to absent or shallow wear marks on intraoral appliance in mild bruxers.[28]

Initially, the study was designed in a randomly systematically sampling manner to minimize the bias during the sample collection, and the distribution of data and study group population were expected to be normal. However, during the experiment, the number of female participants was approximately three times greater than males, and most participants in our study were in the working age. All these factors might affect data interpretation.

Interestingly, the correlation between age range and sensitivity of the Brux Checker® tested on the first night revealed that the sensitivity of Brux Checker® in diagnosis of bruxism in participants between 18 to 24-year-old was approximately four times lower than in 25 to 60-year-old participants. Firstly, this can be due to the skewed distribution of the data resulting from the great difference regarding the numbers of populations between 25 to 60-year-old and 18 to 24-year-old participants. In our study, the number of participants between 25 to 60-year-old was three times greater than the number of participants between 18 to 24-year-old. Therefore, the results may not be reflective of a true correlation between the age range and the sensitivity of the tool. Another possibility is the psychological condition from stress and an urban lifestyle which can contribute to the severity of bruxing activity during sleep.[29] In addition, most 18 to 24-year-old participants were university students in bachelor program, thus they could suffer from academic study stress and personal issues.[30] On the other hand, the 25 to 60-year-old

participants were primarily under work pressure and stress from several life-factors.[31] All of these conditions can be associated with the severity of sleep bruxism. Similar to the age range factor, the data distribution of the gender was not in normal distribution because of the difference in numbers of populations between males and females which could affect the results of data analysis. This can be due to several uncontrolled confounding variables. In the present study, there was no statistical significance between gender, age range, and bruxing activity detected on the first night. However, the correlation between these factors cannot be definitively excluded due to the above-mentioned possibilities. On the contrary, some literature suggested that gender displayed an association with bruxism.[32] Some study explained that females likely paid more attention to their oral health than males resulting in an increased incidence of bruxism in female population.[33]

The aim of the future study is to focus on the identification of correlation between factors that can impact on the presence of wear marks on the Brux Checker®, particularly gender and age range. In addition, the study population selection method should be altered in order to obtain the optimal normal distribution of the study data.

Unfortunately, there are few studies on the use of the Brux Checker® in diagnosing bruxism, and none of the studies report on how many nights to wear Brux Checker®. Only patterns of tooth wear marks have been reported in the form of horizontal grinding and vertical grinding, and the results are used for the diagnosis and treatment of bruxism.[3,17,34]

Our study found that some participants did not give positive results after the first night. Therefore, the participants should continue to wear Brux Checker® until a clear mark appeared since all participants were known bruxism cases according to wear facets on their occlusal splints.

Our hypothesis would be accepted with the confidence interval of 90%. The power of the test of the diagnostic tool was only at 80% for this study. This could be due to limitations in the funding budget and the criteria for study participant recruitment might affect the number of participants. However, if we consider the confidence interval of our study at 95-99% and increase the population size, the sensitivity and accuracy of the Brux Checker® might increase. In addition, the Polysomnography test should be applied in a future study to obtain the true negative results in the participants who do not have sleep bruxism for specificity calculation.

Conclusion

In this study, the Brux Checker® has high sensitivity at 84.1 % with 100% cumulative sensitivity after four-night usage. Thus, the authors suggest that Brux Checker® should be used at least for four consecutive nights as a preliminary bruxism diagnostic method.

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