Examination of pulp innervation of teeth with abrasion

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Изследване на пулпната инервация при зъбно изтриване

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Summary

In the presence of parafunctions such as bruxism, the teeth are subjected to a much greater functional load compared to normal occlusion. As a result, "pulp stress" is generated in the dental pulp, which can lead to slow impairment of normal pulp function and necrobiosis or atrophy. The prevention of complications in this parafunction could have a positive effect on the processes in the pulp. Therefore, examination of pulp vitality in patients with bruxism may reveal the presence or absence of degenerative changes associated with parafunctions and also the effect of its prophylaxis. In our study 30 teeth of 11 patients, with exposed dentin of patients with bruxism were examined by EPT before and after 6 months treatment with occlusal spints. The results obtained by the study showed statistically significant difference between the levels of EPT before and after treatment, which respectively are 18 μA and 6μA. Six months after application of occlusal splints for the prevention of complications of bruxism the EPT values return to normal.

Резюме

При наличие на парафункции като бруксизъм, зъбите са подложени на много по-голямо функционално натоварване в сравнение с нормална оклузия. В резултат на това в зъбната пулпа се генерира „пулпен стрес", който може да доведе до бавно увреждане на нормалната пулпна функция и некробиоза или атрофия. Профилактиката на усложненията при тази парафункция би могло да окаже позитивно влияние и върху процесите в пулпата. Затова изследването на пулпния виталитет при пациенти с бруксизъм може да разкрие наличието или отсъствието на дегенеративни изменения, свързани с парафункциите, но също и ефективността от профилактиката им. В нашето проучване чрез ЕОД са изследвани 30 зъба с изтриване на общо 11 пациенти, засягащо и дентина на пациенти с бруксизъм преди и 6 месеца след приложение на оклузални шини. Получените резултати показват статистически значима разлика между нивата на ЕОД преди и след приложение на шини, които са съответно 18 μA и 6 μA. Шест месеца след използване на оклузални шини за профилактика на усложненията при бруксизъм, стойностите на ЕОД се нормализират.

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Introduction

Structurally, dentin and pulp are two completely different structures, they should not be considered separately because they are connected embryonically, histologically and functionally. In the course of dental development, pulp cells are responsible for the formation of dentin, nerve fibers and blood vessels. The structures of the pulp-dentin complex interact constantly and the change in one of them leads to changes in the others. Therefore, instead of talking about neuro-vascular reactions to certain stimuli, it is more accurate to talk about neuro-vascular-immune-odontoblast interactions [1].

Under the influence of stimuli on the pulpo-dentin complex, a complex network of interactions between the pulp blood and nerve vessels has been established, which takes place through the cellular growths of the dendrites. In addition, immunocompetent cells, peripheral nerve endings, and pulpal blood vessels interact, providing important protective functions at different levels [1, 2].

In the presence of parafunctions such as bruxism, the teeth are subjected to a much greater functional load compared to normal occlusion. As a result, "pulp stress" is generated in the dental pulp, which can lead to slow impairment of normal pulp function and necrobiosis or atrophy. In addition, the abrasion of the enamel with dentin exposition creates pathways for the invasion of microorganisms and their toxins and damage to the dental pulp. Such abrasion can be observed not only on the masticatory surface, but also in the cervical area – the so-called non-carious lesions, due to increased load and eccentric sliding movements of the lower jaw [3, 4]. Therefore, examination of pulp vitality in patients with bruxism may reveal the presence or absence of degenerative changes associated with parafunctions. Also, the prevention of complications in this parafunction could have a positive effect on the processes in the pulp. The use of occlusal splints for treatment of bruxist patients in practice has been recommended for many years. Due to the contradictory nature of bruxism, there is still no universally valid conclusion and its etiology is considered multifactorial [5, 6]. Therefore, various treatment methods capable of stopping bruxism and preventing its destructive effects are discussed [7]. Precisely planned and manufactured, occlusal splints in their variety successfully prevent the negative consequences of parafunction [8, 9]. Examination of the pulp innervation before and after prophylaxis by occlusal splint in these cases may reveal more details about the complex relationships in the pulpo-dentin complex.

Aim

To examine the pulp innervation by electric pulp test (EPT) in teeth with abrasion before and after prevention of complications of bruxism with dental (occlusal) splints.

Material

To accomplish the task, 30 teeth of 11 patients will be examined with abrasion to the degree of exposed dentin, without affecting the dental pulp.

Criteria for inclusion in the study:

– Teeth with abrasion to the degree of exposed dentin without affecting the dental pulp attrition cum abrasione

– Teeth without data for endodontic treatment

– Teeth without radiographic data for the presence of periapical inflammatory processes

– Patients diagnosed with bruxism who are about to be treated with occlusal splints made on the upper jaw

Methods:

A standard patient questionnaire, an intraoral clinical examination, and a single-use BiteStrip miniature portable electromyograph were used to diagnose bruxism (Fig. 1).

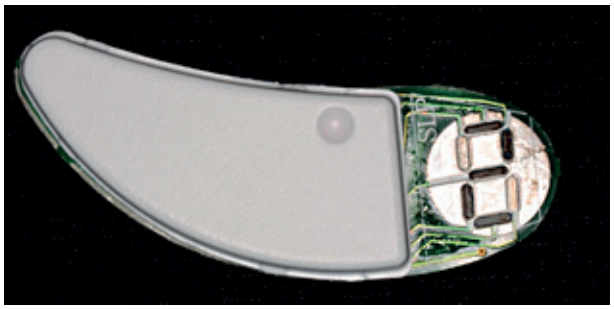

Figure 1. *BiteStrip® portable electromyograph*

A Scorpion EPT device (Optica Laser) is used for examination of the innervation of the tooth. The examination was performed before the start of the treatment and 6 months after wearing bruxism splints according to the following method (Fig. 2):

– The patient holds the passive electrode in his right hand;

– Instructions are given to the patient at the slightest irritation in the tooth to press the button on the passive electrode;

– The examined tooth is isolated from the saliva with cotton rolls;

– The examined tooth is air dried;

– Positioning of the tip of the active electrode perpendicular to the most sensitive point of the examined tooth;

– The measurement is started by pressing the button on the active electrode of the EPT device;

– At the slightest irritation in the tooth, the patient presses the button on the passive electrode, which is located in the right hand;

– The test result, which is stored on the screen of the device, is reported.

An all-digital protocol was used to make the occlusal splints for the prevention of complications of bruxism:

– Scanning of the dentition of the upper and lower jaw, including left and right occlusion with a dust-free intraoral scanner Medit I500 (Medit Corp.) (Fig. 3).

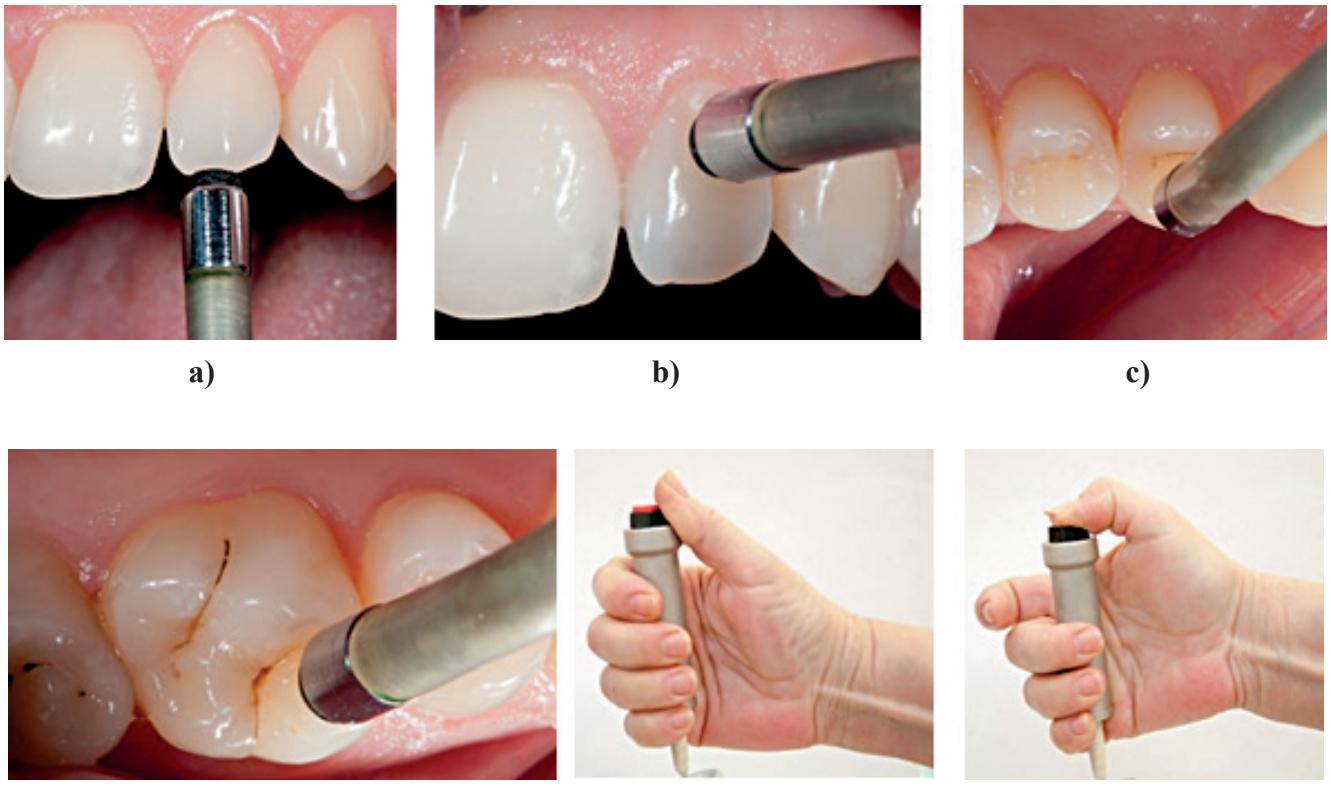

Figure 2. *Examination of teeth by EPT: a), b) of a frontal tooth; c) of a premolar; d) of a molar; e) passive electrode; f) pressing the passive electrode button*

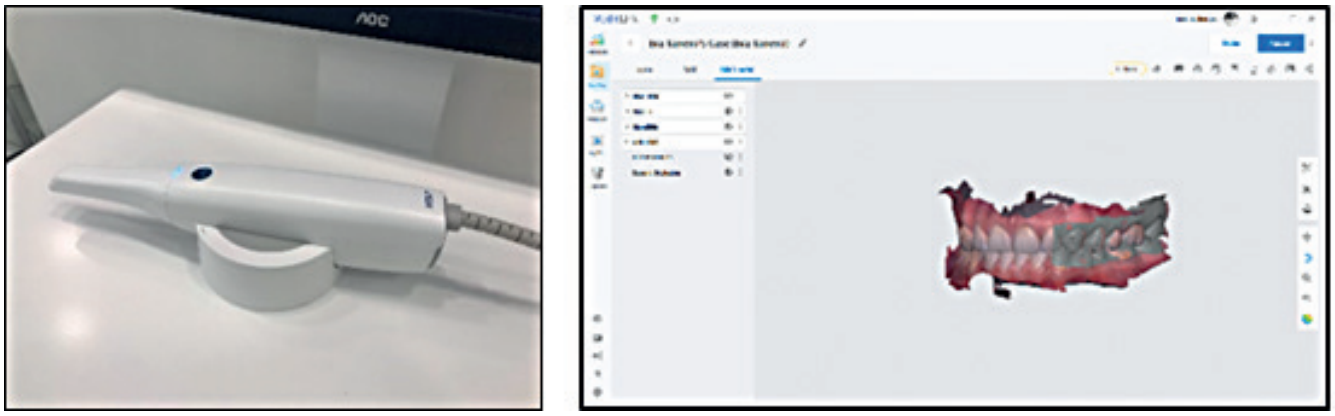

Figure 3. *(a) Medit I500 intraoral scanner; (b) Scanned upper and lower jaw*

– Digital design of the upper jaw splint, using a virtual articulator in Exocad v. Plovdiv (exocad GmbH)

– Production of the splint by three-dimensional (3D) printing in the following steps:

o Introduction of the project in the software for 3D printing PreForm v.3.18.0 (Formlabs); preparation for the beginning of printing by orientation of the printed object and generating supporting structures;

o Printing the splint with a Form 2 (Formlabs) three-dimensional printer (Fig. 4 a) based on stereolithographic technology (SLA). The material used is a transparent liquid photopolymer resin for SLA - Dental LT Clear (Formlabs).

o Post-polymerization processing of the splint by means of the devices accompanying the printer – Form Wash (ultrasonic bath with isopropyl alcohol) – Fig. 4 (b) and Form Cure (ultraviolet polymerization device) – Fig. 4 (c).

– Finishing and polishing the finished splint

– Adjustment of the occlusal-articulation contacts of the splint with the antagonist teeth of the lower jaw in the patient's mouth and handover for use (Fig. 5).

Prophylactic occlusal splints are intended for use during sleep, and patients are given instructions for care and storage. Control examinations are scheduled at the following intervals:

– 2 weeks after placement – in order to check the fit, occlusal-articulation contacts and patient comfort

– 6 months after placement – in order to check the condition of the splints and a second measurement by EPT of the teeth included in the study

Figure 4. *(a) Form 2 3D printer; (b) Form Cure Ultrasonic Bath; (c) Form Cure ultraviolet curing device*

Figure 5. *a) Visualization of evenly distributed contacts within the splint; (b) Intraoral view of a 3D printed splint*

The results of the study were statistically processed using IBM Statistics SPSS v.19 software.

Results

From the conducted researches we received the following results:

Table № 1. *Examination of the electrical excitability of the dental pulp before and after treatment (6 months) with occlusal splints for bruxism*

Statistical data / Examination	n (teeth)	$x \pm SD$	t-test
Before treatment	30	18,17 ± 4,89	t = 1,12 p = 0,15
After treatment	30	6,02 ± 2,69	

The table above shows that in teeth with abrasion before treatment there is a slight increase in the values of electrical excitability of the dental pulp, as they are on average 18μA. This value is slightly higher than the established norms of 2-12 μA. After 6 months of treatment with splints, a decrease in the values and normalization of EPT was observed, on average they were about 6μA. The observed difference in the electrical excitability of the pulp before and after treatment was statistically significant ($p > 0.05$).

Discussion:

Some studies on the effect of irritants on dental pulp have shown that in the presence of an initial inflammatory reaction in the pulp that is not clinically evident, electrical excitability may increase. In these cases, the EPT values can rise to 35 μA. In intact teeth, the pulp responds to EPT with values between 2-12 μA.

The increase in EPT values in abraded teeth is most likely due to several factors. On one hand, by abrasing the enamel and exposing the dentin, dentinal tubules open. As the abrasion progresses, their number increases. It is possible for microorganisms or their products to enter the pulp through the tubules and affect the terminal nerve endings.

On the other hand, in chronic stimuli, adaptation of nerve receptors and their desensitization can occur. Therefore, patients may not be able to respond normally to an EPT test, leading to higher values.

Reactive dentinogenesis due to chronic irritation in exposed dentin may also affect pre-treatment EPT values. With the formation of tertiary dentin, the pulp chamber narrows and this could lead to higher EPT values. In this case, however, there would be a steady trend to increase and maintain the lower threshold of electrical excitability. Probably this is not the case in our study.

After the treatment, the EPT values are reduced to levels typical of intact teeth. This shows the normalization of the function of the dental pulp and in particular of its innervation. This decrease in values is most likely due to the elimination of "pulp stress" after the elimination of the chronic irritant that led to tooth decay. With normal masticatory loading and distribution of masticatory pressure during parafunction on the whole dentition, thanks

to the splint for bruxism, normal functioning of the pulp innervation is ensured. It is not able to compensate for the increased functional requirements and therefore the response to stimuli is normal.

Among the known pathological changes caused by bruxism are in the first place changes in hard dental tissues and mainly occlusal tooth abrasion. The manifestation of parafunctional activity is associated with fractures of the teeth, and in severe cases they are complicated and affect the pulp. There are also changes in the muscles and soft tissues in the oral cavity - hypertrophy of the masticatory muscles, impressions of the teeth on the tongue and cheeks, thickening of the linea alba. Bones are also affected, most often by the formation of exostoses, but also the torus maxillaris and/or mandibularis.

Well-made splints in patients with bruxism are crucial for relieving the joint-muscular component of the masticatory apparatus and together with the prevention of tooth abrasion, are a basic prerequisite for preserving all its functions. In patients who make an exception to this trend, the different types of pathologies of the joint and muscle complex should be taken into account and to what extent they can be influenced only by splint prophylaxis, as well as the possibility of another, additional etiological factor that does not has been removed.

In chronic trauma, the tissue pressure in the pulp increases, leading to stasis and / or ischemia in the closed pulp space [10, 11, 12]. Another probable cause of decreased pulp sensitivity may be due to early neural degeneration as a result of chronic traumatic injury, resulting in delayed conduction of the nerve impulse. According to Ozcelik [13], "intramyelin edema", axonal edema and partial loss of myelin sheath are observed in these cases. Reinnervation and restoration of the schwannoid sheath takes 3 to 6 months [12, 14]. Probably for this reason, after 6 months of treatment with occlusal splints, the innervation of the teeth is normalized, which is proven by our research.

Conclusions

In patients with bruxism, a reduced threshold of electrical excitability of the dental pulp is observed. Six months after application of occlusal splints for the prevention of complications of bruxism the EPT values return to normal.

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