

Effect of conducting media and gender on the functional efficacy of electric pulp test

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Abstract

Aim: To determine the pulpal sensory thresholds in human teeth using different conducting media and to check presence of gender based differences.

Materials and Methods: The study was performed on 40 maxillary central incisors in 40 healthy participants, 20 males and 20 age-matched females. The three conducting media tested were gel based product – Lox 2% Jelly and toothpastes- Sensodyne Repair and Protect & Meswak. The media were used in random order and each medium was tested twice on the tooth with 1 minute interval. The tooth probe of the tester was coated with a thin layer of the test medium and a stimulus was applied on the tooth until felt by the participant. At the faintest sensation felt by the patient, the sensory threshold value and the pain scores were recorded. The mean of the two threshold values for each conducting medium and the VAS scores were used for ANOVA followed by post hoc analysis.

Results: Sensory threshold values elicited by Lox 2% Jelly was significantly lower than the other conducting media ($P < 0.001$). Gender wise comparison revealed that males have a higher sensory threshold value. Significant difference was noted between male and female readings in Lox 2% Jelly group ($P = 0.003$) whereas highly significant difference was noted in Sensodyne Repair & Protect ($P < 0.001$) and Meswak groups ($P < 0.001$)

Conclusion: Pulpal sensory thresholds to electric stimuli generated by EPT differ according to the conducting media used and gender.

Keywords: Electrical conductance, Electric pulp test, Electrical stimuli, Pulp sensibility test, Sensory threshold.

Introduction

Disease identification in the initial stage allows for a conservative management protocol.¹ Unambiguous determination of pulp vitality or non vitality is essential for the successful diagnosis of endodontic pathology.² Certain pulp tests, along with a detailed patient history, clinical & radiographic examination aid in achieving the same.¹ Evaluating the blood supply within the dental pulp (pulp vitality) is the first and only available true yardstick to assess the actual state of pulpal health.³

Pulp sensibility tests (thermal and electric) are used to assess the condition of the nerves within the dental pulp and indirectly assess the pulpal health.⁴ Although, research depicts that cold test and electric pulp test (EPT) provide equally accurate diagnosis on status of pulp vitality in majority of the cases, EPT does have some limitations.^{5,6} A positive response is indicative of vital sensory fibers present within the pulp, but information regarding the health or integrity of the pulp is still inconclusive.⁷ Attempts to connect the EPT results to the histological condition of the pulp continue to be unclear due to a number of variables such as the conducting media, gender, patient and doctor related factors.^{5,8} A conducting medium is used between the tip of electric pulp tester and tooth surface for conductance and concentration of the electric field to invoke a threshold response from the patient. Mickel et al., stated that various conducting media used for EPT produced dissimilar

electrical conductance's as measured by a voltmeter.⁹ Hence, it may be stated that a weak conducting medium may cause false negative response in a tooth that is partially necrosed. Consequently a medium that permits maximum electrical conduction would allow a response at the lower threshold thus helping to determine the state of the pulp.⁸ A recent study has shown that type of conducting media and gender influence the sensory threshold response to electrical stimuli in human teeth.¹⁰ Hence, there is a need for further studies comparing various conducting media and their ability to evoke pulpal sensory thresholds.

Accordingly the present study aimed to determine the pulpal sensory thresholds in human teeth obtained using (i) Different conducting media such as Lox 2% Jelly, Sensodyne repair and protect & Meswak toothpastes and (ii) Presence of gender based differences. Null hypothesis is that there will be no significant difference in pulpal sensory thresholds obtained by using different conducting media and that there will be no significant gender based differences.

Materials and Methods

The study was conducted in the Post Graduate clinic of the Department of Conservative Dentistry and Endodontics, The Oxford Dental College, Bangalore and was approved by the Institutional Ethics Committee. The undergraduate dental students of the college were enrolled as participants after

obtaining informed consent. Inclusion criteria included fully erupted teeth, devoid of caries, restorations, periodontal diseases, and with no history of trauma. Participants with any type of cardiac pace makers or those taking pain killers or any other medications were excluded from the study.

Study Protocol

Double blinded model was used where both the operator and the participant were blinded. A third person randomly selected the test media by drawing chits placed in a box containing the name and number of the test medium.

The study was performed on 40 maxillary central incisors in 40 healthy participants, 20 males and 20 age-matched females. One maxillary central incisor was randomly selected by the toss of a coin. The three conducting media tested were gel based product – Lox 2% Jelly and toothpastes- Sensodyne Repair and Protect & Meswak. Different conducting media were used in random order and each medium was tested twice on the tooth with 1 minute interval. One min interval was allowed between each stimulus to prevent the occurrence of nerve accommodation.¹¹

Firstly, the tooth surface was cleaned with pumice slurry and dried thoroughly following which cotton rolls were used to retract the upper lips. The Electric pulp tester (Digitest kit, Model no: D626D), monopolar and constant voltage type was used for the study. The stainless steel anterior tooth probe of the tester was coated with a thin layer of the test medium to allow electrical conduction from tooth probe to the tooth surface. The tooth probe tip was placed on the incisal third of the tooth.

Conscious effort was made to ensure that test medium thickness did not exceed 0.5 mm, and that the EPT probe's position on the tooth remained same each time during the experiment. The lip clip was placed in the participant's buccal sulcus to complete the circuit. A stimulus was applied on the tooth by pressing the stimulus adjusting control button of EPT until felt by the participant. The participant was asked to respond at the first felt faintest sensation by raising hand. The participants were asked to rate the sensation felt after each stimulus using a simple visual analogue scale (VAS) calibrated from 0 (no sensation) to 10 cm (the most severe pain) as there may be variations between the intensity of stimulus generated by EPT tip and the sensation evoked by different patients at threshold.^{12,13}

The test medium was completely removed from the tooth surface before each succeeding test with 70% alcohol, followed by cleaning with water and blow drying. The values elicited by the EPT were in the range of 0-64 and their corresponding values in micro Amperes were recorded by connecting the EPT tooth probe and lip clip to a digital multimeter's

(Mastech Model no: M92A) positive and negative electrode respectively. The mean of the two threshold values for each conducting medium and the VAS scores were used for statistical analysis.

Anova followed by post hoc analysis was done. P value of <0.05 was considered as statistically significant.

Results

Results of ANOVA revealed highly significant difference ($P < 0.001$) in sensory threshold reading of the three media. Post hoc analysis revealed highly significant difference between Lox 2% Jelly and Sensodyne Repair & Protect ($P < 0.001$) Highly significant difference between Lox 2% Jelly and Meswak ($P < 0.001$) but no significant difference between Sensodyne Repair & Protect and Meswak ($P = 0.77$).

Gender wise comparison revealed significant difference in sensory threshold between male and female readings in Lox 2% Jelly group ($P = 0.003$) where as, highly significant difference in Sensodyne Repair & Protect ($P < 0.001$) and Meswak group ($P < 0.001$). There was highly significant difference in VAS scores between male and female readings in Lox 2% Jelly, Sensodyne Repair & Protect and Meswak groups ($P < 0.001$).

Discussion

In the present study, the test materials used included a topical anesthetic gel and two tooth pastes, as they are readily available in a dental set up. Meswak toothpaste was included as a test medium as there is no literature to date, comparing the electrical conductivity of herbal toothpastes which are popular in Indian subcontinent. The results of the present study demonstrate a significant difference in pulpal sensory thresholds for different conducting media used with EPT. Hence, the first null hypothesis stating that there will be no significant difference in pulpal sensory thresholds obtained from using different conducting media was rejected. Lox 2% Jelly showed the least sensory threshold value while Meswak toothpaste showed the maximum, depicting that gel based Lox 2% had maximum electrical conductivity among the media used. The results are in accordance with a recent study proving that water based gels conduct impulses better than toothpaste.¹⁰ The tip of the EPT electrode was placed on the incisal third of the central incisor as Bender et al stated that incisal edge of anterior teeth serves as optimal site for EPT tip placement.¹⁴

In a recent in vitro study a topical anesthetic gel, 20% benzocaine was used which proved to be inefficient conducting medium.⁹ But, anesthetic gel Lignox 2% used in the same study showed the best results. This disparity between Lignox 2% and benzocaine gels can be explained by the differences

in the molecular arrangement. Lidocaine, the chief constituent of Lignox 2% Gel has a higher dissociation constant causing it to be more ionic in nature than benzocaine.¹⁵ This increased ionic nature of lidocaine resulted in its improved conduction of impulse in the present study. Sensodyne Repair & Protect when compared to Meswak showed better electrical conduction. Conduction of impulse through a medium depends on factors such as viscosity and surface tension between the medium and the tooth surface. Lower the surface tension, better will be the adaptation of the medium to the tooth which may result in improved conduction.¹⁰ The constituents of the toothpaste may also affect the conduction of electric impulses from the pulp tester to the tooth. One example is Sodium carrageen an a sea weed product, which is an ingredient in herbal toothpastes like Meswak. It acts as a stabilizer. It is known to increase viscosity of the toothpaste which may negatively affect its ability of conduction.¹⁶

The present study results demonstrated that, the mean VAS scores and the analogous sensory threshold elicited were significantly higher in males than female counterparts. Hence, the second null hypothesis stating that there would be no gender based differences was rejected. A recent in vivo study showed a similar result.¹⁰ On the contrary it has also been demonstrated that there are no gender based differences in the threshold response.^{17,18}

The significant increase in sensory threshold and VAS score in males can be explained as follows: The increased thickness of dentin which accounts for increased crown dimensions causes the impulse to be applied for an increased period of time to reach the pulpal sensory nerves.¹⁹ Hence, resulting in increased sensory threshold and VAS score in males.

Gender differences in response to experimentally caused pain was researched with variables such as time/intensity of first felt sensation of pain, tolerance to painful stimuli-using patient questionnaires on gradation of pain and it was concluded that females were more sensitive to pain compared to males.²⁰ This difference may be due to sex hormones, in built mechanisms of pain modulation, psychological and social factors.²¹ Contrary to this study, a recent systematic review on gender differences in pain perception did not depict any noticeable pattern.²²

Pulp vitality is determined in its true sense by the vascular supply to the pulp. Presence of reactive A-delta fibres in the pulp chamber can be detected by an EPT but, no information on the pathological status of the pulp can be deciphered.⁷ Furthermore, EPT produces flawed results in scenarios like crowned teeth, teeth during and post orthodontic treatment, immature teeth, consumption of alcohol and narcotics.⁸ Moreover, as EPT works by stimulation of sensory nerves and relies on patient's judgement and interpretation of the impulse generated on to the tooth, the results elicited by patients are subjective and this can be a limitation of the present study.²³

In spite of its deficiencies, EPT remains a safe test and a valuable asset to clinical diagnosis in an endodontic set up.²³ Furthermore, the pulp vitality tests also have limitations, as they are complicated and technique sensitive for everyday use.²⁴ It can be said that presently, no single technique can reliably interpret and diagnose all pulpal conditions.⁸ Further research is warranted to fathom the association of threshold response and pulpal health. In this regard, use of an efficient conducting medium for EPT is essential to overcome the inconsistencies associated with it.

Table 1: Conducting media used in the study

| Conducting Medium | Manufacturer | Active Ingredient |
|---|--------------------------|--|
| Lox 2% Jelly | Neon Laboratories Ltd. | Lidocaine 2% |
| Sensodyne Repair and Protect Toothpaste | The GlaxoSmithKline plc. | Calcium sodium phosphosilicate (NovaminTM)Sodium monofluorophosphate |
| Meswak Toothpaste | Dabur India Ltd. | Salvadorapersica extract |

Table 2: Sensory threshold and VAS scores evoked by electrical stimulations using different conducting media

| Conducting Media | Sensory Threshold (μ A) | | | VAS Scale (1-10 cm) | | |
|---------------------------------------|------------------------------|----------------|----------|---------------------|---------------|----------|
| | Male (n =20) | Female (n =20) | P value | Male (n =20) | Female (n=20) | P value |
| | Mean (S.D) | Mean (S.D) | | Mean (S.D) | Mean (S.D) | |
| Lox 2% Jelly | 0.6571(0.0965) | 0.5737(0.066) | 0.003 * | 5.1250(1.0497) | 2.6000(1.112) | <0.001** |
| Sensodyne Repair & protect toothpaste | 0.9881(0.1494) | 0.7928(0.108) | <0.001** | 5.6750(1.4352) | 2.5225(0.927) | <0.001** |
| Meswak Toothpaste | 1.0239(0.1375) | 0.8008(0.091) | <0.001** | 5.6250(1.1341) | 2.5750(1.029) | <0.001** |

**-highly significant, *-significant, S.D- standard deviation.

Conclusion

Within the limitations of the present study, water based Lignox 2% Gel proved to be superior to toothpaste when used as a conducting medium for EPT. Sensory threshold to electrical stimuli elicited by EPT was significantly higher in males than in female counterparts. Therefore, pulpal sensory thresholds to electric stimuli generated by EPT vary according to the conducting media used and gender.

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