INTRODUCTION

The diagnosis of dental pulp condition should be seen as a synthesis of history, clinical examination, special tests, radiological examination and not as the outcome of anyone specific test. An important aid in the diagnosis of the diseases of pulp and peri-apical tissues is vitality testing.1 Thermal test and electrical pulp test are the most commonly used to check the integrity of pulp in clinical practice.2 These diagnostic tools are also used to differentiate peri-apical lesions of endodontic origin from other pathological entities of similar radiographic appearance.3

Electric pulp tester (EPT) is an electric instrument of high or low frequency designed to determine the response of pulp to an electrical stimulus. It works by passing electrical stimuli, cause an ionic change across the neural membrane producing an action potential with a rapid hopping action.4 The EPT could be a reliable tool to check pulp status if it is used properly and keeping in mind its limitations.5 For getting better results it needs the proper placement of the electrode on the tooth surface. There are different opinions of authors about the best placement site of the electrode on different teeth surfaces. Bender et al reported that the incisal edge gave the lowest threshold values of response to electric pulp testing of maxillary incisors as area is adjacent to pulp horns, which receive the highest nerve density within pulp.6 A recent study has revealed that the optimum site for placement of an electrode of EPT during checking of vitality of molars is the tip of the mesiobuccal cusp which overlies one of elongated pulp horn of molars (mesiobuccal pulp horn) in the molar teeth.7 These results revealed that the area which has high concentration of neural elements could be the optimum site for

ABSTRACT

To find out the appropriate electrode placement site for electric pulp tester on first premolar teeth of both arches.

This was an experimental study performed at Institute of Dentistry, Liaquat University of Medical & Health Sciences, Jamshoro from October 2010 to March 2011. Forty volunteers with first premolar teeth free of restorations and caries were recruited. First premolar from each quadrant was selected, and rubber dam was applied without clamps. Three sites on each crown were tested twice with an electric pulp tester, and lowest threshold responses were recorded.

Data were analyzed with ANOVA variable test. The lowest response for both (maxillary and mandibular) teeth was found on the tip of buccal cusp. Other sites showed an increase in level from the tip of buccal cusp, middle 1/3 of buccal surface and cervical 1/3 of buccal surface. No statistically significant difference was found in the responses of male and female subjects. It was concluded that the appropriate electrode placement site for pulp tester on first premolar teeth is the tip of buccal cusp.

Key words: EPT, dental pulp, diagnosis, pulp vitality test
placement of electrode to check the pulpal vitality accurately. Still dilemma of accurate placement site for EPT electrode is there especially in posterior teeth and no specific site for premolars is suggested in dental literature making clinical problems during testing of these teeth that is why the present study is designed to find such site. Further work is required to be done on these lines to improve the reliability of EPT test.

METHODOLOGY

This experimental study was carried out in the Department of Operative Dentistry LUMHS, Jamshoro from October 2010 to March 2011. Forty volunteers of either gender between 18-30 years of age having first premolar teeth free of restorations and caries were included in the study. However, the teeth with signs of surface loss (erosion, abrasion, attrition, abfraction), teeth having pulptis, pulp necrosis or apical infection and or root-treated teeth were excluded from the study.

The participants were informed fully about the nature of the study and its benefits or any hazard and an informed consent was taken prior to include them in the study.

Rubber Dam was applied on the selected tooth (first premolar) without clamps to isolate it from the surrounding tissues. An EPT (Parkell Digitest Pulp Vitality Tester, D626D) was used in accordance with the manufacturers instructions.

The electrode lightly coated with fluoride gel or tooth paste and position on the testing sites. Participants used their forefinger on the lip clip to complete the circuit. They were instructed to release the clip on first detection of a warm, tingling or painful sensation.

Three sites on each first premolar crown were twice tested namely:

- Tip of buccal cusp
- Middle 1/3 of buccal surface
- Cervical 1/3 buccal surface

Each site was tested twice with 2 minutes interval as recovery time to eliminate the phenomenon of nerve accommodation.

RESULTS

Data were entered and analyzed in computer software SPSS 11 version. Frequency and percentage were computed and chi-square test was applied for categorical variables like age groups, gender. Mean, standard deviation, 95% confidence interval were computed for age, and average response for each site. Analysis of variance (ANOVA) was applied to compared average difference of EPT response among sites. Bonferroni multiple comparison test was used to compare average EPT response between sites. Bar chart, pie diagram and box and whisker plot as well as table were used to present data.

First premolar teeth of 40 subjects were tested in this study. Most of the patients were above 20 years of age Fig 1. The average age of the subjects was 23.13±3.63 years (95%CI: 21.97 to 24.28) Table 1. Out of 40 subjects, 21(52.5%) were male and 19(47.5%). Fifty percent maxillary and 50% mandibular sites of teeth were involved in this study.

Fig 2 showed, box and whisker plot showing average EPT response with respect to site of premolar. Average response of EPT on tip of buccal cusp and middle 1/3 of buccal surface were 2.09±0.54 and 2.49±0.53 while average response of EPT in cervical 1/3 of buccal surface was 5.35±1.03. P-value = 0.0005 showed significant difference. Bonferroni multiple comparison test applied to compare mean difference between sites which is showing that average response of EPT was significantly low in tip site as compare to middle site of buccal surface (p=0.044) similarly significantly lowest response of EPT was also observed in tip site as compare to cervical site. (p=0.0005). Placement of the

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Age (Years)</th>
</tr>
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<tbody>
<tr>
<td>Mean ± SD</td>
<td>23.13±3.63</td>
</tr>
<tr>
<td>95% CI</td>
<td>21.97 to 24.28</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>22(5)</td>
</tr>
<tr>
<td>Minimum</td>
<td>18</td>
</tr>
<tr>
<td>Maximum</td>
<td>30</td>
</tr>
</tbody>
</table>

| Table 1: AGE DISTRIBUTION |

| Table 2: COMPARISON OF AVERAGE EPT RESPONSE AMONG SITE OF FIRST PREMOLAR CROWN (ANOVA) |

<table>
<thead>
<tr>
<th>Average EPT response</th>
<th>TIP</th>
<th>Middle</th>
<th>Cervical</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>2.09±0.54</td>
<td>2.49±0.53</td>
<td>5.35±1.03</td>
<td>0.0005</td>
</tr>
<tr>
<td>95% CI</td>
<td>1.91 to 2.26</td>
<td>2.35 to 2.66</td>
<td>5.02 to 5.68</td>
<td></td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>2(0.7)</td>
<td>2.5(1)</td>
<td>5(1)</td>
<td></td>
</tr>
</tbody>
</table>
DISCUSSION

The buccal cusp tip of both maxillary and mandibular premolars was found the site with lowest threshold to EPT stimulation. Rubber dam without clamp was used to isolate only the tooth being examined to avoid the flow of current to the adjacent teeth and gingiva. A narrow range of age of subject was selected to avoid sensitivity variation caused by secondary dentine deposition which causes reduction in volume of pulp, dental caries and tooth wear.9

Other factors also controlled in the study which may alter the response of tooth to the EPT testing and may result in false positive or false negative response these include enamel and dentine morphology, tooth surface conditions, and the complex oral environment.10 The teeth with signs of tooth surface loss and carious teeth were excluded from the study.

The premolars are the single rooted or could be double-rooted in case of maxillary 1st premolar in dental arch and usually their roots contain more than one pulp canal. There is well defined pulp chamber in the trunk of the tooth with pulp horns elongated under each cusp but more profound under the buccal cusp. Due to these typical anatomical features it is very difficult to perform the pulp vitality procedures especially the Electrical Pulp Testing with more chances of getting false-positive and false-negative responses.10 It is not uncommon that an infected premolar contain necrosed pulp in one canal and some vital pulp in other canal may elicit the false-positive response in otherwise necrosed pulp. The enamel over the crown is also thicker as compared to incisor teeth especially over the cusps.

This can hamper the conduction of electrical current towards the pulp to produce the response.11 So, it should be more important to place the tip of electrode at appropriate site on posterior teeth (molars and premolars) to produce optimum response. But, the selection of appropriate site is yet to be confirmed and still there are several considerations and lack of research. The response threshold can be achieved only when sufficient numbers of nerve terminals are activated to attain by electrical current, which is called a summation effect.12 The level of response to a given stimulus depends upon how close the nerve terminals are present to area of stimulus. Therefore, an area where a neural density is found high can give early and powerful response on least electric current as compared to area with low neural dentistry.13 Lilja J reported that in permanent molar teeth the highest

\[
\begin{array}{|c|c|c|c|}
\hline
\text{Site to site} & \text{P-values} & \text{Lower Bound} & \text{Upper Bound} \\
\hline
\text{Tip-Middle} & .044^{**} & -.805 & -.007 \\
\text{Tip-Cervical} & .0005^* & -3.663 & -2.865 \\
\text{Middle-Cervical} & .0005^* & -3.256 & -2.459 \\
\hline
\end{array}
\]

Bonferroni multiple comparison test was applied.

\[** \text{p<0.05} \]

\[* \text{p<0.01} \]

Fig 1: Age distribution of the patients n=40

Fig 2: Box and Whisker plot showing average EPT response with respect to site of premolar electrode of electric pulp tester on the buccal cusp tip elicited the lowest response.
concentration of neural elements are present in the pulp horns, with progressive decrease in the cervical and radicular of the pulp that was confirmed by Lin et al. in their study that the early response was observed on low electric current at the area of cuspal tip as compared to the cervical regions of the molars. The findings of this study are also suggesting that the tip of buccal cusp is ideal site to place the electrode tip as the area is close to buccal pulp born. However, present study was performed on premolars not on molars as in previous studies. Another laboratory based study by Jacobson used the oscilloscope to find the electrode placement site on extracted incisors and premolars. He observed incisal third and occlusal third of labial/facial surface are the appropriate site for pulp testing in incisors and premolars respectively. However, his study was performed on the extracted teeth where neural density was not considered. The finding of a lower threshold value at the tip of buccal cusp placement sites and a higher threshold value at cervical third of premolar teeth in both arches also agrees with the reports of Christopher I. Udoye and Bender et al. The gender of the subject was not found as a factor which impact on the level of perception of threshold during pulp testing of the teeth in almost all previous studies performed on the subject. The present study also found no statistically difference in the responses of male and female subjects nor between maxillary and mandibular teeth as similar were seen in the study of Lin et al. In the present study, the sample size, population characteristics and study design, differ from those of Christopher I. Udoye, Bender et al, Al Salman, and Lin et al. Forty subjects were employed in the present work, while Christopher I. Udoye, Bender et al., Al Salman, and Lin et al. recruited 21, 53, 20, and 20 subjects respectively. Concerning population characteristics, the age range was 18-30 years of the present study and differs from that of the above four studies, which were 18-71 years, 11-18 years, 20-41 years, and 20-25 years respectively. However, the relation of age regarding the EPT did not find in these studies.

Although the different conducting mediums are suggested in literature but in this study Fluoride gel was used over the area of tooth surface to ensure that maximum current passes from the electrode to the tooth surface. A laboratory study by Martin and co-workers found no profound difference in using different mediums to either voltage or the electric current transmitted during the pulp testing of the teeth. On the contrary, a more recent study reported a small difference in the response of same teeth on EPT testing by using different conducting media.

It is important to select the appropriate site for diagnostic purpose.

It was concluded that the appropriate placement site for the electrode of electrical pulp is the Tip of buccal cusp, and the response of the threshold is increased as the electrode is moved apically to the cervical third of the buccal surface of the tooth.

REFERENCES