

Effect of Different Water-Based and Gel-Based Conductive Media on the Efficacy of Electric Pulp Tester

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ABSTRACT

Background: The Electric Pulp Tester (EPT) is a valuable diagnostic tool used in dentistry to assess the vitality of dental pulp. However, the effectiveness of the EPT can be influenced by the type of conductive media used during the test. This study aimed to investigate the impact of different water-based and gel-based conductive media on the efficacy of EPT.

Subjects and Methods: An Analytical observational study conducted at the School of Dentistry PIMS Islamabad. The Study period was six months from May to October 2022. Three different water-based and gel-based conductive media was applied on the 100 healthy maxillary central incisors to check the efficacy of EPT with different substances. The recorded data were analyzed through SPSS 21.0 for Windows.

Results: The mean age of study participants was 22.5 ± 1.2 . The ultrasound gel has the least pulpal sensory threshold 4.11 ± 1.26 . Independent t-test was applied to find the correlation between gender and preference of materials. P value <0.05 was significant.

Conclusion: The choice of conductive media used during Electric Pulp Tester (EPT) procedures has a significant impact on the efficacy of the test. Ultrasound gel has better electric conductance, and females have a less pulpal sensory threshold.

Keywords:

Electric pulp test, Dental pulp, Trauma, Dental Caries, Gel, Gender

INTRODUCTION

Early detection of dental diseases helps clinicians to employ the most conservative management strategies, avoiding potential consequences and costs that may develop if a disease is kept undetected and untreated for a longer length of time.¹ The assessment of pulp vitality is a fundamental aspect of the dental practice, as it aids in the diagnosis of pulp-related conditions and helps determine appropriate treatment strategies². A comprehensive history, clinical and radiographic assessment, along with special diagnostic tests are performed for diagnosis.³ Dental pulp tests are investigatory tools that offers useful diagnostic and treatment details directly to dental clinicians⁴. Various tests are used to evaluate the status of pulp. Pulp sensibility tests like thermal and electric have been employed to determine the status of the nerves within the dental pulp to identify pulpal health.⁵ The other vitality tests, such as laser Doppler flowmetry and pulse oximetry, that provide information related to dental

pulp blood circulation. However, these tests are not used in daily dental practice due to their high cost.⁶

One commonly used tool for pulp vitality testing is the Electric Pulp Tester (EPT), which measures the nerve response to electrical stimulation. The effectiveness of an EPT relies not only on the instrument itself but also on the conductive medium used to transmit the electrical signal to the dental pulp. EPT is a technique-sensitive procedure.⁷ This can be because a variety of factors influence the validity and application of EPT like correct application method, single tooth isolation, and conductive media.⁸ EPT is especially effective in elderly patients and teeth with reduced fluid flow via the dentinal tubules due to dentine sclerosis and pulp space calcification, because thermal pulp tests are frequently insufficient in these teeth.⁹

Producing the best response from an EPT is dependent on giving adequate stimuli, using the proper application method, and correctly interpreting the result produced.¹⁰ First and foremost, a conducive environment and a single tooth insulator are necessary. Conductivity guarantees that the maximum number of current travels from the electrode to the tooth's surface. As a result, a conducive contact medium is required.¹¹

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In recent years, various water-based and gel-based conductive media have been introduced, each with its unique properties and potential impact on the accuracy and reliability of EPT readings. These conductive media can be toothpaste, water, varnishes, colloidal graphite in alcohol, saline, inert oil, and electrode gel¹². Efficacy and pulpal sensory thresholds of electric pulp tester vary with different conductive media. Both gel-based and water-based substances can be used as conductive tools.¹³ However various studies concluded that Gel based media gives better conduction than saline and saliva which may give false positive results due to difficulty in placement and isolation.¹⁴ On the other hand gel-like material consistency can be easily placed on the tooth surface on a localized area. So, the current study is to find the best-conducting substance among readily available water-based and gel-based substances to evaluate the efficacy of an electric pulp tester.

MATERIALS AND METHOD

The study was conducted at the School of Dentistry SZABMU after taking ethical approval from SOD ethical review board, number SOD/ERB/2022/06. The study followed institutional and ethical principles. This Analytical observational study¹⁵ was registered on clinical trial.gov with approval number NCT05429606. The study period was 6 months from May 2022 to October 2022.

The required sample size of the study was 100 calculated through the WHO calculator by keeping the Confidence level is 95% with absolute precision of 0.50. The population mean is 5.8 and the population standard deviation is 2.2. The probability variance is 4.84¹⁶. Non-probability convenient sampling technique was utilized to raise the required sample size. Before starting the study written informed concern was taken from each participant. The participants included were 2nd year and 3rd-year dental students of the school of dentistry who voluntarily participate in the study.

The inclusion criteria of the study were healthy maxillary central incisor, fully erupted teeth, without any restoration and dental caries, and a history of previous dental trauma. The partially erupted, restored teeth with any pulpal and periodontal infection, and subjects with a history of bruxism, were excluded from the study. One of the central incisors of each participant was randomly selected by a coin toss. The selected tooth was first cleaned with pumice and water to remove any surface stains and deposits. The upper lip was retracted with cotton roll isolation, tooth surface

was dried with cotton and air. There was a total of 3 substances as conductive media including 1:Ultrasound gel(Eco Gel 200, Eco-Med Pharmaceutical) 2:Chlorohexidine gel(Clinica gel, Platinum Pharmaceutical) and 3: Toothpaste(Colgate max fresh; Colgate Palmolive company USA) (Table 1). All conductive media were applied to the same patient at random during a single visit. The Electric pulp tester (Digi test kit, Model no: D626D), monopolar and constant voltage type was used for the study. A coating of approximately 0.5mm medium was applied to the tester's stainless steel tooth probe to permit conduction from the probe tip to the tooth surface. The prob tip was first placed on the incisal third of the facial surface which is the most recommended location for anterior teeth. To ensure the electric conductive the circuit was completed by placing the EPT clip in the patient buccal vestibule. A stimulus was applied to the participant's tooth by pressing the EPT stimulus and adjusting the control button until the participant felt it. The participant was instructed to raise their hand when they felt the tiniest sensation. The reading was noted in a table each reading was noted twice with a difference of 60sec and the same interval was taken in the next material application. After the single test, the tip of the prob was cleaned with 70% alcohol gauze and the surface of the tooth was cleaned with water and dried with gauze and air spray. The same EPT device, lip clip, and probe will be used to ensure standardization in measurements.

The collected data were analyzed using SPSS 21.0 for Windows. Descriptive statistics, such as means, and standard deviations, were calculated for the variables of interest. Comparative analyses, such as independent t-tests were applied to find the significance of gender by application of different substances. The p-value <0.05 was taken as significant.

Table 1: Conducting media used in the study

Conductive Media	Active Ingredient
Ultrasound gel	Sodium Chloride, Potassium Bitartrate
Chlorohexidine gel	Chlorohexidine gluconate
Toothpaste	Sodium Fluoride, Water, Hydrated Silica,

RESULTS

A total of 100 dental students participated in the study, including 50 males and 50 females with an average age of 22.5 ± 1.2 . The pulpal threshold calculated by the EPT for ultrasound gel was 4.11 ± 1.26 , for chlorhexidine gel 4.72 ± 1.17 and for toothpaste was 5.62 ± 1.16 (Table 2). The lowest threshold was for the ultrasound gel.

Table 2: Pulpal sensory thresholds with different conductive materials in electrical pulp test

Conductive media	Pulpal sensory threshold mean \pm SD (min-max)
Ultrasound gel	4.11 \pm 1.26 (1-7)
Chlorhexidine gel	4.72 \pm 1.17 (3-7)
Toothpaste	5.62 \pm 1.16 (3-8)

Table 3: Comparative analysis of sensory thresholds of various conductive media according to gender

Conductive media	Male n=50	Female n=50	p-value
Chlorhexidine gel	4.76 \pm 1.13	4.68 \pm 1.21	0.735
Ultrasound gel	4.62 \pm 1.38	3.6 \pm 0.8	0.0001
Toothpaste	5.62 \pm 1.24	5.62 \pm 1.08	1.000

To determine the significance of any differences observed in the mean pulp threshold between the conductive media and gender an independent t-test was applied. the results are statistically significant for ultrasound gel $p < 0.005$. (Table 3)

DISCUSSION

Pulp testing plays a crucial role in dentistry as it helps dentists assess the vitality and health of the dental pulp, aiding in accurate diagnosis and treatment planning. The ideal pulp test should be accurate, noninvasive, sensitive, specific, cost-effective, efficient and acceptable for the patient. While achieving all these ideal characteristics may not be feasible for a single pulp test, advancements in technology and ongoing research aim to improve the accuracy, reliability, and patient experience associated with pulp testing. The Electric Pulp Test serves as a valuable aid in diagnosing pulp-related conditions and assists dentists in formulating appropriate treatment plans. Providing objective data on pulp vitality contributes to more accurate diagnoses and better patient care. The EPT relies on the fact that vital pulp tissue is innervated and can transmit sensory information. When a low-level electric current is applied, the patient may feel a tingling or mild sensation, indicating a responsive pulp. The other thermal test that is based on the subjective response can provide false results. A study by Salgar AR et al.¹⁷ reported that EPT tends to have higher sensitivity in detecting pulp vitality compared to thermal tests, especially in cases of partial pulp necrosis or early stages of pathology.

The present study evaluates the pulp threshold for electric pulp tests with different conductive materials. The distribution of gender in the study was balanced, with approximately equal representation of males and females like in other studies of pulp testing. A study by Emine Demir Serefli et al.¹⁶ shows properties of the conductive media can have some influence on the test

results and the gel consistency of materials shows better conductance than toothpaste. Our study also reproduces similar results with the lowest pulpal threshold by ultrasound conductive gel. The electrical conductivity of the conductive media can impact the transmission of the electric stimulus during the EPT. Both conductive gel and paste can be used as an aid for enhancing the transmission of the electric stimulus during the Electric Pulp Test (EPT). The choice between a conductive gel and paste may depend on several factors, including personal preference, availability, and the specific requirements of the dental professional. Conductive gel is a commonly used medium for improving electrical conductivity in EPT. It is a viscous, water-based gel that is easy to apply and provides good contact between the EPT device and the tooth surface. Conductive gels typically contain electrolytes or other conductive substances that help transmit the electrical current effectively. They are easy to spread and ensure consistent coverage. The current study utilizes the conductive gel that has the main component of sodium chloride and Potassium Bitartrate. The previous study of E. Chunchacheevachaloke et al¹⁸ uses the gel with the same composition that shows excellent coeducation and convenient application.

The conductive paste is another option for enhancing electrical conductivity in EPT. It is a thicker and more viscous substance compared to gel. Conductive pastes often contain a higher concentration of conductive particles or substances, such as silver or carbon, which facilitate better electrical conduction. The paste is typically applied between the EPT device and the tooth surface, ensuring good contact and efficient transmission of the electric stimulus. Our study also uses the paste for electric conductance with a mean conductance of 5.62 \pm 1.16 which is higher than ultrasound and chlorhexidine gel. the results are very close to the study of Nikita Sood¹⁹ for in vitro assessment of various conductive substances on the EPT. A study by Mickel, A et al.²⁰ uses a list of interface media by keeping dry teeth as a control group. He concludes the dry tooth does not show any electric conductance while the electrode gel had maximum conductance followed by chlorhexidine gel and sensitive toothpaste. Our study also uses similar materials and chlorhexidine gel has the second most excellent conductance followed by toothpaste.

The other important factor in the conductance of electric current in pulp testing is the effect of gender. Various studies show that there is no significant gender difference in the conductance. The results of our study

show that the pulpal threshold in females is less than in males and its value is maximum with the paste media. However, the study of Jespersen JJ et al. 21 shows there is no significant difference in gender on pulp testing. The high threshold in males can be due to the larger size of the crown with thicker dentin that may increase the time of current to reach the pulp by electric conductance of EPT. The underlying mechanism can be influenced by hormonal and neurological changes in both genders.

The study has a few limitations the study did not evaluate the cost-effectiveness of using different water-based and gel-based conductive media. Considering the economic implications of these media would be valuable for dental practices and patients.

CONCLUSION

The study underscores the importance of selecting appropriate conductive media for electric pulp testing procedures. It helps in the selection of appropriate conductive media that can influence the accuracy and reliability of the electric pulp tester results. This information can guide dental practitioners in choosing the most suitable conductive media for their clinical practice, potentially improving diagnostic accuracy and treatment planning. Building upon the current knowledge, further advancements can be made in this field, leading to enhanced diagnostic precision and improved dental care outcomes for patients.

Conflict of Interest

The authors affirm that they have no conflicts of interest to disclose about the research, authorship, and publication of this article.

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