

ORIGINAL RESEARCH

Comparative Study of Pulp Vitality in Primary and Young Permanent Molars in Human Children with Pulse Oximeter and Electric Pulp Tester

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ABSTRACT

Aim and objective: The purpose of this study was to compare the pulp testing methods (pulse oximetry and electric pulp test) in primary and young permanent teeth of children.

Materials and methods: The study included a total of 155 children aged 4 to 15 years. Twenty children formed control group I. Study group included all healthy, 85 primary 2nd molars in group II and 85 permanent 1st molars in group III. Fifty children needing endodontics treatment formed test group IV. The readings were recorded as true positive (TP), false positive (FP), true negative (TN), false negative (FN). Based on this, the sensitivity, specificity, positive predictive value and negative predictive value were calculated for each method. The results were statistically analyzed using Chi-square test.

Results: On comparing pulse oximetry with electric pulp test 'p-value' was found to be 0.487 and 1.00 for groups 1 and 2 respectively and was statistically not significant. Whereas 'p-value' for groups 3 and 4 was < 0.0001 and 0.003 respectively and was statistically highly significant.

Conclusion: The present study indicates that pulse oximetry can be used as a routine method for assessing the pulp vitality in primary, young permanent and mature permanent teeth.

Keywords: Electric pulp tester (EPT), Pulse oximeter, True positive (TP), True negative (TN), Vitality.

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INTRODUCTION

The vitality of a pulp is function of vascular supply of the pulp within a tooth, and pulpal circulation is true determinant of pulp vitality. The assessment of pulpal status is a diagnostic challenge in clinical practice. An accurate diagnosis is important to achieve a good treatment outcome. The conventional pulp testing methods include thermal stimulation, electrical or direct dentin stimulation fall short of ideal pulp vitality testing as they indirectly monitor pulp vitality by measuring neural responses.¹ A new approach to determine vital pulp tissue by optical technology includes dual wavelength spectrophotometry, Pulse oximetry, Laser doppler flowmetry, transmitted light-photoplethysmography. These tests are noninvasive, objective, painless and are very sensitive to detect pulp blood components or blood flow.²

The present *in vivo* study was undertaken to evaluate and compare pulse oximeter and conventional pulp testing method (EPT) to assess pulp vitality in primary 2nd molar and young permanent 1st molar.

MATERIALS AND METHODS

The present *in vivo* study was conducted in the Department of Pedodontics and Preventive Dentistry, ITS—CDSR, Muradnagar, Ghaziabad. Material used: Pulse oximeter with modified ear probe (Nellcor OxiMax) (Figs 1 and 2), Electric Pulp Tester (Gentle-Pulse, Parkell Electronics Division) (Fig. 3), Electrolyte media (toothpaste), cheek retractor, cotton rolls, disposable gloves.

METHODS OF COLLECTION OF DATA

The selection criteria in study group include children that are positively positive on Frankel rating scale between the age group between 6 and 8 years and teeth to be free of caries, restoration, trauma and developmental defect. Patients with any illness (epileptic, mentally challenged), periodontal or periapical pathology in the concerned tooth were excluded.



Source of Data

One hundred and fifty-five cooperative children aged 4 to 15 years were divided into 4 groups. Group I (Control Group) 20 endodontically treated primary 2nd molars and permanent 1st molars. Group II (Study Group) included all healthy, eighty-five primary 2nd molars. Group III (Study Group) included all healthy, eighty-five young permanent 1st molars. Group IV (Test Group) included 50 teeth in need of endodontic treatment. After completing pulp vitality testing, the pulp chamber in test group teeth were opened for direct visual inspection.

MATERIALS AND METHODS

Prior to the study, Ethical clearance and informed consent was taken. Systemic oxygen saturation (SaO₂) of left index finger was measured first. Thereafter, ear probe of pulse oximetry was firmly placed on buccal surface on middle of the clinical crown for 30 seconds (Figs 4 and 5). Pulse oximetry value above 75% oxygen saturation was taken positive.

In electric pulp testing tooth was dried and isolated. Electrode was placed on middle of the clinical crown after toothpaste application³ (Fig. 6). The response at any level was scored as positive. No response to electrical test was scored as negative. Gloves were not worn during the test.

The readings were recorded as true positive (TP), false positive (FP), true negative (TN), false negative (FN). Based on this, the sensitivity, specificity, positive predictive value and negative predictive value were calculated for each method. Chi-square test was applied to determine statistical difference between pulse oximetry and electric pulp tester in all the four groups.

RESULTS

The pulse oximetry test identified all the endodontically treated nonvital teeth as nonvital, in group I. All the vital, primary 2nd molars and young permanent 1st molars were identified as vital, in groups II and III respectively. The pulse oximetry test gave 1 false negative reading, in group IV (Table 1).



Fig. 1: Pulse oximeter



Fig. 2: Ear probe



Fig. 3: Electric pulp tester



Fig. 4: Recording oxygen saturation



Fig. 5: Recording SaO₂ value



Fig. 6: Recording electric pulp tester response

Table 1: Distribution of response to pulse oximetry test in groups I to IV

POxi	TP	FP	FN	TN
Group I	170	0	0	20
Group II	85	0	0	10
Group III	85	0	0	10
Group IV	39	0	1	10

(TP: True positive; FP: False positive; FN: False negative; TN: True negative)

Table 2: Distribution of response to electric pulp test in groups I to IV

EPT	TP	FP	FN	TN
Group I	153	2	17	18
Group II	85	1	0	9
Group III	68	1	17	9
Group IV	35	5	6	4

(TP: True positive; FP: False positive; FN: False negative; TN: True negative)

Table 3: Comparison between pulse oximetry and electric pulp test in groups I to IV

POxi vs EPT	p-value	Level of significance
Group I	0.487	NS
Group II	1.00	NS
Group III	< 0.0001	HS
Group IV	0.003	HS

(NS: Not significant; HS: Highly significant)

The electric pulp test identified 18 of the 20 endodontically treated non-vital teeth as non-vital, whereas 2 endodontically treated teeth gave false positive responses, in group I. All the vital, primary 2nd molars were identified as vital, in group II. Of the 85 vital young permanent 1st molars the electric pulp test identified 85, whereas 17 vital teeth gave false negative responses, in group III. The electric pulp test gave 11 false responses, in group IV (Table 2).

On the basis of these findings, the sensitivity, specificity, positive predictive and negative predictive values, accuracy and level of significance (p-value) were calculated for each method in Tables 3 and 4 respectively.

DISCUSSION

The assessment of pulpal status accurately is important to achieve a good treatment outcome. All conventional vitality tests determined functioning of the nerves. The nerve response to stimulus may not be the true determinant of

the pulp vitality^{2,4} as the life of the pulp tissue is dependent on the blood supply and not on nerve functioning, thus are not indicative of the vitality of a pulp.⁴ Among all the conventional vitality tests, EPT was found to be the relative effective method for checking the vitality of the pulp tissue of a tooth.⁵ Studies by Reynolds⁶ and Petersson⁷ also supported this fact.

The newer pulp testing devices, such as laser Doppler flowmetry, dual wavelength spectrophotometry, pulse oximetry and light photoplethysmography are noninvasive, objective and have shown more accurate results by detecting the blood supply of the pulp. The pulse oximeter is an affordable, reliable and easily available equipment for an average dental office.² Hence, these two methods were selected for the study.

All the 20 endodontically treated primary 2nd molars and permanent 1st molars recorded SaO₂ values of 0% with pulse oximetry. Studies by Goho C⁸ and Gopikrishna⁹ also recorded 0% SaO₂ values on known endodontically treated primary teeth.

The present study showed that all the healthy 85 primary 2nd molars (Group II) and 85 permanent 1st molars (Group III) provided consistent oxygen saturation readings with pulse oximeter. Studies by Gopikrishna,⁹ Goho C,⁸ Cali¹⁰ and Gopikrishna¹¹ have also shown consistent oxygen saturation reading in all vital teeth with pulse oximeter. This demonstrates the ability of the pulse oximeter to differentiate between vital and non-vital teeth.



Table 4: Comparison of sensitivity, specificity, positive predictive value, negative predictive value and accuracy in groups I to IV

Groups	POxi					EPT				
	Sensitivity	Specificity	PPV	NPV	Accuracy	Sensitivity	Specificity	PPV	NPV	Accuracy
I	1.00	1.00	1.00	1.00	1.00	0.90	0.90	0.98	0.51	0.90
II	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.98	1.00	1.00
III	1.00	1.00	1.00	1.00	1.00	0.80	0.90	0.99	0.35	0.80
IV	0.98	1.00	1.00	0.91	1.00	0.85	0.44	0.87	0.40	0.78

(PPV: Positive Predictive Value; NPV: Negative Predictive Value)

Group IV has shown one FN reading with SaO₂ value of 0%, whereas surgically exposed pulp showed sign of normal bleeding. In a study by Gopikrishna, out of 38 vital teeth in need of endodontic treatment, the pulse oximetry test identified 36, whereas two of the vital pulps did not show SaO₂ to pulse oximetry.¹ Motion artefact or non-parallelism of probes have been suggested as possible reasons for false reading (Kahan).¹²

In electric pulp testing group 1 showed 10% of false response. Whereas, group II gave 100% positive responses. In young permanent 1st molars EPT showed 20% false responses. Reason for false negative responses in young permanent 1st molars could be—the increased electrometric threshold value in teeth with incomplete root formation, and neural development is incomplete in immature teeth.¹³

Total of 11 out of 50 affected due to disease/trauma showed false responses with EPT. EPT has shown 22% failure. Gopikrishna has found a failure of 18.7% and Petersson has found 18.6% on diseased teeth with EPT. False responses with electric pulp testing could be—traumatized teeth, teeth with incomplete root development, teeth undergone orthodontic tooth movement, pulp canal calcifications. Or the periodontal membrane response because of conduction along the moist surface of the tooth, multirooted teeth, patient's anxiety.^{14,15}

In group I (endodontically treated teeth), the sensitivity of pulse oximetry and electric pulp test was 1.00 and 0.90 respectively. The sensitivity of pulse oximetry and electric pulp test were 1.00 in group II (mature teeth). In group III (immature teeth) sensitivity were 1.00 and 0.90 respectively with pulse oximetry and electric pulp test and 0.98 and 0.85 respectively with pulse oximetry and electric pulp test in group IV (diseased teeth). The sensitivity of the pulse oximeter in a study of Gopikrishna¹ was found to be 1.00, as compared to 0.71 with the electrical test on diseased teeth.

In the present study, the specificity of the pulse oximetry and electric pulp test was 1.00 and 0.90 for groups I, II and III. The specificity of the pulse oximetry and electric pulp test in group IV were 1.00 and 0.44

respectively. The specificity of the pulse oximeter in a study of Gopikrishna¹⁵ was found to be 0.95, as compared to 0.92 with the electrical test on diseased teeth.

Goho C⁸ evaluated pulp vitality in primary and immature permanent teeth using pulse oximeter and found both sensitivity and specificity to be 1.00. Shender¹⁶ has concluded the same results with pulse oximeter from his review.

Consistent pulse oximeter readings in this study confirm that pulp circulation and blood oxygen saturation can be detected by pulse oximeter and may be used as a standard and as an indicator of pulp vitality irrespective of the health of tooth, the status of development of tooth, type of dentition and status of disease. Electric pulp testing has a reasonable reliability in primary dentition to evaluate its status of health but it has not been found effective in conditions where the pulp is affected by either a disease process or trauma. Thus, pulse oximeter can be used as an effective diagnostic aid in clinical practice.

CONCLUSION

This study shows that pulse oximeter is an objective, very sensitive and noninvasive method that can be used as a routine method for assessing the pulp vitality in primary, young permanent and mature permanent teeth. Furthermore, an accurate and immediate diagnosis of pulpal status in traumatized teeth is possible with pulse oximetry. There is a need to evolve the data to suggest saturated oxygen value of the pulpal tissue in terms of percentage as an indicator of the health or disease of the pulp.

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