



Stress assessment in patients with clinically diagnosed sleep bruxism

Procena stresa kod bolesnika sa klinički dijagnostikovanim bruksizmom

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Abstract

Background/Aim. Many studies investigated association between stress, anxiety or personality traits and sleep bruxism (SB), but results are still contradictory. We aimed to investigate whether there is a relation between clinically diagnosed sleep bruxism and salivary cortisol levels as one of the major stress biomarkers and to examine psychological factors and personality traits specific to sleep bruxism. **Methods.** A total of 23 sleep bruxism patients and 42 healthy non-sleep bruxism adults participated in this study. Diagnose of sleep-bruxism was assessed by self-report and clinical examination and also confirmed by bed-partner. Morning saliva was collected from all participants for analyses of the cortisol level. Sleep bruxism patients underwent a psychodiagnostic personality interpretation using the Minnesota Multiphasic Personality Inventory – MMPI-202 test. **Results.** Statistically significant difference between levels of morning salivary cortisol in the group of SB patients and the control group was recorded ($t = 2.943$, $p < 0.01$). Analysis of the personality profiles indicated that the sleep bruxism patients avoid contact with unpleasant feelings, especially depression, suppress the aggression and censor the expression of anger and rage. **Conclusion.** This study showed that patients with sleep bruxism have higher levels of salivary cortisol. Personality traits such as depression, hypomania and suppressed aggression were found to be common characteristics in patients with sleep bruxism. Present findings might support the hypothesis that sleep bruxism and psychological states such as stress may be related, but the cross-sectional nature of this study does not allow us to draw conclusions about the causal relationship between stress, personality traits and sleep bruxism.

Key words:
sleep bruxism; stress, psychological; anxiety;
personality; saliva; hydrocortisone.

Apstrakt

Uvod/Cilj. Mnoge studije ispitivale su povezanost između stresa, anksioznosti, crta ličnosti i bruksizma, ali su rezultati i dalje kontradiktorni. Cilj ove studije bio je da se ispita da li postoji povezanost između klinički dijagnostikovanog bruksizma koji se javlja tokom spavanja i koncentracije kortizola u salivi koja se smatra jednim od glavnih biomarkera stresa, kao i da se ispituju psihološki faktori i crte ličnosti osoba sa bruksizmom. **Metode.** Studija je obuhvatila 23 bolesnika sa bruksizmom i 42 zdrava ispitanika bez znakova bruksizma. Dijagnoza bruksizma uspostavljena je na osnovu spostvene izjave i kliničkog pregleda kao i potvrde partnera. Uzorci jutarnje pljuvačke prikupljeni su radi analize kortizola. Bolesnici sa bruksizmom podvrgnuti su psihodijagnostičkom ispitivanju pomoću Minesota multifaznog testa ličnosti – MMPI-202. **Rezultati.** U grupi bolesnika sa bruksizmom registrovana je značajno veća koncentracija kortizola u pljuvački u poređenju sa pacijentima bez znakova bruksizma ($t = 2.943$, $p < 0.01$). Psihodijagnostička interpretacija profila ličnosti pokazala je da ispitanike sa bruksizmom karakteriše izbegavanje kontakta sa neprijatnim osećanjima, posebno depresijom i potiskivanje agresivnosti, odnosno izražena autocenzura na otvoreno ispoljavanje ljutnje i besa. **Zaključak.** Kod bolesnika sa bruksizmom registrovane su povećane koncentracije kortizola u salivi. Psihodijagnostička analiza ukazuje da su depresija, hipomanija i supresija agresije izražene kod bolesnika sa bruksizmom. Nalazi bi mogli da podrže hipotezu povezanosti bruksizma u toku spavanja i stresa, ali priroda ove studije ne dozvoljava izvođenje zaključaka o uzročnoj povezanosti stresa, crta ličnosti i bruksizma u toku spavanja.

Ključne reči:
bruksizam; stres, psihički; anksioznost; ličnost;
pljuvačka; hidrokortizon.

Introduction

Sleep bruxism (SB) is defined as an oral activity characterised by grinding or clenching of the teeth during sleep, usually associated with sleep arousal. According to the International Classification of Sleep Disorders SB is listed as the sleep-related movement disorder¹. Similar oral activity can occur during wakefulness, but it is a different phenomenon and it is important to differ those two entities, both in clinical practice and in research. In order to avoid the possibility of misunderstanding concerning the diagnosis of bruxism, an international group of bruxism experts proposed that bruxism had two distinct circadian manifestations: it can occur during sleep (SB) or during wakefulness (awake bruxism). According to diagnosis, bruxism was graded as possible – based on self-report, probable – clinically diagnosed and definite – confirmed by polysomnographic recording². The prevalence of the SB in general population is about 12.8 %³.

Psychological factors such as stress, anxiety and personality traits were often discussed in the genesis of bruxism, both sleep and awake, and results are still contradictory. Many studies showed that patients with SB have a higher stress sensibility – they are mainly people who are easily provoked, unhappy, anxious and often ill-disposed towards the surroundings⁴⁻⁷. On the other hand, recent studies failed to confirm association between stress and the SB^{8,9}.

The aim of this study was to investigate whether there is a relation between the SB and salivary cortisol (hydrocortisone) levels as one of the major stress biomarkers and to evaluate the influence of psychological factors specific to the SB.

Methods

Subjects

Among 200 patients examined at the Clinic of Prosthodontics, Faculty of Dental Medicine, University of Belgrade, Serbia, a total of 23 SB patients with occlusal signs of bruxism were selected to participate in the study. The group included 4 males and 19 females, aged between 20 and 34 (mean age 26.56) years. Control group consisted of 42 healthy adults, 13 males and 29 females, aged between 20 and 35 (mean age 26.3) years, with no signs of SB. Inclusion criteria were the presence of all permanent teeth, except third molars, and at the most two fillings in dental arch. Exclusion criteria were: pregnancy, neurological disorders, use of medications to suppress anxiety, and use of medications that could affect salivary cortisol level, sleep or motor activity. All subjects gave a written informed consent to participate in the study. The present study was approved by The Ethics Committee, Faculty of Dental Medicine, University of Belgrade.

Diagnostic criteria for sleep bruxism

All the selected patients were diagnosed with 'probable' SB², assessed by self-report and clinical examination, and also confirmed by a bed-partner with the aim to avoid former SB. Clinical examination included observation of toothwear

– second, third or fourth degree evaluated by the abrasive scale by Hansson et al.¹⁰. In addition, Krough-Poulsen provocation test was performed¹¹. Patients were instructed to move the mandible till the present bruxofacets were matched (interlocked) in position as "the key in the lock" and then to clench or grind their teeth in that position. If the pain in the masticatory muscles was provoked, the test was positive.

Psycho-diagnostics

The subjects of the SB group underwent a psychodiagnostic personality interpretation using the Minnesota Multiphasic Personality Inventory – MMPI-202 test. The MMPI is a standardized questionnaire developed by Hathaway and McKinley¹² in 1940 at the University of Minnesota. It was published in 1943 and since then it underwent a long path of development, verification, transformation and expansion.

We used the MMPI-202 test which is abbreviated version, modified and standardized for Serbian population¹³. Psycho-diagnostics was carried out at the Institute of Psychiatry, Clinical Center of Serbia, Faculty of Medicine, University of Belgrade, Serbia.

The MMPI-202 test contains 210 items and 15 scales. There are separate test forms and scoring for males and females. Three validity scales, **L**, **F**, and **K** (**L** – lie, **F** – infrequency, and **K**-correction) scales are used to check eligibility and willingness of subjects for this type of testing. Eight "pathological" scales of the MMPI-202 inventory reflects following psychopathological classes: **Hs** – hypochondriasis, **D** – depression, **Hy** – hysteria, **Pd** – psychopathic deviate, **Pa** – paranoia, **Pt** – psychasthenia, **Sc** – schizophrenia, and **Ma** – hypomania. Four additional scales are **Si** – scale of social introversion-extraversion, **An** – anxiety scale, **Ag** – aggression scale, **C** – list of critical statements. **An** – anxiety scale refers to the manifest anxiety while **Pt** – psychasthenia scale represents a latent anxiety. **Ag** – scale of aggression in the MMPI-202 is a latent aggression, and **Pd** is the manifested aggression. Scale **C** contains bizarre and clearly psychotic items, so is aimed to assess psychotic behaviour. It was shown in practice that a "typical" psychotic sections (**Pa-Sc**) is not necessarily a consequence of psychotic disorders, but also can be a consequence of excessive emphasized personality traits. The MMPI test was administered and evaluated by a clinical psychologist. All SB patients were tested and individual scores were assumed and showed in graphics for all control and clinical scales as a profiles for both gender, followed by comments.

Saliva sampling

Samples of the whole unstimulated morning saliva were collected in a sterile glass tubes with a lid using a passive drool technique. Samples were collected before breakfast or 60 minutes after the breakfast, latest at 9 am. Since acidic or high sugar foods can compromise assay performance by lowering sample pH and influencing bacterial growth, patients were instructed to rinse their mouth with water 10 minutes before sample collection. Also, patients were in-

structured not to brush their teeth, smoke or drink coffee or alcohol 12 hours before sample collection, in order to avoid the influence of these factors on the cortisol levels. Specimens were centrifuged and frozen until the analysis.

Salivary cortisol analysis

The level of salivary cortisol was measured by chemiluminescence, using device "IMMULITE DPC", Los Angeles, US, third-generation. For *in vitro* test, barcode-labelled the Cortisol test units (LCO1) that contain polystyrene beads impregnated with anti-cortisol antibodies (polyclonal antibodies obtained from rabbits) were used. The Cortisol reagent wedge (LCO2) contained alkaline phosphatase conjugated to cortisol in buffer.

Statistical analysis

Statistical analysis was performed using the SPSS®21 software. The Leven's test was used to assess the equality of variances of subpopulations. Modified *t*-test was used to compare means between salivary cortisol levels both in the SB and control group.

Results

Mean salivary cortisol levels of the SB group and the control group are shown in Table 1. Since the equal variances were not assumed ($F = 23.601$; $p < 0.001$), we used modified *t*-test to compare the mean values of salivary cortisol levels between the groups. Results show that there was a statistically significant difference between salivary cortisol levels in the SB and the control group ($t = 2.943$; $p < 0.01$).

Table 1
Salivary cortisol levels in sleep bruxism (SB) patients and non-SB subjects (control group)

Group	Salivary cortisol levels (nmol/L)				
	n	mean ± SD	Leven's F test and probability (<i>p</i>)	<i>t</i> -test and probability (<i>p</i>)	95% confidence interval
SB group	23	45.75 ± 17.54	F = 23.601	<i>t</i> = 2.943	38.4–53.1
non-SB group	42	34.42 ± 7.80	<i>p</i> < 0.001*	<i>p</i> < 0.01	32.0–36.8

**t* - test, $\alpha < 0.05$; n – number of patients; SD – standard deviation; SE – standard error.

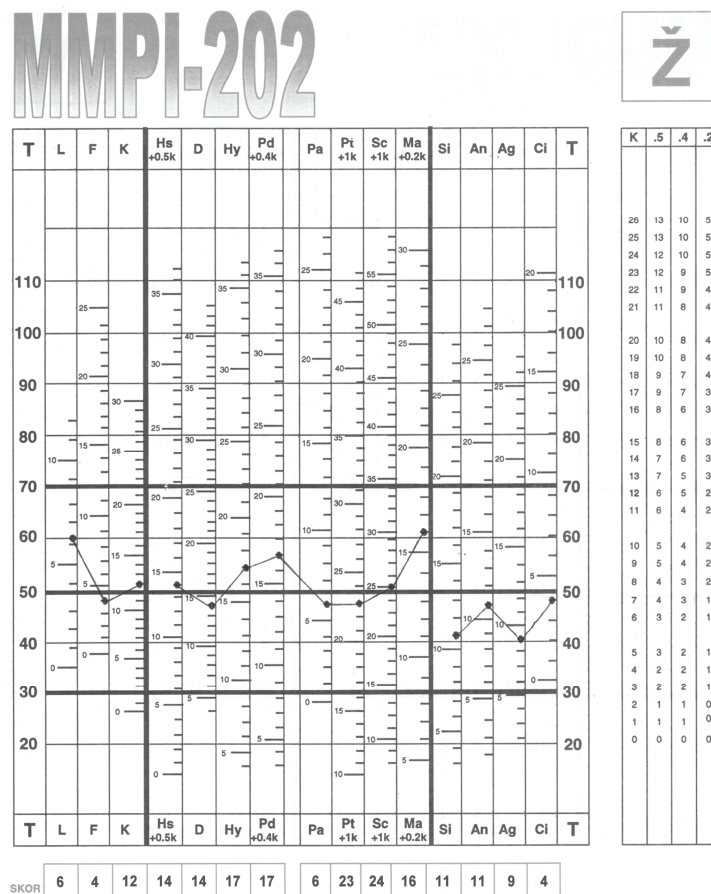


Fig. 1 – Female (Ž) respondents and personality psychological profiles. MMPI – the Minnesota Multiphasic Personality Inventory.

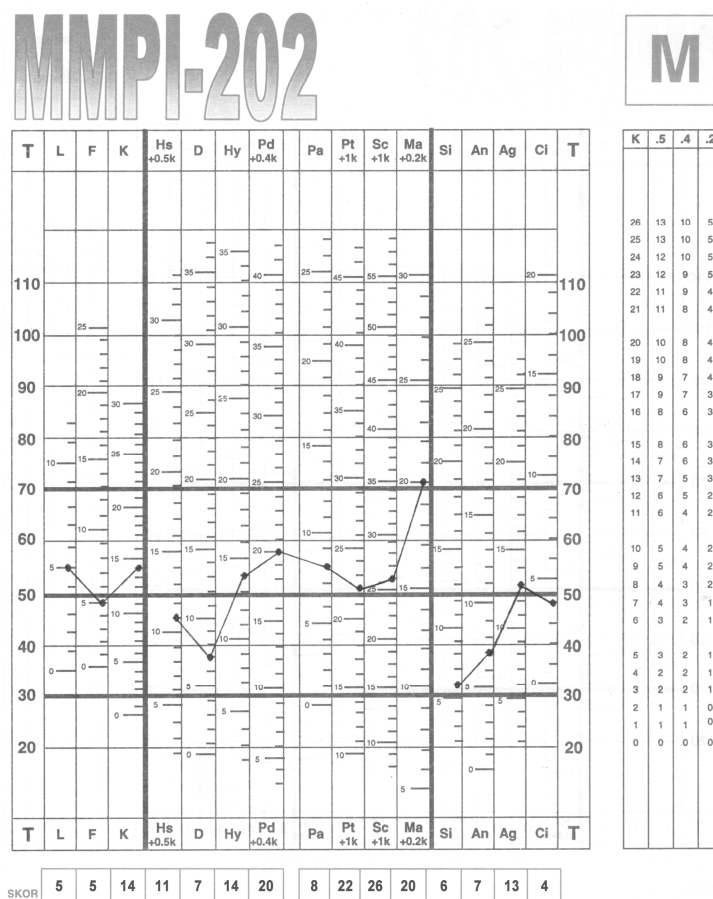


Fig. 2 – Male (M) psychodiagnostic profile according to MMPI-202. MMPI – the Minesota Multiphasic Personality Inventory.

To examine the possibility of influence of psychological factors in the genesis of the SB, we evaluated psychological personality profiles of patients in the study group. The Psycho-diagnostic MMPI – 202 profile for female patients showed dissimulative trend. The overall profile scores were uniform but much decreased, reflecting a tendency of the patients to conceal a problem, presenting themselves in a different manner. The female respondents in our study were hiper-scrupulous, highly socialized and conventional. Characteristics of this type are pedantry, perfectionism and diligence. They perform every task very meticulously and with great energy and perseverance, but they are often dissatisfied with the outcome and prone to self-criticism, so the slightest failure may produce a depressive reaction. Their dissatisfaction and a constant tension in the race for success led them to a prolonged state of stress, which probably resulted in chronic discontent. Nevertheless, they avoided contact with depressive feelings (low D-14, T < 50) and suppress aggression (low Ag-9; T score 40), (Figure1).

The psycho-diagnostic MMPI – 202 profile for males was in favour of hyperactive, sociable personalities, dominate in the society. They evoke sympathy in the environment with their cheerfulness and penchant for humour. They tend to overrate their abilities and undertake numerous projects and simultaneous activities. Hyper-vigilance attention and highlighted inner restlessness (high Ma-20, T score above

70) was stressed within the male respondents (Figure 2). They tended to present themselves as healthy, energetic, confident and enterprising people. In fact, this type of reaction was the defense of the depressive feelings that might occur in stressful situations, i.e. hypomania as a defence against depression. This mechanism is called reaction formation.

Discussion

The aethiology of SB still remains unclear. Theories about the influence of peripheral factors such as occlusal interferences are mainly abandoned today ^{4, 14}. It is widely accepted that central factors could play an important role in the genesis of the SB. Many authors suggested that stress, physical and especially mental, was a generator of SB, while others point out that a certain personality characteristics (extreme responsibility, pedantry, perfectionism) were crucial factors for the occurrence of the SB ⁴⁻⁷. However, association between psychological stress and the SB in literature is contradictory.

This study combined psychological assessment and quantitative stress assessment, using a biochemical stress parameter. Emotional stress is very difficult to objectify. Therefore, in psychiatry, emotional status is measured by issues of fear, anxiety, affect, arousal, behaviour influenced by emotions, jealousy, depression, ability to experience pleasure etc. In addition to psycho-diagnostic parameters, there are objec-

tive biochemical parameters indicating the higher levels of physical and psychological stress. It is well known that high levels of psychological stress cause increased secretion of "stress" hormones in the blood, saliva or urine¹⁵. Psychological stress initiates activation of the hypothalamus-pituitary-adrenal axis (HPAA), one of the systems involved in stress response. This results in the increased secretion of cortisol, epinephrine and norepinephrine in blood, urine and saliva. Therefore, in some studies on the SB objective parameters were used to assess stress¹⁶⁻¹⁹. In this study, levels of salivary cortisol were used to assess HPAA. The synthesis of cortisol has a very distinctive circadian rhythm. In fact, almost all of the daily amount of cortisol is synthesized in the early morning hours, just before waking. It has been shown that perceived chronic stress was related to an elevation of salivary cortisol after awakening^{20, 21}. Therefore, we collected the morning saliva samples for analysis of salivary cortisol. Ninety percent of blood cortisol is bound to cortisol binding globulin (CBG) and only 10% is free cortisol which represents biologically active fraction of this hormone. There is a high correlation between free blood cortisol and salivary cortisol levels¹⁵. Owing to salivary cortisol stability, saliva samples can be stored at 5°C for up to 3 months and at -20°C to -80°C up to 12 months. Saliva sampling is non-invasive, stress-free and relatively easy procedure. All these advantages contribute to extensive use of salivary cortisol as a stress biomarker in researches¹⁵. We found statistically significant difference between levels of morning salivary cortisol in the SB group ($45.75 \text{ n} \pm 17.5 \text{ nmol/L}$) compared to the control group ($34.42 \text{ nmol/L} \pm 7.8 \text{ nmol/L}$) which indicates higher level of stress in individuals with the SB. In accordance to our results, several studies found higher levels of stress biomarkers in the SB patients. An electromyographic (EMG) study of Clark et al.¹⁶ found a correlation between the increased levels of urinary epinephrine as stress biomarker and masseter muscle activity during sleep. Vanderas et al.¹⁷ analysed urinary catecholamine levels in 314 children with clinically diagnosed bruxism. Results indicated a high association between urinary epinephrine and dopamine levels and bruxism, but it was not specified whether it was sleep or awake bruxism. Seraidarian et al.¹⁸ also found the higher levels of urinary epinephrine, norepinephrine and dopamine in individuals with the SB. On the contrary, recent study on children with the SB failed to find a positive correlation between salivary cortisol and the SB¹⁹. These discrepancies in salivary cortisol levels, may be due to different stress response and reactivity of HPAA in children and adults²².

Some authors suggested that the SB was a stress coping strategy²³. The few recent studies investigated influence of chewing and clenching on salivary stress biomarkers. Tahara et al.²⁴ found a decrease of salivary cortisol levels during chewing and clenching, indicating that those actions promote relaxation in subjects under stress. Soeda et al.²⁵ found that the strong chewing force induced a greater reduction of salivary cortisol levels and released mental stress more than a weak one. Study by Takahashi et al.²⁶ indicates that stabilisation splint therapy reduces number of the SB episodes, but increases levels of salivary stress biomarker chromogranin

A. This study is cross-sectional and does not evaluate changes in the salivary cortisol levels in the SB patients, but in further studies it would be interesting to examine whether reduction of repetitive jaw-muscle activity achieved through the long-term SB therapy influences salivary cortisol levels.

It should be also mentioned that different diagnostic criteria used in studies makes it difficult to compare results. In this study, sleep bruxism was graded as 'probable', since it was clinically diagnosed. This should be considered as a limitation of the study. Polysomnographic recording is a golden standard in the SB diagnostics². However, it is often unaffordable and, therefore, not so often used in studies. With the aim to minimise diagnostic errors in this study, the presence of the SB episodes during sleep was confirmed by a bed-partner.

Early EMG studies reported association between stress and SB. The results of Rugh and Solberg²⁷ study showed that the intensity of the SB varied and these variations depended on the intensity of behavioural cognitive factors such as emotional daily stress and the intensity of stressful life events (illness, employment, problems at work, loss of job, family arguments, exam, physical exhaustion, etc.). On the contrary, an EMG study on 100 SB patients done by Pierce et al.⁸ showed no correlation between self-reported stress and the SB. Similarly, another study showed that the SB was not strongly related to a daily stress⁹. However, a few recent studies on self-reported bruxism found that anxiety and stress sensitivity may be related with the SB^{6-7, 28}. Results of the EMG study of Manfredini et al.⁷ indicate that anxiety trait but not anxiety state, is actually important factor in the pathogenesis of the SB.

Regarding the results of the above mentioned studies, it could be suggested that personality characteristics and stress-coping strategies are more important factors in the genesis of the SB than the stress itself. Hence, psycho-diagnostic analysis of personality profiles of the SB patients in this study was performed to reveal the possible role of specific personality traits that might have significant impact on the maintenance of symptomatology of the SB. A common characteristic of personality profile of both males and females with the SB was the avoidance of contact with unpleasant feelings, especially depression, as well as suppression of aggression and censorship of the expression of anger and rage. Inability to discharge aggressive impulses in a socially acceptable manner and the inability of sublimation of aggression probably lead to long-term feelings of discomfort and therefore might influence the development of the SB. The results of this study are also consistent with the results of the study of Molina and dos Santos²⁹ suggesting that anger and hostility are related to the severity of bruxism. One of the possible explanations is the thesis that "A person is the sum total of his/her life experiences, each of which is registered in his/her personality and structured in his body"³⁰. Life of each person consequently affects its physical body. Self-image determines which feelings and impulses will be expressed. The estimated censorship does not allow the expression of depressive mood, even on a verbal level. Due to these difficulties to express unpleasant emotions, psychic energy accumulates in the oral region on the muscular level³¹. This could lead to discharge through the auto-aggressive actions such as bruxism. In

further studies, it would be interesting to compare personality profiles of the SB patients and non-SB subjects.

Conclusion

The results of this study indicate the higher level of salivary cortisol in patients with sleep bruxism. Personality traits distinguished in the psychological assessment, such as depression, hypomania and suppression of aggression might be the important factors that influence the developing of prolonged state of stress which might lead to generating a symptoms of

sleep bruxism. However, the cross-sectional nature of this study does not allow us to draw conclusions about the causal relationship between stress, personality traits and sleep bruxism.

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