Conservative Dentistry

Examination of pulp blood circulation of teeth with abrasion

Dimitar Kosturkov[1], Iva Taneva[2], Todor Uzunov[3]

Изследване на пулпното кръвообращение при зъбно изтриване

Димитър Костурков[1], Ива Танева[2], Тодор Узунов[3]

Summary

When the dentin is exposed, for example as a result of tooth abrasion, the pulp-dentin complex will be exposed to the long-term effects of various irritants resulting from the entry of bacterial substances through the dentinal tubules into the pulp. This can lead to a pulp reaction associated with inflammatory or degenerative changes. The aim of the present study is to investigate pulp vitality in teeth with abrasion in patients with bruxism before and after treatment with occlusal splints for 6 months. Pulp examination was performed by pulse oximetry and the results showed a statistically significant difference before and after treatment, with pulp saturation being 89% and 82%, respectively. An increase in pulp saturation values is observed, close to the levels observed in cases of hyperemia/initial pulpitis. After 6 months of application of occlusal splints for the prevention of complications of parafunction, normalization of pulp blood circulation is observed.

Резюме

Когато дентинът е оголен, например в резултат на зъбно изтриване, пулпо-дентиновият комплекс ще бъде подложен на дългосрочното въздействие на различни дразнители, резултат от навлизане на бактериални субстанции през дентиновите тубули в пулпата. Това може да доведе до пулпна реакция, свързана с възпалителни или дегенеративни промени. Целта на настоящото изследване е да се проучи пулпният виталитет на зъби с изтриване при пациенти с бруксизъм преди и след приложение на оклузални шини за период от 6 месеца. За изследване на пулпата е използвана пулсова оксиметрия. Резултатите показват статистически значима разлика преди и след прилагане на оклузални шини с пулпна сатурация съответно 89% и 82%. Наблюдава се повишаване на стойностите на сатурация, близки до нива, наблюдавани в случаи на хиперемия/начален пулпит. След 6 месечно приложение на оклузални шини за профилактика на последствията от парафункцията се наблюдава нормализиране на пулпното кръвообращение.

[1]Assistant, Department of Conservative Dentistry, Faculty of Dental Medicine, Medical University – Sofia

[2]Assistant, Department of Prosthetic dental medicine, Faculty of Dental Medicine, Medical University – Sofia

[3]Associate professor, Department of Prosthetic dental medicine, Faculty of Dental Medicine, Medical University – Sofia

[1]Асистент, Катедра по Консервативно зъболечение, Факултет по дентална медицина, Медицински университет – София

[2]Асистент, Катедра по протетична дентална медицина, Факултет по дентална медицина, Медицински университет – София

[3]Доцент, Катедра по протетична дентална медицина, Факултет по дентална медицина, Медицински университет – София

Introduction

Although dentin and pulp are structurally different, they react together in response to stimuli, so the pulp-dentin complex is a single functional unit. Changes in one of the structures is associated with changes in the other. When the dentin is exposed, for example as a result of tooth abrasion, the pulp-dentin complex will be exposed to the long-term effects of various irritants resulting from the entry of bacterial substances through the dentinal tubules into the pulp. This can lead to the transition of the acute dentinal reaction (associated with pain from thermal, mechanical and osmotic stimuli) when there exposed dentin to a chronic pulp reaction (associated with dystrophic, atrophic and necrotic changes) [1, 2].

One of the most common causes of dentin exposure is tooth abrasion. It is observed on the occlusal or incisal tooth surfaces. As a result of this process, the peritubular dentin is affected first. As tooth wear progresses, the dentinal tubules enlarge and changes in the intertubular areas are observed. With rapid progress of abrasion, sensitivity appears in the teeth, especially to thermal, mechanical and osmotic irritants. In cases of slow progression of the abrasion, there may be no clinical symptoms, which is the cause of severe damage to the entire dentition [3, 4, 5, 6].

When they enter the dental pulp through the exposed dentin, microorganisms and their products can cause changes of varying severity. It has been debated for decades whether bacterial or chemical irritants cause more severe pulp inflammation. In all cases, however, exposed dentin leads to "stress" in the pulp [1].

The term "stressed pulp" describes a vital dental pulp that has been subjected to repeated damaging effects for a long time. The stressed pulp condition is a clinical concept, not a histological finding. Pulp "stress" can lead to the slow development of conditions such as atrophy, dystrophy or necrosis of the dental pulp [7].

It is known that bruxism results in a much higher functional load on the teeth than the physiological one. In this regard, further research is needed to determine the impact of this parafunction on the dental pulp and in particular the possibility of developing "pulp stress" and subsequent atrophy or necrosis.

Aim

To examine the pulp blood circulation by pulse oximetry (PO) in teeth with abrasion before and after the application of occlusal (dental) splints for the prevention of complications of bruxism.

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 abrasionem

– 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 Contec CMS 8000 pulse oximeter with custom made dental tips (Fig. 1) will be used to examine the blood circulation of the tooth. The study is performed before starting treatment and 6 months after wearing braces for bruxism according to the following method:

– The tooth to be examined is dried;

– A tip is chosen, the model of which should correspond to the tooth group of the examined tooth;

– The tip of the pulse oximeter is positioned so that the diodes are located on the vestibular tooth surface and the photodetector – on the oral;

– After the calibration time of the device has elapsed, the obtained value of the screen is read,

which corresponds to the percentage of blood saturation in the pulp of the tooth;

– The patient remains immobile while the measurement is performed;

– In the presence of large disturbances or very homogeneous peaks and dips in the plethysmogram, the study is repeated.

A standard patient questionnaire, an intraoral clinical examination, and a single-use portable BiteStrip® electromyograph were used to diagnose bruxism (Fig. 2).

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).

– 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 printing by orientation and generation of prorotype supports;

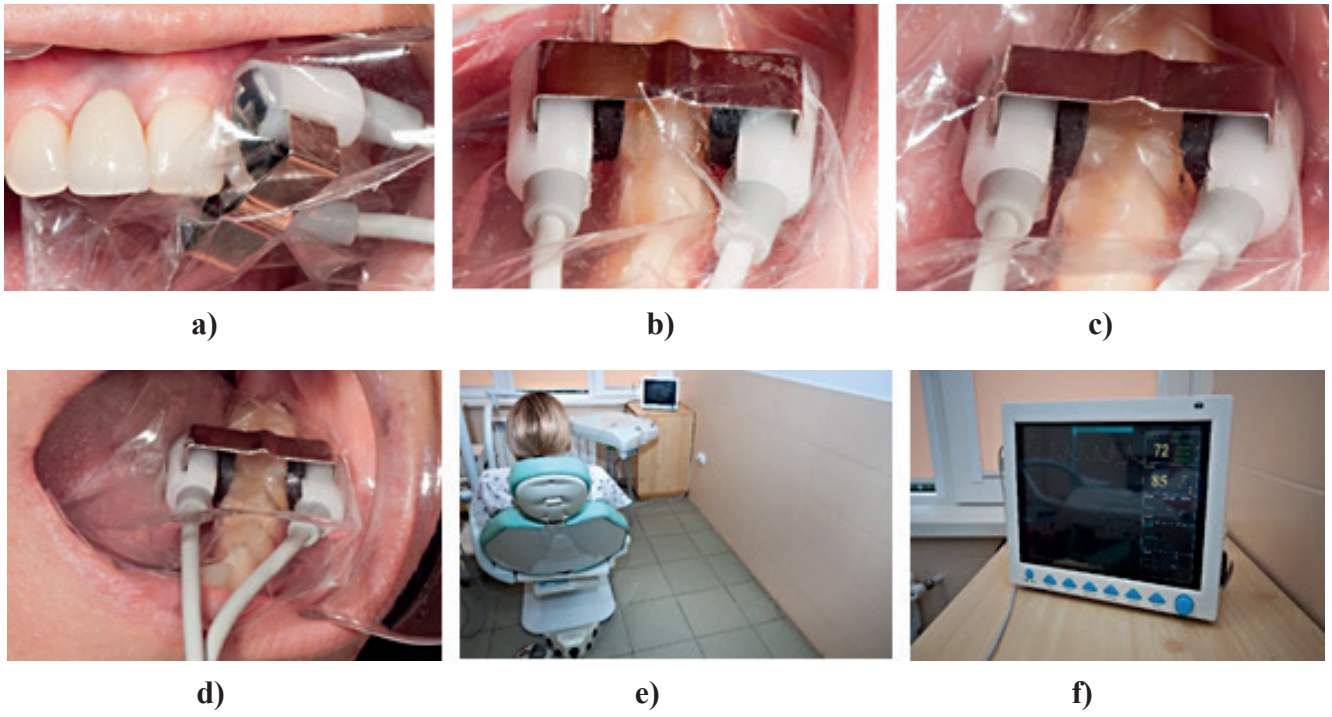

Figure 1. *Examination of teeth by pulse oximeter: a) examination of frontal tooth; b) examination of premolar; c), d) examination of molar; (e) a patient during the examination; f) device monitor showing plethysmogram and saturation value*

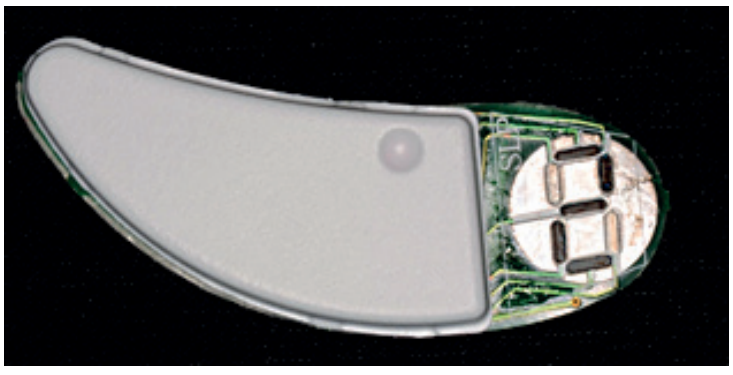

Figure 2. *BiteStrip® portable electromyograph*

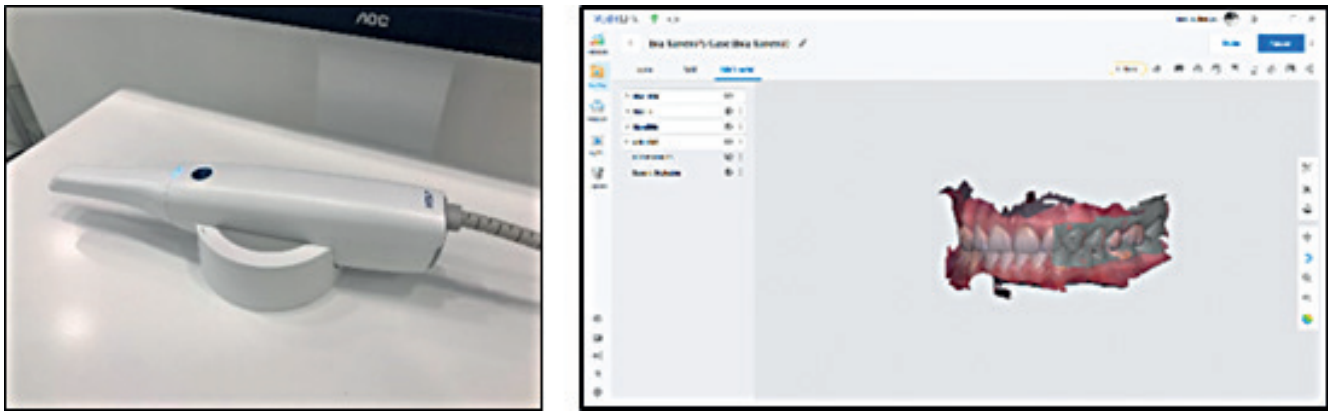

Figure 3. *(a) Medit I500 intraoral scanner; (b) Scanned upper and lower jaw*

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)

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*

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

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 pulp blood circulation with pulse oximeter before and after treatment (6 months) with occlusal splints for bruxism*

Statistical data / Examination	n (teeth)	$x \pm SD$	t-test
Before treatment	30	89,36 ± 3,21	t = 1,29 p = 0,22
After treatment	30	82,53 ± 2,43	

The obtained results show that before the treatment the levels of saturation of the dental pulp are around 90%, which is higher than the established norm. After 6 months of treatment with occlusal splints for bruxism, a decrease in saturation values was observed, as they returned to normal and averaged about 82%.

Discussion:

Pulp circulation has complex compensatory mechanisms, which is mainly due to the capillary network. There are several types of capillaries – fenestrated, non-fenestrated (continuous), intermittent capillaries and connecting capillaries [8, 9]. They form a dense network and anastomoses in the subodontoblast space, which penetrate between the odontoblasts and continue as venules. A system of arteriovenous anastomoses and shunts is formed. They are activated during pulp damage or chronic trauma [9, 10]. All afferent blood vessels (except capillaries), arteriovenous anastomoses and shunts have many mechanisms to control regional blood flow [9]. Inflammation of the pulp also reveals a large number of active arteriovenous shunts, vascular loops, increased blood flow and lymphatic drainage [10, 11, 12, 13]. According to Bishop, pulp microcirculation can be increased by up to 40% in the early stages of the inflammatory process [14].

The high values of pulp saturation before treatment in bruxists are probably due to the involvement of these mechanisms in chronic trauma to the teeth. Shunts and collaterals are opened to compensate for the traumatic condition. In a study by Pileggi, it was found that as a result of the trauma, the number and diameter of blood vessels in the pulp increased, which also increased blood flow – hyperemia occurs, which is transient and gradually disappears in the next 10-14 days [15]. Increased blood flow in combination with stasis means a greater number of hemoglobin-containing erythrocytes and therefore greater light absorption by the photodiodes of the pulse oximeter, which is manifested in the higher value shown on the display of the device [16, 17, 18].

On the other hand, when dentin is exposed, there are conditions for pathogens to affect the peripheral areas of the pulp through open dentinal tubules. Upon stimulation, sensory nerve fibers not only transmit pain but are able to elicit a neurogenic inflammatory response through the secretion of neuropeptides, in particular substance P (SP), vasoactive interstitial polypeptide (VIP), calcitonin (CT), calcitonin gene-linked peptide. (CGRP) and neuropeptide Y (NPY) [19]. The release of these compounds leads to vasodilation and increased vascular permeability, as well as to the activation of immune cells [20]. The presence of an initial, asymptomatic inflammatory process and injury to the sensory nerve fibers cause the formation of terminal branches of neurons in the remaining

healthy pulp tissue [21]. This may enhance the inflammatory response through increased neuropeptide secretion, which further increases pulp blood flow and saturation [22, 23].

Conclusions

Tooth abrasion due to parafunctional activity of the masticatory apparatus can lead to disruption of the normal blood circulation of the dental pulp. An increase in pulp saturation values is observed, close to the levels characteristic of hyperemia / initial pulpitis. After 6 months of application of occlusal splints for the prevention of complications of parafunction, normalization of the pulp circulation is observed.

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Address for correspondence:
Dr. Dimitar Nikolaev Kosturkov
Department of Conservative Dentistry,
Faculty of Dental Medicine
Str. „G. Sofiiski" 1
1431, Sofia
e-mail: d.kosturkov@gmail.com