SUMMARY
Purpose: To conduct pulse oximetry (PO) and electric pulp test (EPT) on intact frontal teeth in clinically healthy patients aged between 18 and 25 years who do not have periodontal disease.

Material/Methods: To achieve the aim 1058 teeth of 31 patients were studied. The following inclusion criteria for the study were set:
1. Age – 18-25 years.
2. Clinically healthy patient, who does not have any systemic diseases, do not take any medicine systematically.
3. Intact frontal teeth – without carious lesions, restorations or root canal treatment.
4. Lack of periodontal disease.

Research was conducted with a pulse oximeter Contec™ - CMS60D and a custom made probe holder.

Results: Average values obtained by pulse oximetry in upper jaw vary between 83% and 85%. In lower jaw – between 82% and 85%. 99% is the maximum and 48% is the minimum registered value. The average value of the measurement of all the teeth is 84%.

The average saturation measured on the small finger of the right hand of the patient is 98%.

The average value of EPT for all teeth is 4 µA. The maximum measured value is 20 µA, and the minimum - 1 mA.

Conclusions:
1. Adequate study of the pulp includes two complementary methods – electric pulp test (evaluation of innervation) and pulse oximetry (assessment of pulp microcirculation).
2. Teeth that are larger in size have larger values of PO and EPT, which is in direct relation to the size of their pulp chamber.
3. The total saturation, measured in the little finger of the right hand is greater than the one of the teeth.

Keywords: Pulse oximetry, dental diagnosis, pulp condition

INTRODUCTION:
Diagnosis of pulp condition is important for creating an adequate treatment plan and prognosis as well as conducting right and successful treatment. As long as the pulp consists of blood vessels and nerves, tests for evaluation of the condition of the pulp can be divided into two groups:
1. Tests for evaluation of the innervation of the tooth.
2. Tests for evaluation of the blood circulation.

Conventional tests for pulp sensitivity (temperature, electric and cavity tests) have some disadvantages [1]:
- Because the nerve tissue is very resistant to inflammatory processes, it can remain reactive even when the surrounding tissues degenerate and thus a false positive result can be detected with a non-vital pulp [2].
- These tests are often accompanied by unpleasant sensations [3], which can compromise the outcome (subjective test that depends on the type of nervous system of the patient).
- In the case of mineral dystrophy, trauma or teeth with incompletely formed apex a temporarily reduced susceptibility may occur [4].
- There is subjectivity [5], as these tests are counted on one side of the patient’s response to stimulus and interpretation of the dentist on the other.
- Several researches [5, 6, 7, 8] show that the study of pulp vascularization instead of innervation is much more appropriate to determine the vitality of the pulp. This can be achieved by Doppler probe or a Pulse oximeter.

Pulse oximetry (PO) is a noninvasive method which measures the saturation of the blood. It is widely used in general medicine. In the field of dentistry it can be used for evaluation the condition of the tooth pulp.

The method is based on modification of the law of Bouguer-Lambert-Beer (Figure 1), which concerns the absorption of light by the solution according to the concentration and optical properties at a given wavelength. It depends on the absorption characteristics of the hemoglobin in the red and infrared spectrum. In the red spectrum the oxyhemoglobin absorbs less light than desoxyhemoglobin and vice versa in the infrared spectrum.
Fig. 1. Schematic representation of the law of Bouguer-Lambert-Beer. $I_0$ - intensity of the transmitted light, $I$ - intensity of the light that passes, $l$ - thickness of the layer through which the light passes, $\alpha$ - concentration of dissolved substance (hemoglobin).

There are number of studies, which confirm the benefits of PO in the diagnosis of the condition of the pulp - Schnettler & Wallace (1991), Mills (1992), Goho (1999) [9 - 13]. However, there are studies that reported disappointing and unexpected results [10, 14, 15].

PURPOSE:
To conduct pulse oximetry and electric pulp test (EPT) on intact frontal teeth in clinically healthy patients aged between 18 and 25 years who do not have periodontal disease.

MATERIAL AND METHODS:
To achieve the aim 1058 teeth of 31 patients were studied. The following inclusion criteria for the study were set:
1. Age – 18-25 years.
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Research was conducted with a pulse oximeter Contec™ - CMS60D (fig. 2, fig. 3) to all included in the study patients. For better adaptation of the diodes and sensors to tooth surfaces, a special holder was created.

During the study, the diode and the sensor were positioned parallel to one another on both sides of each tooth. LED is placed at the vestibular side and the sensor - orally. They must be stable in order to obtain an accurate signal (fig. 4).
Fig. 4. Application of pulse oximetry

An electric pulp test - EPT with “Yonovit” device has been conducted to all teeth examined with pulse oximetry. The general saturation of each patient was measured on the little finger of the right hand. The data was processed statistically by SPSS v 19.01

RESULTS:
The following results shown in the graphics below were obtained from the conducted researches:

Graph. 1. Values of pulse oximetry in upper jaw

Graph. 2. Values of pulse oximetry in lower jaw

Graph. 3. Values of electric pulp test in upper jaw

Graph. 4. Values of electric pulp test in lower jaw

The pulsations of the pulp and periodontal tissues have different characteristics (fig. 5):

Fig. 5A.
5A) A typical signal of the pulse oximeter obtained from a tooth. Measured saturation - 72%.

5B) A typical pulse oximeter signal from periodontal structures. Measured saturation - 94%.

From the survey of the values variations of pulp saturation it came out that 99% is the maximum and 48% is the minimum registered value. The average value of the measurement of all the teeth is 84%.

The average saturation measured on the small finger of the right hand of the patient is 98%.

The average value of EPT for all teeth is 4 µA. The maximum measured value is 20 µA, and the minimum - 1 µA.

From the results shown above is apparent that the larger the teeth are, which have a bigger pulp chamber, the higher results are obtained for both the PO and the EPT.

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