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The effects of type of tooth and the placement site of electrode on the electrical pulp testing of the anterior teeth

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ABSTRACT

The aim of this study is to evaluate the effect of type of the tooth and the placement site of electrode on electrical pulp testing of the anterior teeth. Twenty persons were participated in this study. The six maxillary and mandibular anterior teeth were checked to evaluate the response threshold to electrical pulp testing; each tooth was examined at four placement sites on its labial surface, which are the incisal edge, incisal third, middle third and the cervical third.

The results showed that the response threshold of the mandibular anterior teeth was lower than that of the maxillary anteriors. The canines may respond to the electrical stimulus in a highest threshold than the lateral incisors and the central incisors which had the lowest response threshold. Also, this study showed that the best placement site of electrode was in the incisal edge of the tooth and the pulp tester reading was increased as the electrode moved toward the cervical region of the tooth.

Key Words: Placement site, pulp tester, response threshold.

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INTRODUCTION

The electric pulp tester is a well known by dental practitioners as an effective mean to check the vitality of teeth. It acts by delivering a sufficient electrical current that overcome enamel and dentin resistance and stimulate the myelinated sensory nerve fibers (A–fibers) at the dentino–pulpal junction. The unmyelinated C–fibers are not responding to the pulp tester since they need greater current for stimulation.[1] Such stimulation will typically produce a non–painful sensation known as "pre–pain", which is difficult to describe in terms of other, more natural, sensations.[2] Abdullah[3] found that the electrical vitality testing is more reliable procedure than the hot and cold (thermal) testings and should be used by the dentist for proper diagnosis, except when there are limitations.

In addition to test the vitality of the dental pulp, the electric pulp tester may provide a better indication of the adequacy of local anesthesia for tooth restoration than is afforded by the traditional soft tissue signs.[4, 5] The amount of electric current passing through an area in the pulp is greater where the pulp tissue is thinner.[6] Bender *et al*.[7] studied the effect of the type of the tooth on the threshold response to electric pulp testing and found that the canine having the higher threshold of response than the incisors, and the maxillary teeth having higher threshold than the mandibular teeth. They correlated these findings to the thickness of pulp chamber.[7]

Testing teeth with the electric pulp tester needs the placement of the electrode on the tooth surface. Different opinions of authors are there about the best placement site of the electrode on the tooth surface. Jacobson[8] tried to determine the optimal electrode placement site on extracted teeth. The results indicated that the middle third region of the incisors required the

lowest level of electrical current of pulp tester.[8] Other authors found the same results of Jacobson, but the studies performed on patients (*in vivo* studies).[9, 10] Cooley and Robison[11] suggested the optimal electrode placement at the cervical third of the labial surface. Bender *et al*.[7] reported that the incisal edge gave the lowest threshold values of response to electric pulp testing.

The aims of the present study are to determine the best placement site of electrode of an electric pulp tester on the anterior teeth to evoke a response with the least amount of electrical current; and to determine which of the anterior teeth may respond to electrical pulp testing with the least threshold.

MATERIALS AND METHODS

Twenty persons ranging in age from 20 to 45 years were participated in this study. They were from the patients and staff members of the College of Dentistry, University of Mosul. Patients with incisal edge wear and any restorative work in their anterior teeth was not included in this study. The patients were instructed to raise one of their hands with the first perceived an abnormal sensation in the tooth. The anterior teeth of each subject were isolated with cotton rolls and dried with cotton gauze. Air dryness was not used because this may evoke pain in hypersensitive teeth. Dentotest TB09 electrical pulp tester (battery operated) (J Morita Corporation, Japan) was used to test the pulp vitality of the teeth. It was operated in accordance with the manufacturer's instructions. This unit operates on a fixed frequency, varying voltage principle with a measuring scale of calibrations numbered from 0 to 10. The six maxillary and six mandibular anterior teeth of each subject were examined. Four pulp tester readings were taken in a specific sequence at each of four test sites on the labial surface of the crown of each tooth as follows: The incisal edge, incisal third, middle third, and cervical third (Figure 1).

The data were entered into a computer and the analysis of variance was performed to compare the effects of different variables on the mean values obtained with the pulp tester. The variables included differences among maxillary and mandibular teeth, types of teeth and placement sites of electrode of the pulp tester.

Figure (1): Examination for pulp vitality at different placement sites of electrode

RESULTS

The total pulp tester readings were 960 readings for all the 20 subjects. The mean values of threshold response of the maxillary and mandibular teeth are shown in Table (1). The mean test value for maxillary teeth was 4.880 whereas the mean value for the mandibular teeth was 3.473. This difference was statistically significant at the $p<0.05$ level. In both the maxillary and the mandibular teeth, central incisors had the lowest response threshold. The response threshold of the lateral incisors was significantly higher than that of the central incisors and the canines had higher response threshold than the lateral incisors at the $p<0.05$ level (Table 2 and Figures 2 and 3).

The mean threshold responses for the different electrode placement sites of the maxillary and mandibular teeth are shown in Table (3). The results indicated that there was a significantly different threshold response at each of the four placement sites for the maxillary and mandibular teeth at the $p<0.05$ level (Figures 4 and 5 respectively).

Table (1): Comparison of the mean threshold response of the maxillary and mandibular anterior teeth

Arch	Mean ± SD	F–value	*p*–value
Maxillary	4.88 ± 1.487	61.90	0.000*
Mandibular	3.473 ± 1.292		

SD: Standard deviation

* Indicates significant difference exists at $p \leq 0.05$.

Table (2): Mean ± standard deviation of the different types of teeth of the maxillary and mandibular teeth

Arch	Central Incisor	Lateral Incisor	Canine	F–value	*p*–value
	Mean ± SD				
Maxillary	4.450 ± 0.998	5.041 ± 1.692	5.172 ± 1.606	2.76	0.048*
Mandibular	2.878 ± 0.559	3.734 ± 1.495	3.806 ± 1.414	7.04	0.001*

SD: Standard deviation

* Indicates significant difference exists at $p \leq 0.05$.

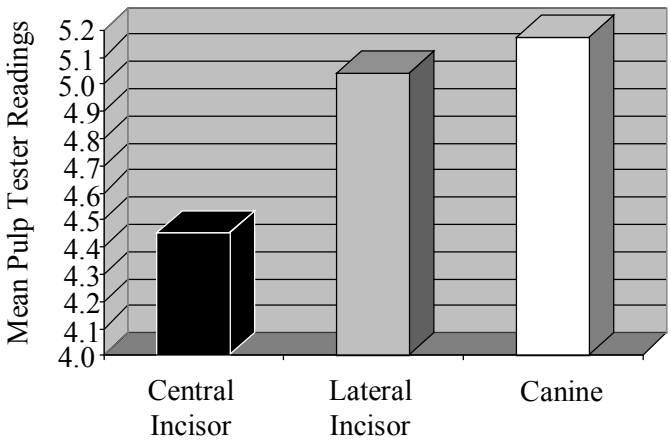

Figure (2): Means of pulp tester readings of the maxillary anterior teeth

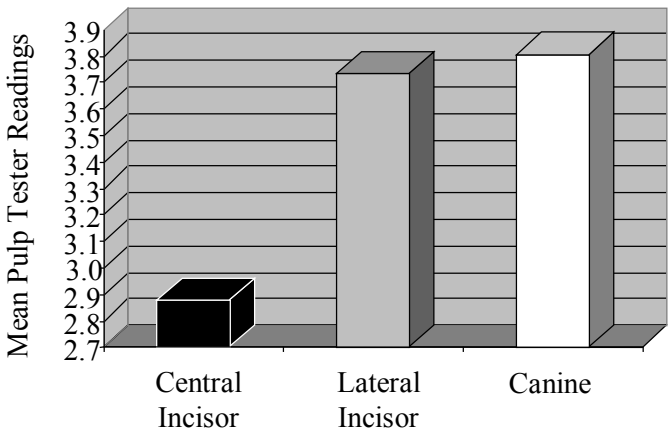

Figure (3): Means of pulp tester readings of the mandibular anterior teeth

Table (3): Mean ± standard deviation of threshold response at different placement sites of the maxillary and mandibular teeth

Arch	Incisal Edge	Incisal Third	Middle Third	Cervical Third	F–value	*p*–value
	Mean ± SD					
Maxillary	3.683 ± 0.953	4.850 ± 1.186	4.950 ± 0.543	5.600 ± 1.157	3.86	0.025*
Mandibular	2.583 ± 0.604	3.116 ± 0.818	3.750 ± 0.712	4.250 ± 0.383	7.53	0.001*

SD: Standard deviation

* Indicates significant difference exists at $p \leq 0.05$.

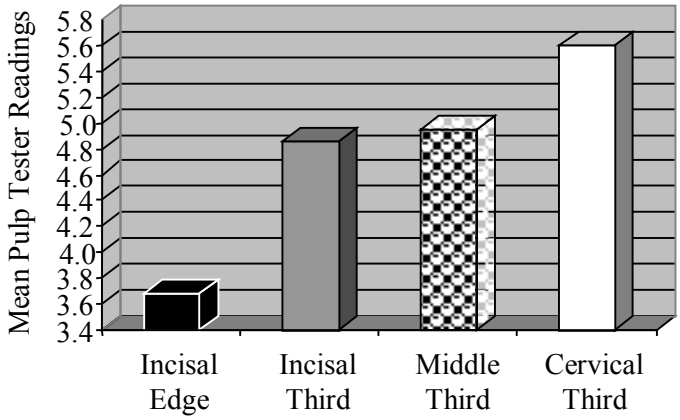

Figure (4): Means of pulp tester readings at different placement sites of the maxillary anterior teeth

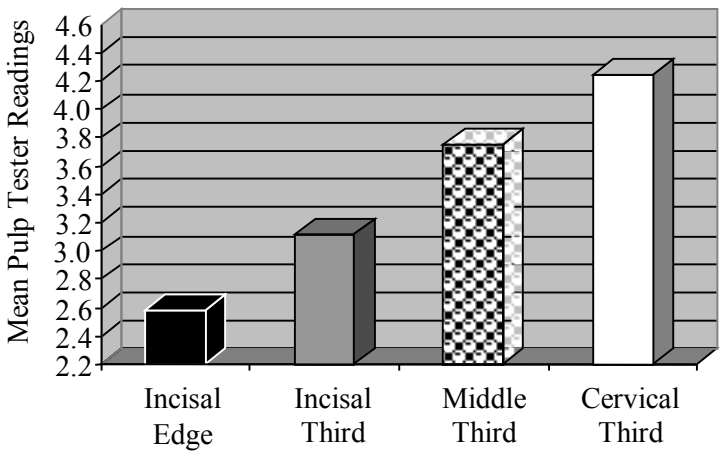

Figure (5): Means of pulp tester readings at different placement sites of the mandibular anterior teeth

The lowest threshold response was noted at the incisal edge of the tooth; the incisal third had a higher response threshold than the incisal edge; the middle third had a higher threshold than the incisal third and the cervical third had the highest threshold response among all the different electrode placement sites.

DISCUSSION

The results of this study agreed with Bender *et al.*,[7] who found that the lowest response threshold was observed when the pulp tester electrode was applied on the incisal edges of the teeth and increased as the electrode was moved apically from the incisal edge to the cervical region of the

tooth. These findings disagreed with Jacobson's results,[8] which found that the optimal electrode placement site is the middle third of the labial surface, and the results of Cooley and Robison,[11] who found that the optimal placement site is on the cervical third of the tooth. In regard to the optimal placement site of electrode, there are several considerations to be discussed. The optimal response threshold is reached when an adequate number of nerve endings are activated, so the response to a given stimulus will be greatest where the neural density is the highest; that mean the area of high neural density will have a relatively low response threshold. Lilja[12] found that the highest concentration of neural elements in the pulp is in the pulp horn region. A progressive decrease in the number of nerve fibers as directed apically to the cervical and radicular areas of the pulp was observed. Also, the direction of the dentinal tubules may have a role in evaluating the pulp tester response threshold in different regions of the tooth crown. The dentinal tubules at the pulp horn region are almost run in a straight course from the pulp to the dentino–enamel junction, whereas the course of the dentinal tubules in the other regions of the crown is somewhat curved and resembles an S in shape. Logically, the shorter the distance between the electrode and the pulp, the faster is the conduction of the electricity from the pulp tester to the pulp and the lower is the response threshold.[13]

It has been shown that enamel thickness may have an effect on the response to the electrical pulp testing.[7] Because enamel acts as a barrier against the flow of electrodes to the pulp, more current is needed to stimulate teeth with thick enamel than those with thin enamel. This explains why mandibular anterior teeth, with relatively thin enamel, respond with a relatively low threshold than do maxillary anterior teeth.

The size of the pulp chamber is also having an effect in the response threshold to the electrical testing; greater electrical current is needed to produce a response in teeth with large pulps than in teeth with small pulps.[6] This observation explains why canines, which have relatively large pulp, having a higher response threshold than teeth with relatively small pulps, like central and lateral incisors.

CONCLUSIONS

The mandibular anterior teeth having a lower response threshold to the electrical pulp testing than the maxillary anteriors.

Whether maxillary or mandibular, the canine responds to the electrical stimulus in a highest threshold than the lateral incisor and the central incisor which has the lowest response threshold.

The optimum placement site of the electrode of electrical pulp tester is the incisal edge of the tooth and the response threshold is increased as the electrode is moved apically to the cervical third of the labial surface of the tooth.

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