



The role of cortisol in etiology and treatment of bruxism – a literature review

Rola kortyzolu w etiologii i leczeniu bruksizmu – przegląd piśmiennictwa

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ABSTRACT

The aim of the study was to analyze the role of cortisol in both the treatment and etiology of bruxism. A literature review was conducted using the PubMed and Embase databases, focusing on publications from November 2013 to November 2023, with no language restrictions. The titles and abstracts were initially screened, followed by a full-text selection process. Observational studies and randomized controlled trials that assessed the relationship between diagnosed bruxism and salivary cortisol levels were included in the analysis. Methodological quality assessment and data extraction were performed on the included studies. Ultimately, eight articles were included in the review. The analysis revealed a significant correlation between higher cortisol concentrations and the occurrence of bruxism. Moreover, individuals with bruxism exhibited higher cortisol concentrations before the initiation of treatment compared to the post-treatment levels.

KEYWORDS

bruxism, cortisol, hydrocortisone, sleep bruxism

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**STRESZCZENIE**

Celem badania była analiza roli kortyzolu zarówno w leczeniu, jak i etiologii bruksizmu. Przeprowadzono przegląd piśmiennictwa dostępnego w bazach danych PubMed oraz Embase, opublikowanego w okresie od listopada 2013 r. do listopada 2023 r. bez ograniczeń językowych. W pierwszej kolejności przeprowadzono ocenę tytułów oraz abstraktów, a następnie dokonano selekcji na podstawie całych artykułów. Do analizy włączono badania obserwacyjne oraz randomizowane kontrolowane badania kliniczne, które oceniały związek między zdiagnozowanym bruksizmem a poziomem kortyzolu w ślinie. Przeprowadzono ocenę jakości metodologicznej badań i ekstrakcję danych. Finalnie do przeglądu włączono osiem artykułów. Analiza wykazała znaczącą korelację między wyższymi stężeniami kortyzolu a występowaniem bruksizmu. Ponadto u osób z bruksizmem stężenie kortyzolu przed rozpoczęciem leczenia było wyższe niż po jego zakończeniu.

SŁOWA KLUCZOWE

bruksizm, kortyzol, hydrokortyzon, bruksizm senny

INTRODUCTION

Cortisol and corticosterone are glucocorticosteroids produced by the zona fasciculata of the adrenal cortex and belong to the group of steroid hormones. Among them, cortisol is the primary hormone, whose secretion follows circadian rhythms, reaching its peak concentration in the morning and its lowest concentration in the evening [1].

The primary function of cortisol is to regulate blood glucose levels, particularly during stressful situations, by increasing its concentration in the bloodstream. Additionally, cortisol exhibits anti-inflammatory properties and influences various metabolic processes [2]. Cortisol acts on various tissues and organs, including the liver, muscles, and adipose tissue. In the liver, it increases glucose production through gluconeogenesis. In the muscles, it reduces glucose uptake and enhances protein degradation. In adipose tissue, it stimulates lipolysis [3,4].

Chronic stress and elevated cortisol levels can damage the hippocampus, which plays a crucial role in the regulation of emotions. This, in turn, may lead to chronic hypercortisolism, triggering a range of negative effects [5]. This affects glucose metabolism, leading to insulin resistance and obesity, as well as weakens the immune system, increasing susceptibility to infections and leading to immunosuppression. In the cardiovascular system, it may cause hypertension, while in the reproductive system, it can impact hormonal imbalances, the menstrual cycle in women, and sperm production in men. Additionally, it may lower neurotransmitter levels, resulting in sleep disturbances, anxiety, depression, and impaired cognitive function [1].

Stress and elevated cortisol levels are closely linked. Prolonged stress can lead to excessive tension in the masticatory muscles, which is considered a major etiological factor in bruxism [6].

Bruxism is characterized by repetitive activity of the masticatory muscles, manifested as unconscious clenching or grinding of the teeth, occurring both during sleep (sleep bruxism) and while awake (awake

bruxism) [7]. It presents with stiffness and pain in the head and neck muscles, restricted mouth opening, and tooth wear. Chronic bruxism can lead to tooth fractures, hypertrophy of the masticatory muscles, and serious complications within the temporomandibular joint (TMJ) [8].

Manfredini et al. [9] estimate the prevalence of bruxism in adults to range between 8% and 31.4%, regardless of gender, with a decreasing tendency with age. The prevalence of daytime bruxism is estimated to range between 22.1% and 31% of the population, while approximately $12.8\% \pm 3.1\%$ of the population suffers from sleep bruxism. This issue is increasingly being observed among children and adolescents.

The etiology of bruxism is complex, involving central, peripheral, and psychosocial factors [10].

Macaluso et al. [11] demonstrated an increased number of transient arousals during sleep in individuals with bruxism, associated with arousal responses and restless legs syndrome. No significant association was found between bruxism and occlusal factors, but a connection was observed with psychosocial factors such as stress, anxiety disorders, and environmental pressure [12,13,14,15] (Table I).

Table I. Potential etiological factors of bruxism

Central	Peripheral	Psychosocial
<ul style="list-style-type: none"> Central arousal response 	<ul style="list-style-type: none"> Iatrogenic disorders of articulation and centric relation 	<ul style="list-style-type: none"> Stress
<ul style="list-style-type: none"> Sleep disorders 		<ul style="list-style-type: none"> Anxiety
<ul style="list-style-type: none"> Drug/substance use 		<ul style="list-style-type: none"> Frustration
<ul style="list-style-type: none"> Alcohol/caffeine consumption 		<ul style="list-style-type: none"> Lack of social support
<ul style="list-style-type: none"> Smoking 		<ul style="list-style-type: none"> Social pressure
<ul style="list-style-type: none"> Genetic/inherited factors 		

The aim of this study was to analyze the available literature concerning the role of cortisol in both the treatment and etiology of bruxism over the past decade.



MATERIAL AND METHODS

The literature review was conducted by searching online databases such as PubMed and Embase. Articles were sought on the etiology, diagnosis, and treatment of bruxism, with a focus on cortisol levels. The PubMed database was searched using the following phrases: “cortisol bruxism” [All fields]; ((hydrocortisone) OR (cortisone)) AND ((bruxism) OR (sleep bruxism)) [All fields]. The Embase database was searched using the phrases “bruxism” [All fields] and “hydrocortisone” [All fields]. Additionally, the references of the retrieved articles were manually searched. All available articles published between November 2013 and November 2023 were considered, with no language restrictions. The initial selection of articles was based on analysis of the titles and abstracts, and those that did not meet the inclusion criteria were excluded at this stage. The remaining articles were thoroughly analyzed in full by two independent reviewers. During this stage, the study characteristics, the number of subjects, methodology, and results were assessed.

Inclusion and exclusion criteria for the literature review

The literature review included observational studies and randomized controlled clinical trials that assessed

the relationship between diagnosed bruxism and salivary cortisol levels. Excluded from the review were case reports, animal studies, in vitro studies, technical notes, dissertations, review articles, textbooks, studies that did not report cortisol levels, and studies involving children. The quality of the included studies was assessed based on the adequacy of the study design relative to the research objective, the risk of bias, the reliability of the results, statistical analysis, and the quality of reporting.

RESULTS

As a result of searching the databases using the specific search terms in addition to the inclusion and exclusion criteria, a total of 108 articles were identified, with 46 sourced from PubMed and 61 from Embase and 1 was found manually after searching. After analyzing the titles and abstracts, 29 articles were selected. The next step involved a thorough analysis of the full texts of the selected articles. Following the application of the selection criteria, a total of 8 studies were included in the literature review. Most of the studies demonstrated a significant correlation between the occurrence of bruxism and poorer psychosocial conditions [16,17,18, 19,20,21,22,23] (Figure 1).

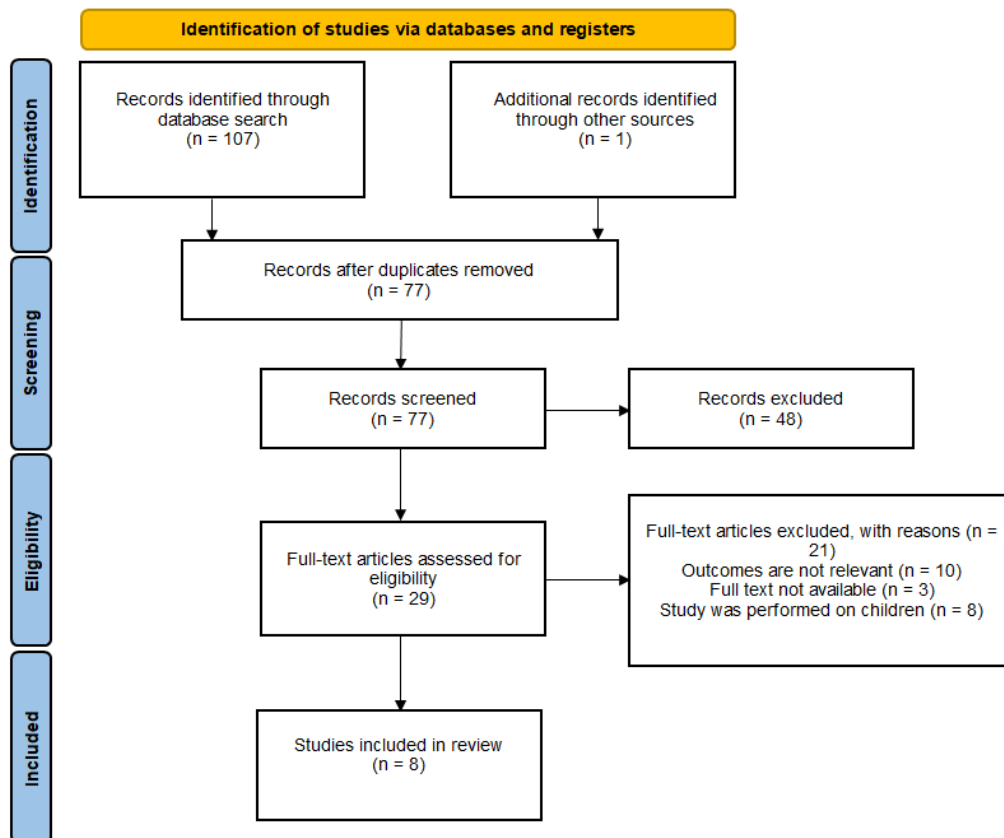


Fig. 1. Study selection flowchart.



The study by Fluerașu et al. [16] showed that individuals suffering from bruxism are more likely to experience stress, frustration, anxiety, and depressive states. A correlation was also found between the occurrence of pain and clicking sounds in the TMJ and higher cortisol levels. The cortisol concentrations were also noticeably higher in patients suffering from anxiety and in women. The authors suggest that cortisol measured in saliva could become a useful, non-invasive biomarker for assessing the presence and severity of bruxism.

The results of the study by Karakoulaki et al. [17] present a significant correlation between elevated salivary cortisol levels and severe stress. The study utilized BiteStrip, a device that allows the self-diagnosis of sleep bruxism. Positive results following the use of BiteStrip were also correlated with elevated salivary cortisol levels. In the study by Rosar et al. [18], which compared sleep before and after treatment in patients suffering from bruxism, it was proven that sleep quality, latency, and duration improved, while the frequency of sleep disturbances and the need for sleeping medications decreased.

In the study by Miletić et al. [19], the personality traits of patients suffering from bruxism were assessed. It was shown that depressive states, hypomania, and the suppression of aggression, which cause prolonged stress, can lead to the manifestation of symptoms of sleep bruxism. Khayamzadeh et al. [20] observed more frequent occurrences of depressive, anxiety, and stress states in patients suffering from sleep bruxism. Salameh et al. [21] demonstrated that the group of patients with bruxism had significantly higher stress levels than the healthy control group and were much more likely to experience anxiety and depressive states.

Cortisol levels in patients diagnosed with bruxism compared to healthy individuals

Six studies that analyzed the cortisol levels in patients with confirmed bruxism and in a control group comprising 397 adult participants were classified according to the established criteria included in the review (Table II).

The analyzed studies focused on evaluating salivary cortisol levels in patients diagnosed with bruxism compared to a group without this diagnosis. The examination of the mean values and standard deviations of the cortisol levels revealed a significant

difference in favor of the control group, suggesting that individuals diagnosed with bruxism exhibited higher levels of salivary cortisol. Most of the articles utilized the same method for verifying salivary cortisol levels for both patients and the control group – the ELISA technique. However, the study conducted by Miletić et al. [19] used chemiluminescence techniques. The discrepancies in the results may stem from differences in the procedures and sample collection times. It is noteworthy that all the studies, except for the study by Khayamzadeh et al. [20], which did not provide information on the age of the studied population, used groups in a similar age range.

Cortisol levels before and after treatment in patients diagnosed with bruxism

For the literature review concerning treatment, two studies were included that compared cortisol levels before and after treatment. In this context, “treatment” encompasses therapeutic methods focused on alleviating stress, anxiety and muscle tension, which are essential in managing bruxism. These studies encompassed a total of 102 adult participants and were selected according to established criteria (Table III).

The study conducted by Rosar et al. [22], aimed to evaluate salivary cortisol levels before and after treatment in patients diagnosed with bruxism, compared them to a group of patients without this condition. This treatment involved the use of an interocclusal appliance designed to reduce masticatory muscle activity, thereby alleviating stress and tension in the temporomandibular region. In contrast, the study by Al-Oudah et al. [23] divided patients diagnosed with bruxism into two groups: one group received treatment with oral Chlordiazepoxide tablets (5 mg), an anxiolytic benzodiazepine aimed at managing anxiety, a significant contributing factor to bruxism. The tablets were administered once daily after the evening meal for 10 days, while the other group received a placebo in the form of orally disintegrating tablets, also administered once daily after the evening meal for the same period. The cortisol levels were then evaluated. Both studies observed significant reductions in cortisol levels following treatment, which suggests the effectiveness of therapeutic interventions in reducing the levels of this hormone [22,23].



Table II. Characteristics of studies comparing cortisol levels between individuals with diagnosed bruxism and healthy patients

Author	Year and country of publication	Type of study	Number of participants	Number of patients with bruxism	Average age of patients with bruxism	Cortisol levels in patients with bruxism	Number of healthy participants	Average age of healthy participants	Cortisol levels in healthy participants	Measurement technique	Sample collection time
Fiueraşu et al. [16]	2019 Romania	analytical, observational, cohort, cross-sectional, and prospective study	60	30	24 (23–24.5) years	5.63 µg/dL (4.49–10.44)	30	23 (20.75–23) years	3.11 µg/dL (1.37–6.58)	elisa	7:00
Karakoulaki et al. [17]	2015 Greece	case-control study	45	25	34.5 ± 6.4 years	0.37 ± 0.08 µg/dL	20	34.5 ± 6.4 years	0.27 ± 0.06 µg/dL	elisa	7:00–9:00
Miletić et al. [19]	2018 Serbia	cross-sectional study	65	23	26.56 years	45.75 ± 17.54 nmol/L	42	26.3 years	34.42 ± 7.80 nmol/L	chemiluminescence	no later than 9:00
Khayamzadeh et al. [20]	2019 Iran	case-control study	64	32	–	4.28 ± 0.14 ng/mL	32	–	3.68 ± 0.19 ng/mL	elisa	9:00–11:00
Salameh et al. [21]	2015 Syria	case-control study	120	60	19–44 years	21.78 ± 13.69	60	19–44 years	7.13 ± 4.28	elisa	I. Upon awakening II. 30 minutes after awakening III. 60 minutes after awakening
Rosar et al. [18]	2021 Brazil	cross-sectional study	43	28	22.57 (2.74) years	I 0.19 (0.21) µg/dL II 0.24 (0.28) µg/dL	15	21.60 (1.2) years	I 0.16 (0.13) µg/dL II 0.16 (0.09) µg/dL	elisa	I. Upon awakening II. 30 minutes after awakening

**Table III.** Characteristics of studies comparing cortisol levels before and after bruxism treatment

Characteristics	Rosar et al. [22]	Al-Oudah et al. [23]
Year and country of publication	2017, Brazil	2021, Iraq
Type of study	case-control study	randomized clinical trial
Number of participants	43	59
Number of participants in study group	28	30
Mean age of participants in study group	22.6 (2.7) years	45.0 ± 6 years
Cortisol levels before treatment in study group	5.9 (5.3)	81.08 (7.95)
Cortisol levels after treatment in study group	I month after treatment 2.6 (4.2) II months after treatment 2.5 (5.3)	78.98 (3.52)
Number of participants in control group	15	29
Mean age of participants in control group	21.6 (1.7) years	45.0 ± 6 years
Cortisol levels before treatment in control group	4.9 (2.0)	81.42 (7.32)
Cortisol levels after treatment in control group	I month after treatment 4.4 (3.3) II months after treatment 4.3 (2.1)	80.96 (6.93)
Measurement technique	elisa	N/A
Sample collection time	upon awakening and 30 minutes after awakening	N/A

DISCUSSION

In this literature review, the role of cortisol, a steroid hormone produced by the adrenal cortex, was analyzed in detail in the context of the etiology and treatment of bruxism. This relationship is crucial as cortisol plays a significant role in the body's stress response, which may directly influence the occurrence of bruxism. The results of available studies indicate a clear association between elevated salivary cortisol levels and the frequency of bruxism, which may be linked to etiological factors such as anxiety disorders, apprehension, frustration, and stress.

Studies comparing the cortisol levels in patients diagnosed with bruxism and those without this diagnosis confirmed higher cortisol values in individuals suffering from this condition. These findings underscore that cortisol levels may be an important factor in the development and progression of this disease. An important aspect is also the analysis of cortisol levels before and after bruxism treatment. Studies have shown significant reductions in cortisol levels following treatment in patients with bruxism. This is a significant observation, suggesting that therapy may impact not only the symptoms of bruxism but also the level of stress hormone in the body, confirming the existing correlation between these factors.

The results of the literature analysis confirm the association between cortisol and bruxism and highlight the need to consider psychosocial factors in the

diagnosis and treatment of this condition. Nonetheless, further research is needed to better understand this correlation, which could contribute to the development of more effective therapeutic strategies. Future studies should focus on more precisely defining the mechanisms through which cortisol influences bruxism, potentially opening new avenues for the prevention and treatment of this condition.

CONCLUSIONS

The analysis of the literature clearly indicates a significant correlation between bruxism and elevated cortisol levels. These findings suggest that cortisol, as the primary stress hormone, may play a crucial role in the development and progression of bruxism. These observations emphasize the importance of considering both psychosocial factors, such as stress and anxiety, as well as hormonal factors, in the diagnosis and treatment of this condition. The fact that bruxism and elevated cortisol levels coexist opens new perspectives for understanding the pathomechanisms of this condition. Knowledge of the causes of this correlation will make it possible to develop targeted therapeutic approaches that focus not only on the symptoms, but also on the causes of the disease. Given these results, further research is needed to gain a more comprehensive understanding of the complex interaction between cortisol and bruxism, which will consider both the psychological and biological aspects.



Author's contribution

Study design – S. Baron

Data collection – W. Galińska, I. Burliga

Manuscript preparation – W. Galińska, I. Burliga, M. Moskała

Literature research – W. Galińska, I. Burliga

Final approval of the version to be published – S. Baron

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