Evaluation of occlusal contact patterns obtained by red-colored sheets in adult sleep bruxers

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Abstract

Background: A color-stained sheet was recommended to evaluate various occlusal contact patterns during sleep. **Objectives:** The study aimed to assess the occlusal contact patterns and to survey the status of TMD symptoms related to occlusion patterns in sleep bruxers. **Materials and methods**: 30 patients who visited Hue University of Medicine and Pharmacy Hospital were diagnosed using criteria suggested by American Association of Sleep Medicine and the EMG Logger. Then, they were fitted with a Bruxchecker® to examine the occlusal contact patterns. The Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) was utilized to detect temporomandibular disorders. **Results:** The average bruxism index in the male group was higher than in the female group, 10.42 ± 4.47 and 9.38 ± 2.32 respectively (p>0.05). The ICPM (incisor-canine-premolar-molar) + MG (mediotrusive guiding) pattern occupied the largest proportion (93,3%). There were no IC, IC + MG, or ICP patterns. Nearly all of the quadrants (98,3%) showed an MG pattern. The percentage of sleep bruxers with clicking, arthralgia, masseter myalgia, and temporalis myalgia were 50%, 33.3%, 80%, and 33.3% respectively. **Conclusions:** The ICPM and MG (when evaluating laterotrusive and mediotrusive contact respectively) were common occlusal contact patterns in adult sleep bruxers. The proportion of TMD symptoms in adult sleep bruxers was relatively high.

Keywords: *sleep bruxers, Bruxchecker®, occlusal contact patterns, temporomandibular disorders.*

1. INTRODUCTION

The definition of bruxism has changed significantly over the years. In 2018, an International Consensus Conference proposed two definitions for sleep and awake bruxism. Sleep bruxism (SB) is defined as the activity of the masticatory muscles during sleep characterized by rhythmic (phasic) or non-rhythmic (tonic) contraction of these muscles [1]. SB might be diagnosed by many different methods. Polysomnography (PSG) is still the gold standard among definitive diagnostic modalities [2]. However, PSG has many limitations in clinical practice (high cost, changing sleep environment during the testing procedure, and so on), therefore, various alternative tools are proposed. The device that is considered highly accurate is the electromyography of masticatory muscles (masseter or temporalis muscle), followed by devices that record tooth contacts or bite force in the mouth [3], [4]. Recently, a new tool using screening questionnaires and clinical examination (Standardised tool for the Assessment of Bruxism - STAB) has been introduced and is under a validating process [5].

A systematic review found that sleep disturbances had the strongest association, whereas few occlusal characteristics had a moderate association with adolescent sleep bruxism [6]. However, some studies found a relationship between sleep bruxism, TMD signs and symptoms, and occlusal factors [7-9]. Another review when referring to the causes of bruxism, suggests that specific occlusal interferences might trigger bruxism, despite emphasizing that bruxism is a multifactorial and central-nervous-driven process [10]. The occlusal factors that are paid attention to the most include occlusal contact patterns and mediotrusive (MT) or nonworking-side occlusal contacts. Occlusal contact patterns are the status of occlusal contact during sleep bruxism, which is usually revealed by evaluating an intraoral color-stained sheet. The 9th Edition of the Glossary of Prosthodontic Terms defines MT contacts as "contact on the teeth on the side opposite to the direction of laterotrusion of the mandible" [11].

Bruxism has caused excessive force on the muscles, joints, and dentition, which is believed to be associated with many potential consequences. The possible damage includes tooth wear (e.g. mechanical wear of enamel and dentin); loosening or fractures of the tooth (crown or root); fractures or failures of dental restorations and implants; and temporomandibular disorders (e.g. pain and dysfunction of the masticatory muscles and/ or

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temporomandibular joint) [10]. Certain occlusal patterns that might be common in sleep bruxers or SB in patients with particular occlusal patterns might also cause symptoms of temporomandibular disorders (TMD) [3], [7], [8]. The above issues have been mentioned in some previous studies [7], [9]. However, in these studies, the criteria for diagnosing participants with sleep bruxism have not been clearly stated. Therefore, we conducted this study to clarify the occlusal patterns in sleep bruxism patients diagnosed by an electromyographic device, and to survey the status of TMD symptoms related to occlusion patterns in sleep bruxers.

2. MATERIALS AND METHODS

Diagnosis sleep bruxers: This study was conducted at the Dental Clinic in Hue University of Medicine and Pharmacy Hospital. Participants over 18 year olds who visited the hospital with a suspicion of sleep bruxism were subjected to a thorough clinical examination to diagnose this behavior. Firstly, ASSM (American Association of Sleep Medicine) criteria were utilized for screening sleep bruxism. Then a surface electromyograph (EMG) device (EMG Logger, GC Corporation, Japan) was used to diagnose sleep bruxism. Patients who were evaluated as having sleep bruxism with both AASM criteria and EMG device were included in this study.

Bruxchecker® preparation: The Bruxchecker® (BC) used in this study is a 0.1-mm-thick polyvinyl chloride sheet. It was coated with red food colorant and its color-stripped portion indicates the occlusal contact patterns during sleep bruxism. The maxillary arch of the participant was taken impression by alginate and the stone cast was poured. BC was customized for each subject by heating it at 2300 C for 15 seconds in a thermoforming machine named Ministar® (Scheu-Dental, Iserlohn, Germany), then compressing it over the upper stone cast. It was trimmed before being fitted into the maxillary arch of the patient [3], [12].

Experimental procedure: On the first night of the experiment, patients were instructed to wear an unactivated EMG Logger (EL) device on the masseter region and a maxillary transparent splint with a thickness of 0.1 mm. This first night set-up allowed the patient to adapt to EL and BC to remove the bias of the equipment-induced irritations during sleep. In the two following consecutive nights, EL was activated to collect muscle activity data and BC was fitted intraorally. After three nights, EL and BC were returned to the dentist for data analysis. The study was approved by the Ethics Committee in Biomedical Research of the University of Medicine and Pharmacy, Hue University.

Data collection:

Patients were detected as sleep bruxers by AASM if they met two following requirements [2]: (1) The Questionnaire consists of 6 questions: "*1. Has anyone heard you grinding your teeth at night? 2. Is your jaw ever fatigued or sore on awakening in the morning? 3. Are your teeth or gums ever sore on awakening in the morning? 4. Do you ever experience temporal headaches on awakening in the morning? 5. Are you ever aware of grinding your teeth during the day? 6. Are you ever aware of clenching your teeth during the day?".* Patient must be indicated having bruxism sound at night (positive response for the first question) and must have at least one yes-answer for the rest five questions. (2) Clinical examination: having bruxofacet (compulsory) and one or more than one of these symptoms: joint clicking sound, joint pain, muscle pain, muscle tenderness, limited mouth movements.

Patients who satisfied AASM criteria would be confirmed as having sleep bruxism by EMG Logger. We instructed patients to wear EL prior to going to bed. Patients did basic movements, including a clenching last 3 seconds, 3 times firmly biting at the maximal intercuspal position, and ended with a 3-second clenching. Sleep bruxism was evaluated based on the average number of bruxism per hour (bruxism index) over two nights (at which the EF was activated for collecting data). If the bruxism index is from 5.5 to 7.6, the patient has moderate sleep bruxism and severe bruxism when it is over 7.6 [13].

Evaluation of tooth contact pattern: Each maxillary quadrant of patients was evaluated (60 sides in 30 patients). Occlusal contact patterns in sleep bruxers obtained by Bruxchecker® were classified based on a combination of laterotrusive-side tooth contact and mediotrusive-side tooth contact [7]. Laterotrusive grinding patterns include IC (incisor-canine), ICP (incisor-canine-premolar), and ICPM (incisor-canine-premolar-molar): if only the IC area was worn off, it was categorized as an IC pattern; if tooth contact appeared in the P area, it was called an ICP pattern; if tooth contact occurred in the M area (despite the ICP area was stripped off or not), it was classified as ICPM pattern. On the mediotrusive side, the MG (mediotrusive grind) pattern was observed in the internal inclined plane to the lingual cusp tip or the ridge of the lingual cusp of premolars or molars. Therefore, occlusal contact patterns were classified into 6 types, including IC, IC + MG, ICP, ICP + MG, ICPM, and ICPM + MG. Occlusal contact patterns on both sides (right and left) were also evaluated for

TMD symptoms were assessed by one calibrated dentist based on Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) suggested by Schiffman in 2014, including TMJ clicking sound, arthralgia, and myalgia (masseter or temporalis) [15].

Data were processed using SPSS 22.0 software (IBM, SPSS Inc., Chicago, IL, USA), with a p-value of 0.05 for statistical significance.

3. RESULTS

3.1. Distribution of sleep bruxers

Thirty patients participated in this study, including 11 males and 19 females. There was no difference in the distribution of severity of bruxism in the gender group. Bruxism index in males and females were 10.42 ± 4.47 and 9.38 ± 2.32 respectively, with no statistically significant difference (p > 0.05).

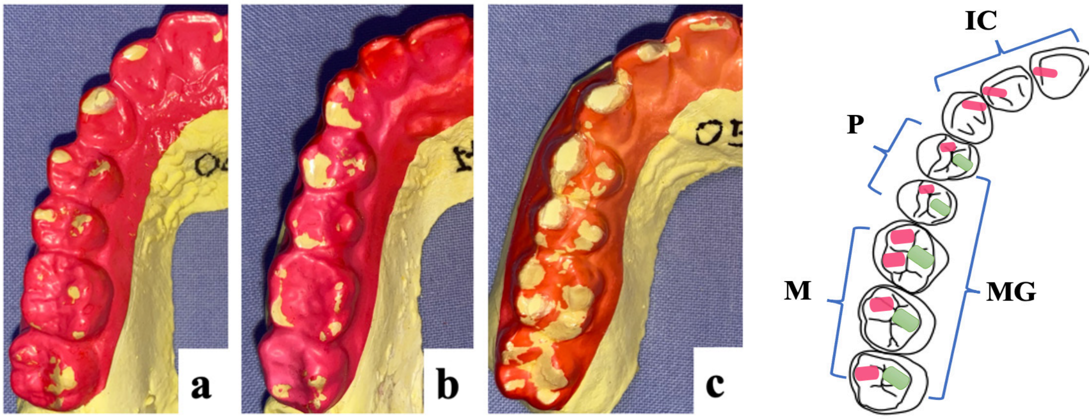
Table 1. Distribution of bruxism index in participants according to gender.

Number of bruxism episodes per hour	Participants			
	Gender - number (%)		Bruxism index	
	Male	Female	Male	Female
5.5 - 7.6 (Moderate)	5 (45.5)	5 (26.3)	6.72 ± 0.37	6.32 ± 0.58
> 7.6 (Severe)	6 (54.5)	14 (73.7)	13.51 ± 3.84	10.47 ± 1.58
Total	**11 (100)**	**19 (100)**	**10.42 ± 4.47**	**9.38 ± 2.32**
p - value	**0.425 ***		**0.403****	

* Fisher exact Test; **: Independent – Samples T test

3.2. Occlusal contact patterns

Figure 1 demonstrated occlusal contact patterns assessed by Bruxchecker®. In the category of occlusal patterns, the ICPM + MG pattern occupied the largest proportion (93,3%). There were no IC, IC + MG, or ICP patterns observed in this experiment. Nearly all of the quadrants (98,3%) showed an MG pattern in mediotrusive griding (Table 2).



A B

Figure 1. Occlusal contact patterns inspected by Bruxchecker®

A. Observed area to evaluate cclusal contact patterns on right side: IC (incisor-canine), P (premolar), M (molar) and MG (Mediotrusive Guide)

B. Occlusal contact patterns on Bruxchecker®: a. ICP+MG, b. ICPM, c. ICPM + MG

Table 2. Occlusal contact patterns during sleep bruxism assesed via Bruxchecker®

Occlusal contact pattern	Number of side (n = 60)	Frequency (%)
IC	0	-
IC + MG	0	-
ICP	0	-
ICP + MG	3	5.0
ICPM	1	1.7
ICPM + MG	56	93.3
MG	59	98.3

IC: incisor – canine, ICP: incisor – canine – premolar;
ICPM: incisor – canine – premolar- molar, MG: mediotrusive guide

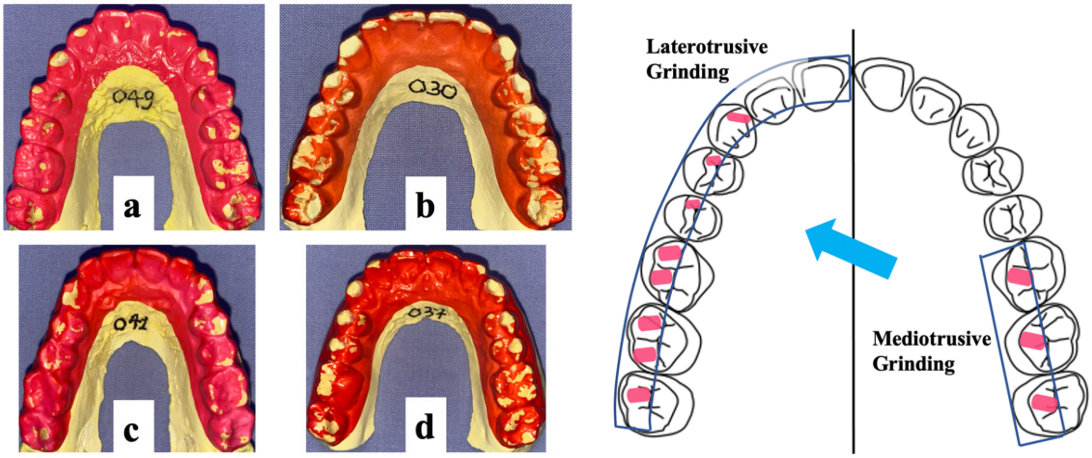


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Figure 2. Both sides tooth contact patterns
A. Observe area when evaluating grinding pattern on the right side
B. Laterotrusive contact pattern: a, c. ICP+ICPM; b, d. ICPM+ICPM;
and Mediotrusive contact pattern: c. Unilateral MG; a, b, d. MG+MG

3.3. State of both sides tooth contact pattern and temporomandibular disorders' symtoms

In Table 3, the tooth contact pattern of both sides was evaluated. The majority of bruxism patients (90%) had ICPM patterns on both sides (ICPM + ICPM). The rest three bruxers (10%) had ICP + ICPM pattern. In terms of mediotrusive guiding, an extremely high percentage of patients showed an MG + MG pattern (96.7%). Only one bruxers had unilateral MG. A relatively high proportion of patients experienced TMD symptoms, such as clicking, arthralgia, or myalgia.

Table 3. State of laterotrusive and mediotrusive tooth contact
and temporomandibular disorders symptoms

Both sides contact pattern		Number (%)	Clicking	Arthralgia	Myalgia	
					Masseter	Temporalis
Laterotrusive contact pattern	ICP + ICPM	3 (10)	2	2	3	1
	ICPM + ICPM	27 (90)	13	8	21	9

Mediotrusive contact pattern	MG + MG	29 (96.7)	14	9	23	9
	Unilateral MG	1 (3.3)	1	1	1	1
	No MG	0	-	-	-	-

ICP: incisor - canine - premolar; ICPM: incisor - canine - premolar - molar, MG: mediotrusive guide.

4. DISCUSSION

In this study, 30 sleep bruxers were diagnosed using ASSM criteria and the EMG Logger, were fitted with a Bruxchecker to evaluate the occlusal contact patterns. We also examined the clinical symptoms of TMD to define whether there is a relationship between occlusal contact patterns and TMD symptoms.

There were more women bruxers than men, and the average grinding index in the male group was higher than in the female group (Table 1). However, there was no difference in the distribution of severity or index of bruxism in the gender group. Saczuk K. (2019) showed no difference between genders in terms of SB status [16]. The reason for the higher proportion of women observed in the study might be when teeth grinding occurs, women are more likely to be worried and want to seek medical care than men.

Electromyography devices are increasingly used in the diagnosis of SB [4], [16]. In this research, we used an EMG Logger device. When comparing the results measured by the EMG Logger with the gold standard PSG, with a cut-off point of 5.5 episodes/hour (equivalent to 2 episodes/hour when using PSG), the sensitivity and specificity of the device is 100 % [13]. In this study, we chose the cut-off point of 5.5 episodes/hour to determine a subject with SB. Therefore, the diagnostic results of SB using EMG Logger in the study are highly reliable. We use Bruxchecker® to record occlusal contact patterns. It was first introduced by Onodera and colleagues and could be useful for screening occlusal contact patterns during sleep bruxism [3]. In our study, first-night data were excluded to remove the bias. A previous study excluded 2 first nights and just used the third-night data for analysis [17]. However, our patient reported adapting the device and 0.1mm thick splint quickly right in the first night. None of the participants complained of the irritation caused by EF or BC in their sleep. Measuring 2 consecutive nights, EF and BC at the same time made it reliable for the collected results. Onodera also suggested wearing BC for two consecutive nights to evaluate grinding patterns during sleep bruxism [3].

Occlusal contact patterns

We evaluated occlusal contact patterns on 60 maxillary quadrants of 30 patients. ICPM + MG was the most prevalent pattern (93,3%). Interestingly, there were no IC, IC + MG, and ICP patterns observed in this experiment (Table 2). According to Park B. (2008), the highest proportion of ICPM + MG is 59%, followed by ICP + MG at 33% [7]. In the study of Nguyen VTQ (2014), the rate of ICPM + MG was 52.5%, followed by ICP + MG at 15%, then ICPM and IC + MG at 12.5% [12]. Another study showed that in sleep bruxers, the ICPM and ICPM + MG grinding types are significantly more common than the IC and ICP types [18]. This means that grinding motions involving the molars will result in greater muscle activities. According to Park B. (2008), the average maximum separation distance of excursion and incursion and the average maximum condylar lateral deviation during protrusion/retrusion and open/close movements in the ICPM and ICPM+MG types were larger than those of the IC and ICP types [7]. Bruxism, a common cause of microtrauma, often leads to the lengthening of the capsular ligaments, the thinning of the articular disc, and loss of muscle coordination. The condylar lateral movement is wider and the displacement of the condyle is more prolonged. Therefore, bruxism might result in the displacement of the articular disc [7]. Tago C. (2017) mentioned that the ICPM and MG contacts observed in Bruxchecker might be higher than those observed during intraoral examination. Because SB involves severe powerful contractions of the masticatory muscles, these tooth contacts are difficult to see by examining patients while awake, even using articulating papers [14]. Nearly all of the quadrants (98,3%) showed an MG pattern in mediotrusive griding contact (Table 2). The proportion of MG in studies of Nguyen VTQ (2014), Onodera K (2006), Tago C. (2017) were 80%, 84%, and 95.9% respectively [3], [12], [14]. In our study, participants were moderate and severe bruxers (evaluated by EMG Logger), therefore, the proportion of MG could be probably higher than others (in which diagnostic criteria were not mentioned nor clarified).

Relation of occlusal contact patterns (laterotrusive and mediotrusive) and TMD symptoms

We assessed the tooth contact pattern of both sides (Table 3). In terms of laterotrusive contact patterns, the majority of bruxism patients (90%) had ICPM patterns on both sides (ICPM + ICPM). The rest three bruxers (10%) had ICP + ICPM pattern. A relatively high proportion of patients experienced TMD symptoms, such as clicking (15/30), arthralgia (10/30), masseter myalgia (24/30), or temporalis myalgia (10/30). In a study of Tago C, 34/49 participants had ICPM + ICPM while 6/49 had ICP + ICPM. Among these 40 patients, 25 and 15 had clicking sound and joint pain respectively. Park B. (2008) and Tago (2017) investigated transversal condylar deviation during bruxism movement among various types of occlusal contact patterns, using condylography. They concluded that the patients with ICPM were more likely to have TMD than those with IC pattern [7], [14]. In our study, no patient had the IC pattern. Therefore, we have not been able to compare the rates of TMD symptoms between different types of occlusal contacts.

In terms of mediotrusive guiding, especially, all participants in our study had the MG pattern. An extremely high percentage of patients showed an MG + MG pattern (96.7%). Only one bruxers had unilateral MG. The percentage of participants with clicking, arthralgia, masseter myalgia, and temporalis myalgia were 50%, 33.3%, 80%, and 33.3% respectively. A study by Tago C. showed 46/49 (93.9%) cases had MG + MG pattern while 2/49 (4.1%) had unilateral MG, only one case had no MG. Subjects with MG contact on both sides showed a high frequency of TMD symptoms: 65.2 % had clicking, and 32.6 % experienced pain [14]. MG could be consider as mediotrusive contact. The 9th Edition of the Glossary of Prosthodontic Terms gives two opposite descriptions of MT contact. One definition is “an undesirable contact of opposing occlusal surfaces on the nonworking-side when it interferes with anterior guidance or group function on the working side” and the other is that —“nonworking-side contacts are desirable with removable complete dentures when establishing balanced articulation” [11]. The roles of contact on the non-working side (mediotrusive -MT- contact) on the function and health of the masticatory system have been debated. Marklund S. et al (2000) conducted a review to evaluate the role of occlusal contacts on the mediotrusive sides on the functioning of the mandible. The results showed that MT contacts had no protection for the mandibular function. They suggested that more longitudinal studies are needed [19]. Walton T. et al (2021) continued to establish a review on the topic of mediotrusive occlusal contacts. They terminated that there is still no document that provides a complete and accurate way to clinically evaluate mediotrusive contacts. However, the review concluded that MT contacts might influence the symptoms of TMD [9]. A study by Fuentes A. et al (2015) showed no difference between jaw and neck electromyography (anterior temporalis and sternocleidomastoid) in groups with or without mediotrusive contact. Therefore, they suggested the predominance of central nervous control over peripheral inputs (mediotrusive contacts) on anterior temporalis and sternocleidomastoid motor neuron pools [20]. To more clearly evaluate the relationship between TMD symptoms and occlusal contact patterns, it is necessary to conduct an assessment on a larger population. Collecting enough occlusal contact patterns makes it possible to compare the prevalence of TMD symptoms among various patterns.

5. CONCLUSION

The ICPM is a common occlusal contact pattern in adults with sleep bruxism. Most patients had MG contact on the non-working side. The proportion of TMD symptoms in adult sleep bruxers in the study was relatively high. This suggests that screening for TMD symptoms should be taken into account when evaluating sleep bruxism. However, the small sample size and the majority of ICPM and MG patterns in the study make it unable to conclude the relationship between TMD disorders and occlusal contact patterns. It is necessary to evaluate sleep bruxism and occlusal contact patterns in younger subjects. Longitudinal follow-up is critical to clarify the association. Moreover, considering central factors when examining this association is also suggested.

REFERENCES

1. Lobbezoo F, Ahlberg J, Raphael K, Wetselaar P, Glaros A, Kato T et al. International consensus on the assessment of bruxism: Report of a work in progress. Journal of Oral Rehabilitation 2018, 45(11): 837-844.

2. Koyano K, Tsukiyama Y, Ichiki R, Kuwata T. Assessment of bruxism in the clinic. Journal of Oral Rehabilitation 2008; 35(7): 495-508.

3. Onodera K, Kawagoe T, Sasaguri K, Protacio-Quismundo C, Sato S. The use of a bruxchecker in the evaluation of different grinding patterns during sleep bruxism. The Journal of Craniomandibular Practice 2006; 24(4): 292-299.

4. Yamaguchi T, Mikami S, Maeda M, Saito T, Nakajima T, Yachida W et al. Portable and wearable electromyographic devices for the assessment of sleep bruxism and awake bruxism: A literature review. Cranio. 2023; 41(1): 69-77

5. Manfredini D, Ahlberg J, Aarab G, Bender S, Bracci A, Cistulli P et al. Standardised Tool for the Assessment of Bruxism. Journal of Oral Rehabilitation 2024; 51(1): 29-58.

6. Castroflorio T, Bargellini A, Rossini G, Cugliari G, Deregibus A. Sleep bruxism in adolescents: a systematic literature review of related risk factors. Eur J Orthod 2017; 39(1): 61-68.

7. Park B., Tokiwa O, Takezawa Y, Takahashi Y, Sasaguri K, Sato S. Relationship of tooth grinding pattern during sleep bruxism and temporomandibular joint status. The Journal of Craniomandibular & Sleep Practice 2008; 26(1): 8-15.

8. Sugimoto K, Yoshimi H, Sasaguri K, Sato S. Occlusion factors influencing the magnitude of sleep bruxism activity. Cranio. 2011; 29(2): 127-37

9. Walton T, Layton D. Mediotrusive Occlusal Contacts: Best Evidence Consensus Statement. J Prosthodont. 2021; 30(S1): 43-51.

10. Thayer L, Ali M. The dental demolition derby: bruxism and its impact - part 1: background Br Dent J 2022; 232: 515–521

11. The Glossary of Prosthodontic Terms: Ninth Edition. J Prosthet Dent 2017; 117(5S): e61-e62

12. Nguyen VTQ, Nguyen TKA., Nguyen PDT, Đoan HP., Tran TNN. 2014, The efficiency of Bruxchecker in the diagnosis of sleep bruxism, Ho Chi Minh City Journal of Medicine 2014, 18(1): 325-331.

13. Maeda M, Yamaguchi T, Mikami S, Yachida W, Saito T, Sakuma T, Nakamura H et al. Validity of single-channel masseteric electromyography by using an ultraminiature wearable electromyographic device for diagnosis of sleep bruxism. Journal of prosthodontic research 2019; 64(1): 90-97.

14. Tago C, Aoki S, Sato S. Status of occlusal contact during sleep bruxism in patients who visited dental clinics–A study using a Bruxchecker®. The Journal of Craniomandibular & Sleep Practice 2017; 36(3): 167-173.

15. Schiffman E, Ohrbach R, Truelove E, Look J, Anderson G, Goulet J et al. Diagnostic criteria for temporomandibular disorders (DC/TMD) for clinical and research applications: recommendations of the International RDC/TMD Consortium Network and Orofacial Pain Special Interest Group. Journal of Oral & Facial Pain and Headache 2014; 28(1): 6-27.

16. Saczuk K, Lapinska B, Wilmont P, Pawlak L, Lukomska-Szymanska M. The Bruxoff device as a screening method for sleep bruxism in dental practice, Journal of clinical medicine 2019; 8(7): 930-945.

17. Hokama H, Masaki C, Mukaibo T, Tsuka S, Kondo Y, Hosokawa R. The effectiveness of an occlusal disclosure sheet to diagnose sleep bruxism: A pilot study. Cranio. 2019; 37(1): 5-11.

18. Tokiwa O, Park B, Takezawa Y, Takahashi Y, Sasaguri K, Sato S. Relationship of tooth grinding pattern during sleep bruxism and dental status. The Journal of Craniomandibular & Sleep Practice 2008; 26(4): 287-293.

19. Marklund S, Wänman A. A century of controversy regarding the benefit or detriment of occlusal contacts on the mediotrusive side. J Oral Rehabil. 2000; 27(7): 553-62.

20. Fuentes A, Miralles R, Santander H, Gutiérrez M, Bull R, Martin C. Effect of natural mediotrusive contact on electromyographic activity of jaw and cervical muscles during chewing. Acta Odontol Scand. 2015; 73(8): 626-632.