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Research Article

# PULP VITALITY TESTS IN DECIDUOUS TEETH - A COMPARATIVE EVALUATION –AN IN VIVO STUDY

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## ABSTRACT

Diagnosis is the first step of an adequate treatment and methodical and disciplined approach, along with a good measure of patience, will help to establish it. Traditionally, the dentists have relied on testing methods designed to reproduce symptoms associated with pulpal pathosis. Unfortunately, these tests fall short of the ideal pulp vitality testing on several criteria. This study explores the reliability of pulp testing methods in deciduous teeth using thermal test, electrical test and pulse oximetry and compared applicability and reliability of visual analogue and verbal pain scales for recording discomfort/pain.

**Keywords**: Pulp Vitality Test, Gutta Percha, Ethyl Chloride, Electric Pulp Tester, Pulse Oximetry, Visual Analogue and Verbal Pain Scales

## INTRODUCTION

The assessment of pulp vitality is a crucial diagnostic procedure in the practice of dentistry. Traditionally, the dentists have relied on testing methods designed to reproduce symptoms associated with pulpal pathosis which include thermal stimulation, electric stimulation or direct dentin stimulation (test cavity)[1]. Unfortunately, these tests fall short of the ideal pulp vitality testing on several criteria.Thermal or electric testing of only the pulp neural response may lead to false positive results if only the pulp vasculature is damaged. For the electric and thermal testing to be effective, the pulp must have a sufficient number of mature neurons.[1] However, both the primary and young permanent teeth are not fully innervated with the neural components, which are responsible for the pulpal pain response, thereby more susceptible to obtain negative results from the tests.

On the other hand a moribund pulp may give a positive reaction to one of the above tests as the nervous tissue may continue to function in extreme state of disease[2].

Electrical stimuli may induce action potentials in nerves outside the pulp or in adjacent teeth and assessment of a patient's response to these tests is therefore open to misinterpretation[3,4]. Thermal and electric tests are difficult to administer or inconclusive when used in children as these tests are subjective tests that depend upon perceived response of the patient to a stimulus, as well as the interpretation of that response by the dentist[5]. All these pain-rating scales are valid, reliable and appropriate for use in clinical practice although the Visual Analogue Scale has more practical difficulties than the Verbal Rating Scale or the Numerical Rating Scale as the problem of vocabulary limitation might be there. For simplicity patients prefer the Verbal Rating Scale, but it lacks sensitivity and the data it produces can be misunderstood as it is limited by choice of words and is sensitive to gender differences[6].

## MATERIALS AND METHODS

60 children in the age group of 6-10 years, reporting to the Department of Pedodontics and Preventive Dentistry were considered for the study.

Subjects who posed at least one clinically sound maxillary deciduous canine were selected keeping in view its easy accessibility, isolation and least likely to have pulpal disease[7].

Intra oral periapical radiograph of the selected tooth was made in order to exclude subjects with canine that had pathology and undergone physiological root resorption more than one third of its length. Children with presence of any

developmental defects, history of trauma or systemic disease were not considered for the study[1].

Each of the selected subjects underwent four pulp vitality tests using-

- Ethyl Chloride
- Gutta Percha stick
- Electric Pulp Tester
- Pulse Oximeter

The study was carried out in 2 phases.

**PHASE – I-** Each tooth was subjected to true and sham tests except for the pulse oximeter test where only true test was conducted. The order for sham and true test was randomized by asking the subject to draw one of the 60 envelops which had a slip indicating either 'sham-true' or 'true-sham' which were 30 each in number.

**PHASE – II-** 2% lignocaine hydrochloride topical anesthetic gel was applied on labial aspect of the tooth to be tested, 3mm cervically from the gingival margin.[7] The applied gel was wiped off 3 minutes after application following which, sham and true tests were conducted.

A minimum of 2 minutes[7] time interval was kept between Sham and True test while, time interval of 10 minutes was placed between each of the four pulp vitality tests to be conducted.[8]

**(I) Ethyl Chloride Spray Test**

In true test one end of a double ended ear bud was saturated with ethyl chloride spray outside the range of subject's vision. The bud was held back until it was frosty, following which, it was applied on the middle third of the labial surface of the canine[9,10]. An interval of 2 minutes was allowed to minimize the influence of one test over the other. Sham test was carried out with the application of the dry end of the cotton bud. In both true and sham application, the cotton bud was held in contact with the tooth for a maximum of 10 seconds or until a sensation was reported by the subject

**(II) Heated Gutta Percha Test**

Following isolation and drying the tooth a layer of Vaseline was smeared on the labial surface of the tooth to avoid sticking of gutta percha to the surface. One end of the gutta percha stick was heated on flame out of the subject's sight to the point till it was softened and just began to glisten[11,12]. Heated gutta percha stick was gently applied on middle – third of the labial surface for 10 seconds or until a sensation was felt, which ever was earlier[13].

In Sham test, the gutta percha stick was placed on the tooth surface without heating it.

**(III) Electric Pulp Test**

After cleaning the probe of electric pulp tester with alcohol, an electrolyte was applied and placed on middle third of the labial surface of the tooth. To assure completion of the circuit, subjects were asked to be in touch with the metal strip of the pulp tester throughout the test period[14,15]. The rate of increase in intensity was standardized to one numerical per 5 seconds[9].

In Sham test, the electrode tip of the pulp tester was placed on the tooth surface, but without activation for a period of 30 seconds.

**(IV) Pulse Oximeter**

Pulp testing was carried out with BPL CLEO 5529S pulse oximeter using the ear probe OxiMax Dura-Y D-YS. Reading for oxygen saturation was noted on the index finger of each subject which was kept as a gold standard for comparison of the readings obtained on teeth[9,16,10]. Probe modified to fit closely to the tooth surface was placed on the labial surface in middle third of the crown. Care was taken to place the sensor on the palatal surface so that the red - infrared rays passed from labial to palatal surface through the middle of the crown thereby; creating a long axis that was perpendicular to the axis of the crown[1]. Each tooth was evaluated for 30 seconds following which the readings were recorded.

Readings obtained on the pulse oximeter and response as expressed by the subject in various tests on Verbal Pain Scale and Visual Analogue Scale was recorded.

## RESULTS

**Observations made in Ethyl Chloride Spray Test [ECS] are as follows:**

**Phase I**

On Visual analogue scale (VAS) the range varied from 1-5 for true sham with mean being 1.22(±0.715), whereas for sham true the range was 0-1 with 0.02(±0.129) being the mean. (Graph 1)

The difference in mean between true sham and sham true on VAS was found to be statistically highly significant. (t=14.697) (p=0.001**)

**Phase II**

VAS recorded a range of 1-5 for true sham with mean being 1.17(±0.615), while the range observed was 0-1 with 0 .02(±0.129) being the mean for sham true. (Graph 2)

Paired t-test showed the difference between true sham and sham true on VAS to be statistically highly significant. (t=17.292) (p=0.000**)

**Comparison of true sham in Phase I and Phase II on VAS**

The mean recorded for true sham in phase I was 1.22(±0.715), while the same was 1.17(±0.615) in phase II. Paired t- test showed the difference to be statistically non – significant. (t=1.000) (p = 0.321)

**Observations made in Heated Gutta Percha Test [HGP] are as follows:**

**Phase I**

Mean observed on VAS for true sham and sham true was 1.80(±0.953) and 0.02(±0.129) respectively, with the range varying from 1-5 for true sham and 0-1 for sham true. (Graph 1)

The difference observed in mean of true sham and sham true was found to be statistically highly significant. (t= 15.286) (p = 0.001**)

**Phase II**

The range and mean as recorded for true sham was 1-5 and 1.80(±0.953) respectively, whereas for sham true the range was 0-1 with mean being 0.02(±0.129) on VAS. (Graph 2)

A statistically highly significant (t=15.286) (p=0.001**) difference was recorded between the means of true sham and sham true on VAS.

**Comparison of true sham in phase I and Phase II on VAS**

A mean of 1.80(±0.953) for true sham was recorded both in phase I and phase II. The difference was found to be statistically insignificant as the correlation and t - value could not be computed for the standard error of the difference being 0.

**Observations made in Electric pulp Test [EPT] are as follows:**

**Phase I**

VAS recorded range of 1-5 and mean value of 1.65(±0.709) for true sham, whereas for sham true 0-1 and 0.02(±0.129) was the observed range and mean respectively. (Graph 1)

The difference in mean of true sham and sham true was found to be statistically highly significant (t=19.864) (p= 0.001**) on VAS.

**Phase II**

The range for true sham on VAS varied from 1-5 with mean of 1.63(±0.712), whereas for sham true the range was 0-1 with the mean value being 0.02(±0.129). () (Graph 2)

The difference in mean of true sham and sham true was found to be statistically highly significant. (t=19.560) (p=0.000**)

**Comparison of true sham in Phase I and Phase II on VAS**

On VAS for true sham the mean recorded was 1.65(±0.709) in phase I while the same was 1.63(±0.712) in phase II. The difference observed was statistically non – significant. (p = 0.321) (t =1)

**Observations made in Pulse Oximetry are as follows:**

Percentage of blood oxygen saturation as recorded on the index finger for tested subjects was in the range of 97.50-99.90 with the mean value being 98.7900(±0.51477), whereas on the tooth tested the mean was 81.1117(±5.13305) with the range varying from 71.60 - 90.00. (Graph 3)

**Observations made on inter- comparison between true sham of ECS, HGP and EPT:**

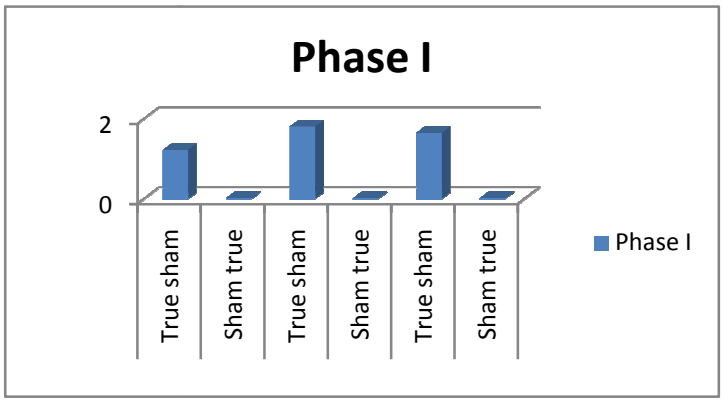
In phase I on VAS the difference between mean of ECS with that of HGP (p= 0.001**) was found to be statistically highly significant whereas it was statistically significant when compared to EPT (p= 0.010**)

The difference in mean on VAS was statistically non-significant (p = 0.918) between HGP and EPT.

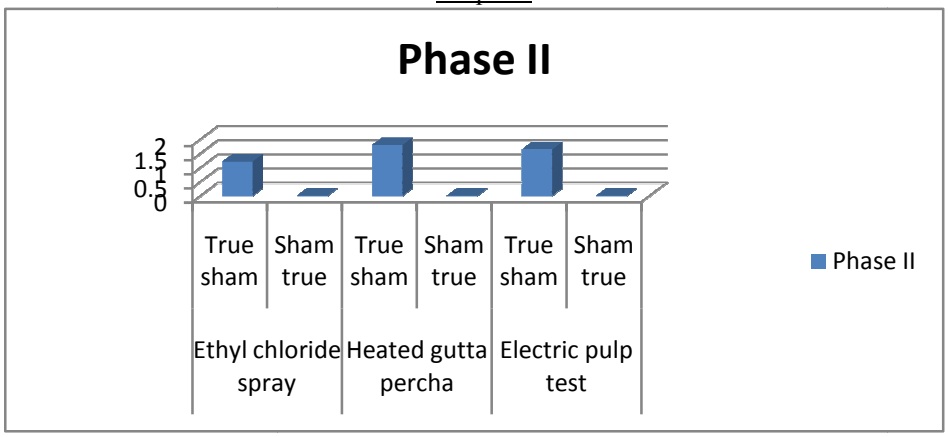
**Comparison between Visual Analogue Scale and Verbal Pain Scale**

Comparison of mean of VPS and VAS in three tests shows statistically insignificant results with p=0.908 for ECS, p=0.578 for HGP and p=0.640 for EPT. (Graph 4)

Graph 1

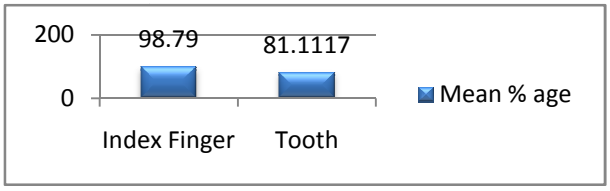


Graph -2

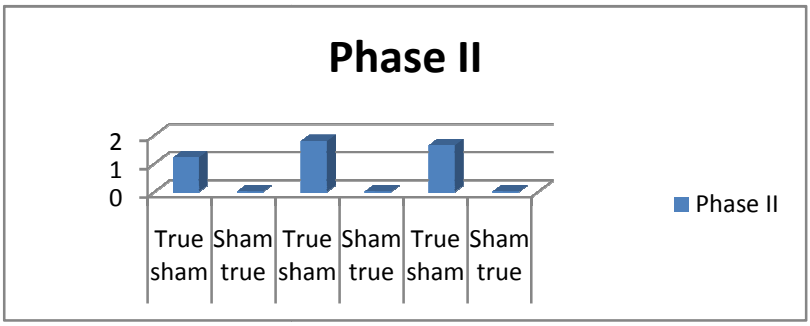


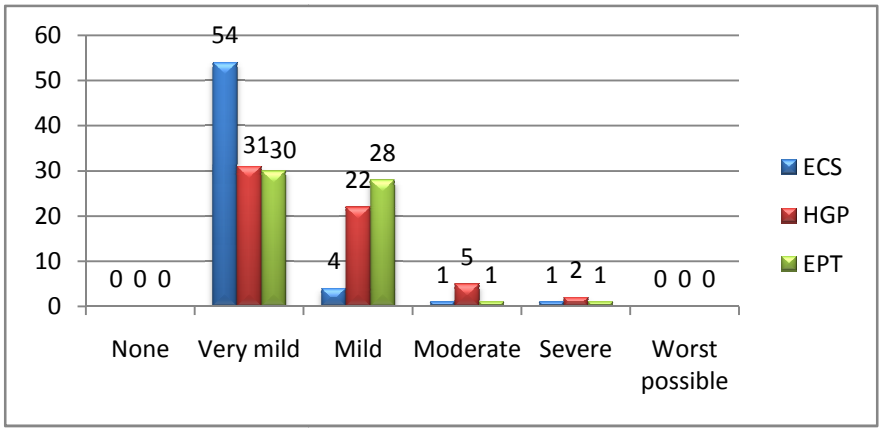

Mean value of blood Oxygen saturation level measured by Pulse Oximeter on Index finger & tooth

Graph-3




Number of subjects responded to different readings on VAS (Graph 4 & Graph 5)




## DISCUSSION

It is a established fact that vascular supply and not innervation is the most accurate determinant for assessing pulp vitality[17]. Pulp vitality purely being a function of the vasculature health, vital pulp with an intact vasculature may test non-vital if only the neural component is injured as in case of recently traumatized teeth. On the other hand, the pulp nerve fibers are more resistant to necrosis than the vascular tissue and thermal or electric testing of only the pulp neural response may lead in false positive results if only the pulp vasculature is damaged[9,10]. Most of the pulp tests carried out have the

potential to produce an unpleasant and occasionally painful sensation along with inaccurate results. Measure of pain depends either on objective signs such as facial expressions or on reports from the patient. Even though various scale can be used to describe different degree of discomfort/pain encountered during various pulp vitality testing procedures, Visual Analogue scale and Verbal pain Scale are considered to be simpler to use and is more acceptable to a young child.[7, 6]

***ECS*** – A cotton bud saturated with ECS which evaporates rapidly thereby cooling the tooth was applied on the middle third of the crown, which was the preferred site.[9, 10, 18, 12] VAS recorded lower values than HGP and EPT displaying that the pain experienced by the subjects was less than that of the other tests. All tested teeth responded positively for true sham and the time recorded to elicit a response was within 4 seconds following application which was in accordance to the results of the study conducted by Vincent et al. in 2002.[18]

***HGP-*** The test was carried out by applying the HGP stick on the middle - third of labial surface of the crown which is the preferred site[9, 10] as it usually results in response in less than 2 seconds.[12] In the present study higher values were recorded on VAS thus displaying that the pain experienced by the subjects was more than that experienced in ECS test and EPT. For true sham, all tested teeth responded positively and the time recorded to elicit a response was within 4 seconds following application which is in normal limits of 5 seconds as suggested by Cohen, 2002.[12]

EPT- Enables application of gradually increasing current on to the tooth. It produces impulses of negative polarity which is claimed to reduce the voltage required to stimulate a pulpal response [7] and avoid stimulation of the nerves in the periodontal membrane.[4] The mean value recorded for electric pulp test on VAS was found to be lower than that of HGP, but higher than that recorded for ECS thus displaying that the pain experienced by the subjects was less than that of the HGP but more than that of ECS. All tested teeth responded positively for true sham in the range of 3-5 with mean of 4 on the numerical scale of the electric pulp tester.

This is in accordance to studies by Asfour M.A. et.al, 1996 [7] who had standardized the pulp tester reading as 4 in their study. Our study demonstrated that the application of 2% lignocaine gel on the gingival margin had no significant effect on the results of the thermal and electrical tests, suggesting that the response obtained was through the tooth and not through the adjacent gingiva.Following thermal and electrical test the response obtained from the subjects were recorded on visual analogue and verbal pain scale. Visual analogue scales have been shown to be simpler to use and more acceptable to subjects.[7] The comparison of the mean recorded on VAS and VPS for both the thermal tests and the electrical test showed the difference to be statistically insignificant.

***Pulse Oximetry-***

Pulse oximeter is a non-invasive method that estimates the arterial haemoglobin saturation by measuring the light absorbance of pulsate vascular tissue at two wavelengths.[10] Systemic oxygen saturation values on the index finger of the subject was recorded which in our study served as the control for the comparison of oxygen saturation values of pulp. In this study oxygen saturation readings in the range of 71.60 - 90.00 with the mean value of 81.1117[± 5.13305] were recorded for the teeth tested, whereas the reading obtained from index finger was in the range of 97.50 - 99.90 with the mean being 98.7900[± 0.51477]. The difference in mean values recorded on tooth and finger in our study may be attributed to diffraction of the infrared light by the enamel prisms and dentin.[9] The comparison of mean of true sham of ECS with HGP and EPT was statistically highly significant. These scores showed that ethyl chloride spray produced less discomfort as compared to HGP and EPT and therefore can be considered more reliable.

## SUMMARY AND CONCLUSION

The observations are summarized as follows:

1) Pulp testing in deciduous teeth using thermal tests, electrical test and pulse oximeter resulted in positive response in 6-10 year old children.
2) Application of 2% lignocaine gel on the gingival margin did not effect the results of thermal and electrical tests.
3) Pulse oximetry is an objective and effective method of evaluating pulp vitality in deciduous teeth.
4) The comparison of VAS and VPS used for recording the patients response in thermal tests and electrical test showed both the scales to be reliable and easy to use in children for recording the pain/discomfort level.

Through this study it can be concluded that the pulse oximeter being an objective one, is independent of the patients response and could be regarded as a reliable method for pulp vitality testing. Since reproducible oxygen saturation values can be obtained, it has immediate clinical value by providing baseline clinical data and also assists to overcome the fear of obtaining false results as and when thermal and electrical test are considered

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