INFLUENCE OF THE GINGIVAL TISSUES ON THE MEASURED SATURATION LEVEL OF THE DENTAL PULP BLOOD FLOW

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Abstract. Pulse oximetry is a method by which the oxygen saturation of the blood is measured. It is based on the specific absorption of red and infrared light from the hemoglobin. In dentistry, when teeth are tested by pulse oximeter, the oral mucosa could change the light signal entering the photodetector of the device. The aim of this study is to investigate the influence of the gingival tissues on the results when teeth are tested by pulse oximeter. To realise the goal, 44 teeth of 22 patients aged 23 – 29 years are examined. The teeth are examined with pulse oximeter Contec CMS 60 D by positioning the diodes on the labial side of the teeth and on the photodetector from the oral. Two tests are conducted on each tooth. The first is by directly attaching the probe to the tooth. In the second test, the gingival tissues are isolated by condensation silicone.The following mean values of saturation of the pulp are determined – in the group of direct examination of the teeth: 83% ± 1%; when the gingiva is isolated with silicone: 83% ± 1%. Analysis by SPSS v.19 show that there is no statistically significant difference between the measured saturation of the teeth in the two groups. Gingival tissues does not affect the results obtained and does not change the measured saturation levels of the dental pulp. Pulse oximetry can be used for vitality test of the teeth without the need for gingival tissues to be isolated.

Keywords: pulse oximetry; dental pulp; gingiva; diagnostics; saturation

Introduction

Pulse oximetry is a method by which the oxygen saturation of the blood is measured. It is based on the specific absorption of red and infrared light from the hemoglobin. This light is transmitted through the tissues from diodes and is registered by photodetector.

The working principle of pulse oximetry is based on a modification of Beer Lambert's law (Vaghela & Sinha, 2011) which refers to the absorption of light from a solute in relation to the concentration and the optical properties at a given wavelength (Cohen & Hargreaves, 2006; Kamat, 2002).

In the basis of the method is the specific absorption of red and infrared light from the hemoglobin, depending on its saturation with oxygen (Kamat, 2002). The deoxygenated and the oxygenated hemoglobin absorb different wavelengths. The deoxygenated hemoglobin have a greater light absorption with of light with wavelength of about 660 nm and the oxygenation – about 940 nm (Lopez, 2011).

Various factors may influence the accuracy of the results – scattering, swallowing, refraction of light. In dentistry, when the teeth are examined, the oral mucosa may change the light signal entering the photodetector of the device.

The aim of this study is to investigate the influence of the gingival tissues on the results when teeth are tested by pulse oximeter.

Material and methods

To achieve the aim, 44 frontal teeth of 22 patients aged 23 – 29 years are examined. These teeth are divided in two groups: *Group No. 1* – teeth examined directly, without isolation of the gingiva with silicone; *Group No. 2* – teeth examined after isolating the gingiva with silicone.

The following inclusion criteria are applied to the tested teeth and patients in the study: (i) intact frontal teeth, with no evidence of caries or trauma; (ii) vital frontal teeth without history of inflammatory diseases of the pulp; (iii) fontal teeth without evidence of periapical alterations; (iv) patients without medication and without common diseases; (v) patients aged between 20 and 30 years.

The teeth are examined with pulse oximeter Contec CMS 60 D (Fig. 1) by positioning the diodes on the labial side of the teeth, and the photodetector from the oral (Fig. 2).

Figure 1. Pulse oximeter Contec CMS 60 D and a probe for the device

Figure 2. Positioning of the probe of a pulse oximeter on the tooth surface

Figure 3. Direct application of the probe of a pulse oximeter on the tooth surface

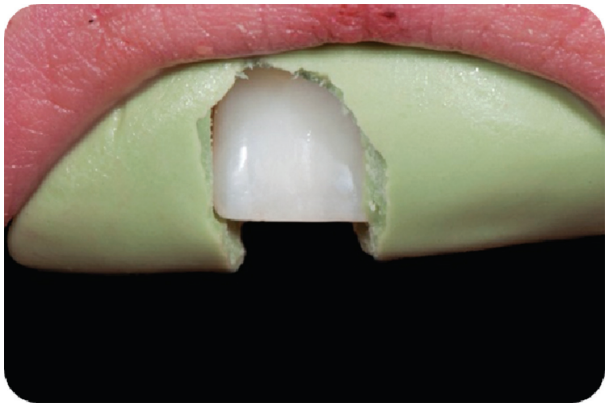

Figure 4. Isolation by condensation silicone of the gingival tissues

Two tests are conducted on each tooth. The first is by directly placing the probe of the device on the tooth (Figure 3). In the second study, the gingival tissues are isolated by condensation silicone (Figure 4).

The values obtained from the tests are subjected to statistical analysis by SPSS v. 19 – two paired samples T-test.

Results

The following results are obtained from the studies: (A) Average value of the saturation of the pulp blood flow when teeth are examined directly, without silicone isolation of the gingiva (Group №1): 83% ± 1%; (B) Average value of the saturation of the pulp blood flow when teeth are examined with silicone isolation of the gingiva (Group № 2): 83% ± 1%.

The analysis by SPSS v.19 show that there is no statistically significant difference between the measured saturation of the teeth in the two groups of the study – $p = 0.128079 (> 0.05)$.

Discussion

In the available literature there is no data for similar researches. Many studies show the effectiveness and accuracy of pulse oximetry in determining pulp saturation (Calil et al., 2008; Goho, 1999; Gopi Krishna et al., 2006; 2007a; 2007b; Kahan et al., 1999; Karayilmaz & Kirizoğlu, 2011). Only few studies report disappointing and unpredictable results (Sadique et al., 2014; Schmitt et al., 1991; Schnettler & Wallace, 1991).

This study clearly shows that the gingival tissues do not affect the signal of pulp saturation measured by pulse oximeter. An important condition for this is that the diodes and the photodetector are firmly attached to the surface of the

tooth. They should also be placed parallel to each other in the cervical area of the tooth a distance from the gingival edge. The production of specific probes which allow the diodes and the photodetector to be adapted in the described way will guarantee the accuracy of the measurements. The level of the saturation measured in the dental pulp is lower than the normal level of the general saturation of the body. Pulp saturation values of about 80 – 85% are considered normal and found in other studies (Kosturkov et al., 2015; 2017). The lower percentage of the pulp oxygenation is due to different optical phenomena of solid dental tissues when red and infrared light is transmited. Such are partial absorption, scattering, refraction and reflection of the light. Therefore, it is not possible to make conclusion for the general condition of the body by the pulp saturation, but only for the state of the pulp of the tooth.

Conclusion

The gingival tissues do not affect the results obtained and does not change the measured saturation levels of the pulp by pulse oximetry.

Pulse oximetry can be applied for examination of the teeth, without the need for gingival tissues to be isolated.

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