

# PULSE OXIMETRY AND ELECTRIC PULP TEST IN INTACT TEETH AND TEETH WITH HYPERAEMIA PULPAE

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**Abstract.** *The pulp hyperaemia is associated with increased blood flow in the pulp. Diagnosis of this condition is very important for the outcome of a dental treatment. There are new methods, which can detect the pulp blood flow. Such method, gaining increasing popularity nowadays, is pulse oximetry. In this study, intact teeth and teeth with diagnosis of hyperaemia pulpaе are examined by pulse oximeter and electric pulp test. The results show that the threshold of irritation is decreased in teeth with hyperemia, and the saturation of the pulp is increased by 12.34% in frontal teeth and 7.27% in distal teeth. There is a statistically significant difference ( $p < 0,05$ ) in the values measured with pulse oximeter in the intact frontal and distal teeth and the teeth with hyperemia. Pulse oximetry can detect changes in pulp microcirculation in state of hyperemia. It is an extremely valuable method for early, objective diagnosis of pulp blood flow, as well as for its monitoring in dynamics.*

**Key words:** dental diagnosis, pulp, hyperaemia, pulse oximetry, electric pulp test

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## INTRODUCTION

In dentistry, the term ‘hyperemia’ refers to a reversible pathological condition of the pulp, a precursor of the acute pulpitis. In medicine and physiology, the term „hyperemia“ is associated with increased blood flow in a particular tissue.

Some studies have shown that pulp conditions, clinically defined as hyperemia, histologically very rarely correspond to this diagnosis [7]. Therefore, it is spoken about pulp hypersensitivity [4, 6, 13, 14]. Clinically, dental hypersensitivity may be associated with histological hyperemia or vice versa.

There are different methods that diagnose blood circulation. One of the most widely used in general medicine is pulse oximetry. It is based on the absorption of red

and infrared light from different types of hemoglobin in the blood. In dentistry, this is a new, non-invasive, non-subjective method for determining pulp blood circulation, which is gaining increasing popularity.

## AIM

The aim of this study is to determine the percentage of blood saturation in the pulp by pulse oximetry (PO) in intact teeth and in teeth with hyperemia and to conduct a parallel examination of the innervation of these teeth with electric pulp test (EPT).

## MATERIAL AND METHODS

To realize the aim by PO and EPT 2 groups of patients are examined:

1. Group 1: 22 patients with intact teeth – 41 frontal and 37 distal teeth.
2. Group 2: 23 patients with teeth with diagnosis of hyperaemia pulpae – 16 frontal and 15 distal teeth.

Criteria for inclusion of patients in group 1:

- Patients without general disease
- Patients who do not take medicine
- Teeth without anamnestic and clinical data for presence of caries or pulp disease
- Teeth without conducted endodontic treatment
- Permanent teeth with complete root development.

Criteria for inclusion of patients in group 2:

- Patients without general disease
- Patients who do not take medicine
- A history of a single pain attack within the last 24 hours, duration of the attack within 1-2 minutes; acute, triggering and localized pain with a drop of not more than 1 day
- Presence of a provoked, short-lived pain with or without prolonged response within 1 minute after removal of the stimulus
- Presence of a reduced threshold of irritation to irritants with normal strength and action
- EPT less than 2  $\mu$ A.

Pulse oximetry is performed with Contec CMS 60D device and a specially modified probe. The study was conducted according to the following methodology:

- The dental unit reflector is turned off
- The patient is asked to remain stationary
- The examined tooth is air-dried
- The diodes and photodetector of the device are positioned parallel in the area of the cervix of the examined tooth. The diodes are placed from the vestibular side of the tooth and the photodetector from the oral side
- Device calibration is allowed to proceed
- The saturation value of pulp blood flow is reported in percentages (%).

EPT is performed with Scorpion SM.405.7<sup>a</sup> device from "Optica laser" using the following methodology:

- The patient holds the passive electrode in his/her right hand
- Instructions are given to the patient. When the slightest irritation in the tooth is felt, he/she must press the passive electrode button

- The examined tooth is isolated from the saliva with cotton rolls
- The examined tooth is air-dried
- The tip of the active electrode is placed perpendicularly to the most sensitive point of the tooth
- Measurement is started by pressing the button on the active electrode
- The result is read after the button is pressed by the patient.

The results obtained from both studies are processed with IBM Statistics SPSS v.19.

## RESULTS

The results obtained from the examinations are shown in Table 1.

**Table 1.** Results of the study conducted by EPT and PO in intact teeth (group 1) and teeth with hyperaemia pulpae (group 2)

Type of the test Tooth's affiliation	EPT		Pulse oximetry	
	Group 1	Group 2	Group 1	Group 2
Frontal teeth	3.91 $\mu$ A	2 $\mu$ A	81.47%	93.81%
Distal teeth	6.05 $\mu$ A	2 $\mu$ A	86.86%	94.13%

When comparing the values obtained from the EPT in the two groups, the following dependencies are obtained (Figure 1).

There is a decreased threshold of irritation in the group of teeth with hyperemia. All cases investigated respond with values below 2  $\mu$ A. The pulp is hyper-sensitive.

When comparing the values obtained from the pulse oximetry in the two groups, the following dependencies are obtained (Figure 2).

Figure 2 shows that there is a significant increase in the saturation in teeth with pulp hyperemia. This increase is more notable in the frontal teeth group. Therefore, the difference compared to the group of intact teeth is 12.34%. For distal teeth this difference is lesser – 7.27%. A statistically significant difference ( $p < 0.05$ ) was observed in both groups.

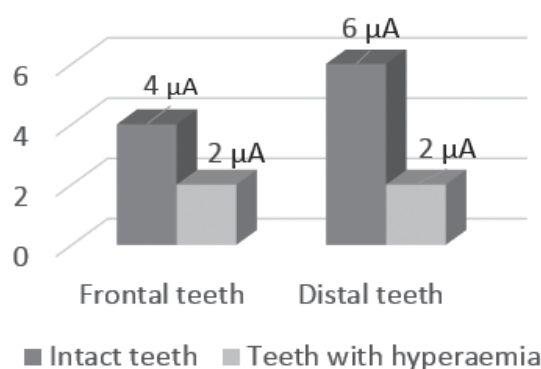


Fig. 1. Values of EPT in intact teeth and teeth with hyperemia

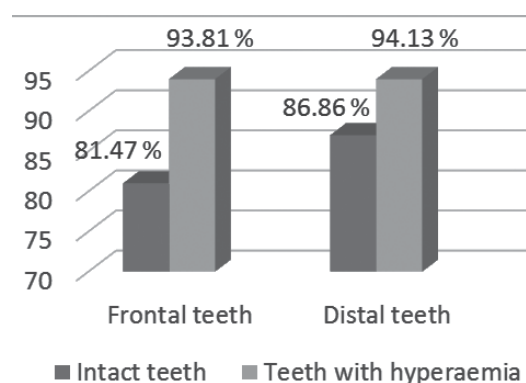


Fig. 2. Values of saturation (PO, %) in intact teeth and teeth with hyperemia

## DISCUSSION

Clinically, hyperemia is most often manifested by the presence of an acute, localized pain caused by a cold stimulus that fades rapidly after removal. A single attack of spontaneous pain with a slight intensity and a very short duration [8] can be observed.

The pain associated with dental hypersensitivity can be explained by the hydrodynamic theory of Brännström [3]. According to it, the movement of fluids into the dentinal tubules causes stimulation of the nerve fibers at the periphery of the pulp. This movement can be caused by an air jet which leads to absorption of odontoblasts in the dentinal tubules. It can also be caused by cold stimuli that lead to fluid shrinkage in the dentinal tubules. This creates pressure and formation of a nerve impulse at the periphery of the pulp.

The same phenomena may arise as a result of dental rotary instruments that create heat through friction and surface tension. They lead to displacement of the fluid in the tubules [12].

The diagnosis of the pulp hyperemia is based mainly on patient complaints and clinical manifestations. Early diagnosis is sometimes difficult because the pulp does not have proceptive nerve endings and the patient cannot always locate the problematic tooth [5, 14]. The process of diagnosis is particularly difficult in the early stages of pulpal diseases that are reversible.

For the diagnosis of pulp hyperemia, the most commonly used clinical tests are cold-applied thermal treatments. However, they are subjective and in some cases cannot be used [1]. Electric pulp test is also a subjective diagnostic method, in which false positives or negative results can be obtained. Teeth with hyperemia respond normally to percussion and palpation. Normal radiological findings are observed.

In addition, these methods examine the innervation of the tooth rather than the blood circulation that has been altered in hyperemia. The innervation depends on blood circulation, so thermal and electric pulp tests are studies that can be judged indirectly about pulp blood flow. The pulp blood supply can be measured by other modern and innovative methods that are introduced in dental medicine – laser Doppler flowmetry and pulse oximetry [2, 9, 10, 11].

Pulse oximetry is a non-invasive method, by which blood saturation is measured. It judges directly about the functional state of blood flow. Through proper adaptation of the diodes and the pulse oximeter sensor, the test can be applied for pulp diagnosis. The values obtained for the saturation are not dependent on the patient's responses, meaning that the study is not subjective. The changes in the pulp microcirculation in the early stages can be detected by pulse oximetry and the dynamic processes in the pulp can be monitored.

For this reason, pulse oximetry is an extremely valuable method for both an early, objective diagnosis of pulp blood flow and its monitoring in dynamics.

In the accessible literature no similar studies were found. There was no information about research on the blood circulation in hyperemic teeth. Therefore, our study is considered the first in the world to reveal the dependencies between the innervation and the blood supply. It shows correlation between the innervation and the microcirculation status of the pulp. However more studies regarding this topic have to be done, including pulse oximetry and other innovative methods for dentistry that can detect the blood supply.

## CONCLUSION

The threshold of irritation is decreased in teeth with hyperemia, and the saturation of the pulp is increased by

12.34% in frontal teeth and 7.27% in distal teeth. There is a statistically significant difference ( $p < 0,05$ ) in the values measured with pulse oximeter in the intact frontal and distal teeth and the teeth with hyperemia. Pulse oximetry can detect changes in pulp microcirculation in state of hyperemia. It is an extremely valuable method for an early, objective diagnosis of pulp blood flow as well as for its monitoring in dynamics.

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