Received: 5th December 2013 Accepted: 21st March 2014 Conflict of Interest: None

Source of Support: Nil

Original Research

Evaluation of Efficacy of a Pulse Oximeter to Assess Pulp Vitality

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How to cite the article:

Sadique M, Ravi SV, Thomas K, Dhanapal P, Simon EP, Shaheen M. Evaluation of efficacy of a pulse oximeter to assess pulp vitality. J Int Oral Health 2014;6(3):70-2.

Abstract:

Background: To evaluate the efficacy of pulse oximeter as a pulp vitality tester.

Materials and Methods: The sample group consisted of 60 patients of age 15 to 30 years with normal maxillary anterior teeth. Thirty nonvital teeth with complete endodontic fillings were tested as control group. Systemic oxygen saturation values from the patient's fingers served as the control sample for comparison of pulp oxygen saturation values. Readings were recorded on index fingers first; teeth were then evaluated by placing sensor onto the tooth.

Results: Nonvital teeth recorded oxygen saturation values of 0%. The mean value for central incisor was 85.11 (SD ± 2.07), for lateral incisors 80.21 (SD ± 2.03) and for canines 89.55 (SD ± 1.09). Their control values (patient's index fingers) averaged 95.88% (SD ± 0.66). Pearson's correlation analysis showed a correlation of 0.11 for central incisors, 0.19 for lateral incisors and 0.12 for canines.

Conclusion: This study confirms that pulse oximeter is effective equipment for pulp vitality testing. Pulse oximeter evidences the actual method of evaluating the pulp vitality compared to contemporary methods.

Key Words: Oxygen saturation, pulse oximeter, vitality tests

Introduction

An accurate assessment of the pulpal status is crucial for proper endodontic diagnosis. It is known that the vascular supply of the tooth is a more accurate determinant to pulp vitality. However the current vitality tests rely on patient response to induced nerve stimulation.

Recent studies have shown that teeth involved in trauma or surgery may retain their vascularity despite temporarily losing its sensory function.[1,2] It has also been reported that nerve tissue is highly resistant to inflammation and may remain reactive long after the degeneration of the surrounding tissue. Therefore, the reliability of using nerve stimulation in order to assess the vitality of pulp is questioned.[3] So most of the tests do not meet the ideal pulp vitality testing criteria.

Research to find a determination method for evaluating pulpal circulation has involved the use of dual wavelength spectrophotometry, laser Doppler flowmetry (LDF), and pulse oximetry. The former detects quantitative presence of haemoglobin and not blood circulation. Moreover, this method has been examined only in laboratory setting. Laser Doppler flowmeter though successful in medical applications, in dentistry its use is hampered due to lack of reproducibility, expenditure and sensitivity to motion.[4] Pulse oximeter is a kind of noninvasive monitoring device for calculating oxygen saturation which is popularly used in medical practice while administering intravenous anaesthesia with the help of finger, foot or ear probes. Pulse oximeter transilluminates the tissue using red and infrared spectrum and detects absorbance peaks due to pulsatile blood circulation. This information is used to calculate oxygen saturation and pulse rate.[5]

Various researchers have reported an oxygen saturation of pulpal circulation can be correlated with systemic blood using pulse oximeter. Thus, they strongly suggest its use as a true pulp vitality tester.[6]

Materials and Methods

For the present study the sample groups consisting of normal maxillary central incisors, lateral incisors and canines were selected from 60 patients with ages ranging from 15 to 40 years. The criteria for selection were based on the absence of caries, fracture, discoloration, radiographic periapical changes and good periodontal health. The Teeth were then divided into the following groups. Group I - maxillary central incisors, Group II - maxillary lateral incisors, Group III -maxillary canines.

Control group of 30 nonvital and root canal treated teeth were used to compare pulse oximeter's evaluation of pulp vascularity.

To compare oxygen saturation values of pulp with systemic oxygen saturation, values of patient's fingers were taken as the control group (Table 1).

A criticare 504-US oxygen sensor was used to obtain oxygen saturation values of finger and teeth.

The patient's systemic oxygen saturation values were first recorded (index finger) with finger probe. Then the maxillary anterior teeth (central incisors, lateral incisors and canines) were evaluated by using the same sensor on the teeth. It was kept in a position that ensured parallelism of the sensor (light emitting diode) and the photoreceptor to each other so that phototoreceptor receives all the light emitted by the light emitting diode sensor. The readings were calculated after monitoring for 30 s on every tooth. Oxygen saturation results were measured and analyzed using the Karl–Pearson correlation analysis for evaluating the correlation between pulse oximeter readings of finger and teeth (Figures 1-4).

Results

The control group (30 nonvital teeth) showed 0% oxygen saturation. The mean value of 85.11 (SD ± 2.07) for maxillary central incisors, 80.21 (SD ± 2.03) for lateral incisors and 89.55 (SD ± 1.09) for maxillary canines. Average value of patient's index fingers (control group) was 95.88% (SD ± 0.66).

Table 1: Comparisons of oxygen saturation values.

	Mean	Standard deviation	Correlation with finger
Maxillary central incisor	85.11	2.07	0.11
Maxillary lateral incisor	80.21	2.03	0.19
Maxillary canine	89.55	1.09	0.12
Index finger	95.88	0.66	

Figure 1: View of methodology.

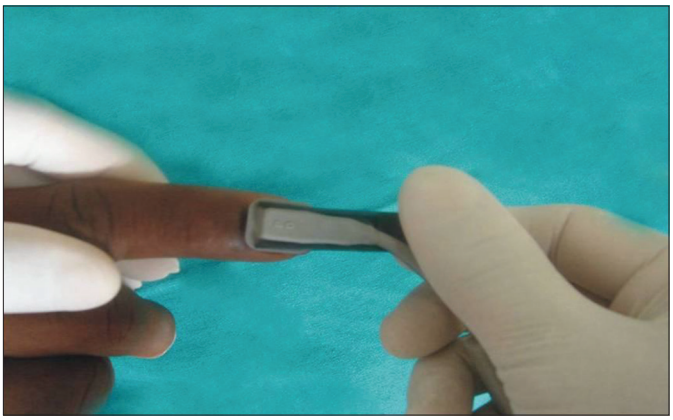

Figure 2: Evaluation on finger.

After Pearson's correlation analysis for oxygen saturation values of each individual's finger and tooth, it showed correlation of 0.11 for maxillary central incisors, 0.19 for maxillary lateral incisors and 0.12 for maxillary canines.

Discussion

Diagnosis is the art of identifying the problem and using scientific knowledge to determine the cause of the problem. The purpose of diagnosis in endodontics is to assess the condition of a tooth and to identify the cause of the discomfort. Over the years, the thermal and electrical tests were very commonly used for assessing the tooth vitality. Pulse oximeter can be used in dentistry as an objective tool which is popularly used in medical grounds. It is effective and accurate while calculating oxygen saturation of blood. It can be utilized as a vital instrument for differentiating vital and necrotic pulp.

The pulse oximetry sensor works with two light emitting type of diodes; first with red light (wavelength of 640 nm) and the other one with infrared light (wavelength of 940 nm). On the opposite side it has a photo detector of the vascular bed. The light emitting diode transmits light through a vascular bed such as finger, toes or ear. Oxygenated hemoglobin and

Figure 3: Evaluation on tooth.

Figure 4: Oximeter reading.

deoxygenated hemoglobin absorbs different amount of red/infrared light. Periodic changes in the amount of red/infrared light absorbed by the vascular bed before reaching the photo detector indicates the pulsatile change in the blood volume. This relationship is utilized by pulse oximeter to analyze the saturation of arterial blood. The information collected is converted into digital signals that are processed by the oximetry computer. A numerical estimation of the hemoglobin oxygen saturation is then produced and displayed.[7]

LDF is another new innovation. It is an accurate, noninvasive, reproducible, reliable method. It has a diode that emits a beam of infra red light through the crown and pulp chamber, for measuring blood flow in microvascular systems. But LDF takes about an hour to produce recordings, making it impractical in dental practices.[8]

On comparing Pulse oximetry vs conventional pulp sensitivity tests, Gopikrishnana et al. (2006) found Pulse Oximetry to be more accurate. Sensitivity of the pulse oximetry was 100%, cold test 81%, electric pulp test 71% in a study reported by Abd-Elmeguid and Yu.

Our present study results correlate with the values reported by Gopikrishna where the mean oxygen saturation value for maxillary central incisor was 79.31 (SD = 3.07), for maxillary lateral incisors 79.61 (SD = 2.73) and for maxillary canines 79.85 (SD = 2.09).

The explanation for lower oxygen saturation values in teeth compared to the finger can be that the diffraction of infrared light by the enamel prisms and dentin may cause decrease in oxygen saturation values and light scatter through the gingiva.

Although many researchers reported pulse oximeter as a reliable method for vitality test of the pulp it hasn't become routine yet. The probable cause would be all of them required the modification of the probe. So search for commercially available probes which would adapt to the teeth without modification led us to select the current equipment with this probe which served and justified the purpose.

This study proved the efficacy of pulse oximeter to be a reliable tool in diagnosing vitality of pulp. A consistent oxygen saturation values were obtained from all vital teeth and no oxygen saturation were seen in all nonvital teeth.

Conclusion

Pulse oximeter evidences as an accurate method for evaluating the pulp vitality compared to contemporary methods.

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