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Thresholds of vital premolar teeth to stimulation with Electric Pulp Tester in adults

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ABSTRACT

Objective: The study investigated the optimum electrode placement site in mature premolar teeth and the response threshold of these teeth using electrode pulp tester and also highlighted the effect of gender and age, and arch variables on threshold values., Study Design: Eighty sound premolar teeth in 20 adults aged 18-50 years were tested using an EPT to determine the thresholds at which a response was evoked at 5 sites of each premolar tooth., Result: In both arches, the mandibular first premolar teeth responded at al over threshold while the 18- 20 years age band had the highest value. However, gender effect was not statistically significant., Conclusion; Within the limitation of the study, the report will enhance clinical practice.

Key words: Electric pulp test, premolar teeth, mean threshold response.

INTRODUCTION

Electric pulp test (EPT) is a non-invasive diagnostic sensibility test whereby a pulsed electrical stimulus is applied on an isolated tooth for the purposes of determining a tooth's vitality. The assessment of the pulp vitality is an important diagnostic procedure in clinical dental practice. Many aids are in clinical use, including cold tests and warm tests[1]. The most recent methods are laser doppler flowmetry, dual wavelength spectrophometry, pulse oximetry and tooth temperature measurement [2-4].

The physiological basis for EPT rests on the stimulation of sensory nerves, mainly A beta and delta fibres in the pulp chamber with electric current [5]. These nerve fibres form bundles that divide and branch out towards the pulpo-dentine junction. The intensity of electrical stimulus is directly proportional to the nerve activation, resulting in a progressive increase in the sensory response. As a result, there is greater response in areas of highest neural density [5].

The draw backs associated with the use of EPT to evoke responses in human teeth had been reported by author [5,6,7]. Besides, the choice of the best EPTer is problematic, because of a confusing array of EPT types available [8]. Nevertheless, it is a safe clinical aid that can provide useful information regarding tooth's health and disease when properly used.

Literature shows that greater amount of electric current passes through an area where pulp tissue is thinner [10] and that maxillary teeth have higher threshold than the mandiblar teeth [6]. Lilja reported that neural element are most concentrated in the pulp horn region than elsewhere. Similarly, authors [6,7,12] unanimously agree on decreased concentration of nerve fibres in cervical and radicular areas of a tooth.

Also, it is of note that the distribution and the course of dentinal tubulues in a tooth are not

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uniform; the course is straight at incisal and cuspal edges and 'S' shaped elsewhere. Areas where tubules take a straight course tend to have low thresholds of electrical responses [6].

Grossman[13] showed that calcification of the root canal system due to aging may either block or raise threshold responses to electrical stimulus. Of note is that with age, there is decrease in the number of nerve fibres in the pulp [6]. This may be the result of increased depositions of reparative dentine. However, Segura Egea et al [15] warns that age related increase in thresholds is not to be attributed to change in the physiological pain system. Gender differences in pain show that women report more pain than men. Furthermore, there is lower threshold in women than men [15].

The study will provide a baseline; baseline thresholds serve as controls and controls are important when a clinician wants either to monitor tooth's vitality overtime or to compare the control with recordings from the test tooth prospectively or cross sectionally. It is hoped that the report will impact positively on EPTing as a diagnostic aid in endodontic practice. The purpose of the study was to investigate the optimum electrode placement site in matured premolar teeth and the response thresholds of these teeth using EPT. Also, the study highlighted the effect of gender and age, and arch variables on threshold values.

MATERIALS AND METHODS

The cross sectional randomized clinical study involving 80 sound permanent premolar teeth in 20 adults who attended a teaching hospital endodontic clinic over a period of 4 months were studied.

Four sound premolar teeth (a first and second premolar teeth from one arch side) were selected from each subject. The arch side, right or left, was selected by die throwing.

The investigation was carried out in the morning hours to eliminate the effect of diurnal variations in sensation threshold. Similarly, the study was explained to the subjects to minimise the Hawthorne effect. Earlier, preoperative bitewing and periapical radiographs of the teeth which had neither a history of recent ortherdontic treatment nor surferred from recent traumatic injury were taken. Additionally, mentally and emotionally unstable subjects, as well as those on "pain killer" in the last 24 hours were disqualified from the study.

The 4 premolar teeth (2 from either side of each arch) in the qualified subjects were isolated with cotton rolls and dried by a stream of compressed air; the test was conducted with a Digitest EPT (Parkell, Farmingdale, NY) in accordance with the manufacturer's instructions. The circuit was completed by the subject's finger on the EPT metal sheath, while the gloved researcher conducted the test.

A drop of normal saline was applied to the tooth electrode before each test, while a gentle pulsed electric current was applied to the tooth until a response was evoked. The threshold at which a response was perceived was recorded from EPT digital read out.

Five sites on the buccal surface (cervical, middle and coronal thirds, as well as buccal incline of the buccal cusp and lingual incline of lingual cusp) in each of the two study teeth were tested sequentially, allowing not less than a minute to elapse before revisiting same tooth so as to eliminate the so called phenomenon of nerve accommodation. Thus 5 recordings were generated and the means recorded. Also recorded were the age and gender of subjects, premolar type and the arch, as well as the threshold values at various sites.

The date were analyzed with SPSS, Version 6. Means of variable were compared with t- test, while critical level of significance was set at $P<0.05$.

Four hundred (400) readings and grand mean of 40.68 ± 22.04. EPT values were recorded from 80 premolar teeth. The population, male and female mean ages are

24.90 ± 5.42, 24.67 ± 5.28 and 25.00 ± 5.57, respectively.

In the mandibluar arch, the lingual incline of the lingual cusp placement site required the lowest electric current. (28.05 ± 19.08) to evoke a response, followed by the buccal incline of the buccal cusp placement site (30.63 ± 22.24). In constrat, a progressive higher stimulus is required to evoke a response from occlusal to cervical regions in both arches. On the maxillary arch, the least electric current was required to evoke a response in the buccal incline of the buccal cusp placement site (28.00 ± 18.82), followed by the palatal incline of the palatal cusp site (34.33 ± 23.48)

Table 1: Mean Thresholds by Site and Arch

ARCH	ELECTRODE PLACEMENT SITE				
	Occlusal Third	Middle Third	Cervical Third	Buccal incline	Palatal. Incline
Mandible	45.30 ± 20.84	49.60 ± 19.61	50.33 ± 19.52	30.63 ± 22.24	28.05 ± 19.08
Maxilla	41.58 ± 20.33	49.28 ± 19.58	49.70 ± 19.33	28.00 ± 18.82	34.33 ± 23.43
P-Value	P = 0.421 t = 0.81	P = 0.941 t = 0.07	P = 0.06* t = 0.14	P = 0.570 t = 0.57	P = 0.193 t = 1.31

(table 1).

In the mandible, the first premolar tooth responded at a lower threshold (36.39 ± 21.53) than the second premolar teeth (45.17 ± 22.20). The same trend was observed in the maxillary arch. However, in both arches, the mandibular first premolar teeth responded at a lower threshold (36.97 ±21.97), while the reverse holds for the second premolars in both arches (P>0.05) (Table

Table 2: Mean thresholds by Tooth Type and Arch.

ARCH	First Premolar Tooth	Second Premolar Tooth
Mandible	36.39 ± 21.53	45.17 ± 22.20
Maxilla	37.97 ± 21.97	43.18 ± 21.57
P-Value	P = 0.608 t = 0.51	P = 0.521 t = 0.64

2). The 21-30 year age band (36.98 ± 22.30) followed by the 31 -40 year age band (40.60 ± 24.78) responded at the lowest threshold in the mandible. The reverse trend was observed in the maxillary arch. In both arches, the highest threshold was observed in the 18-20 year age band (P>0.05) (Table 3).

In both arches and genders, threshold values were not significantly different (P> 0.05) (Table 4).

Table 3: Mean Thresholds by Age and Arch

Age (Years)	ARCH		P – Value
	Mandible	Maxilla	
18 - 20	51.53 ± 17. 98	50.40 ± 18.35	P = 0.783 t = 0.28
21 - 30	36.78 ± 22.30	37.78 ± 22.12	P = 0.920 t = 0.10
31 - 40	40.60 ± 24.78	37.65 ± 23.08	P = 0.583 t = 0.55
41 - 50	50 10 16.80	49.90 16.93	P = 0.958 t = 0.05

Table 4: Mean Thresholds by Sex and Arch

Gender	ARCH		P – Value
	Mandible	Maxilla	
Female	40.78 ± 22. 10	40.44 ± 21.79	P = 0.896 t = 0.13
Male	40.78 ± 22.78	40.90 ± 22.25	P = 0.977 t = 0.03
P- Value	P = 0.999 t = 0.06	P = 0.891 t = 0.14	

DISCUSSION

The present study found that electrode placement site on the premolar teeth cuspal inclines required lowest electric current to evoke a response. Previous reports [6,7,12] had found that in molar and anterior teeth, the mesio buccal cusp and the incisal third placement sites, respectively had lowest response thresholds.

The proximity of the pulp horn to the electrode tip is a common denominator in the studies under references.

A tooth is electrically stimulated when an adequate number of nerve terminals are activated to attain the so called summation effect [16]. It might be that these areas have high neural density, which made it possible for them to respond at lower threshold. Lilja's report [11] that

the pulp horns contain the highest concentration of neural elements, which progressively decreases cervically is in support of this.

Other factors which are in harmony with the lowest response threshold at the cusps and a progressive increase in response threshold in the cervical areas are the thickness of the enamel, the distance between the electrode tip and the pulp horn, as well as the course of the dentinal tubules. A thick enamel presents higher resistance to electric current flow and therefore a higher response threshold [6]. While the dentinal tubules are straight at the incisal and cuspal edges, they are curved and look like an 'S' in shape elsewhere6. It is the fluid in the dentinal tubules that conducts current and this explains the lowest response threshold at cusp placement sites [10]

Furthermore, the lowest response threshold may also be due to intimate relationship between the nervous structures and the odontoblastic processes coronally, while they are frequently unrelated on the cervical region [18].

It may also be that A delta and Beta fibres are more numerous at the cusp placement site and are progressively replaced by C fibres cervically [20]. The intensity of the electric current required to activate C fibres is three times that needed for A delta fibres [20].

The reported lower response threshold in the maxillary buccal incline of the buccal cusp than the palatal incline of the palatal cusp may be due to thinner enamel or higher concentration of underlying neural elements. Similarly, the same explanation may hold for the mandibular lingual incline of the cusp's lower response threshold over the buccal incline of the buccal cusp's response threshold.

Comparatively, in both arches, the first premolar tooth's response at a lower threshold than the second premolar tooth may be due to less pulp tissue content, higher concentration of neural elements or thinner enamel.

The lower response threshold in the 21-30 years age band than the 18-20 years age band may be attributed to the fully underdeveloped plexus of Rashkow in young teeth [17]. Many authors are in agreement [21] that EPT is often unreliable in testing immature teeth.

The present report agrees with the finding of Walkins et al [22] that subjects less than 35 years of age experience more pain than those 35 years or above. Higher response thresholds seen with advancing age may be due to calcification of the root canal system [14] associated with aging or irritation. Of note is that with age, there is decrease in the number of nerve fibres in the pulp [6]. This maybe the result of increased depositions of reparative dentine. However Sequra Eglea et al [15] warn that age related increased response threshold is not to be attributed to change in the physiological pain system.

The present report is at variance with the finding of Segura Egea et al that women report more pain than men and that women have lower response threshold than men [23,24]. This disagreement might be due to the fact that men might have been apprehensive during the test or that the Hawthorne effect was more on the women than men [12].

As several factors can affect the validity, reliability and reproducibility of EPT results, some of these limiting factors deserve discussion. A perfect diagnostic test would always be positive or negative according to prevailing circumstances12. However, false negative or positive results disturb this perfection in an EPT's ability to establish a diagnosis [12].

Reproducibility of most EPTers which are based on manual current increment are in question if several teeth are to be tested or if a comparison test is being carried out [25].

Because of the array of available EPTers, the issue of choice and reliability become problematic [26].

Results from EPT would be affected if a researcher fails to accommodate Hawthorne effect, phenomenon of nerve accommodation and

reaction time during an investigation.

The rate of current increase is a critical factor [26]. Slowly increasing the current produces no pain and it is a preferable rate, whereas a rapid current increase at the rate of more than 6μA a second would give pain and it is undesirable [27].

Finally, procedural errors such as inappropriate electrode placement, non usage of conducting medium, improper tooth isolation, as well as incomplete circuit completion etc would limit the usefulness of EPTs'.

CONCLUSION

The first premolar teeth in both arches have lower thresholds than the second premolar teeth. Further, the optimum electrode placement sites were the buccal inclines of the buccal cusp of the maxillary premolar and the pulatal incline of the lingual cusp of the mandibular premolar. The 21-30 year age band recorded the lowest threshold values in both arches, while no significant response threshold difference amongst genders was reported. Baring all limiting and confounding factors, the report will be valuable in clinical practice.

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