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Investigating the Sizes of Anatomical Landmarks of Coronal Pulp in the First Permanent Human Molars on Bite Wing Radiography

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ABSTRACT

Knowledge of dental pulp anatomy is effective in preventing random pulp exposure in remedial procedures. This study determined and compared the dimensions of the pulp chamber and the contours of the tooth to the pulp chamber in the first molar teeth on the bite-wing images. The present study was a cross sectional and descriptive one that was performed on 62 bitewing radiographies in the age group of 25-35. Bitewing images were exposed by the oral X-ray machine and processed by the Sordex scanner and 7 anatomical landmarks were measured on these bitewing images in MATLAB. The obtained sizes were analyzed by SPSS 17 and ANOVA was used for statistical computations. The significance level was determined to be P ≤ 0.05. There was a significant difference in the distance between the pulp horns, the height of the pulp chamber, the pulp chamber roof to the place of furcation and the tip of the cusps to the furcation site in the upper and lower jaw (P-value = 0.000). Also, there was a significant difference between the tip of the distal cusp and the distal horn (P-value = 0.050) and the bottom of the pulp chamber to the furcation (P-value = 0.014) in the upper and lower jaw and there was no statistically significant difference between the two jaws only at a distance between the tip of the mesial cusp and the mesial horn (P-value = 0.822). The precise knowledge of the dimensions of the pulp chamber and also the external surfaces of the tooth to the pulp chamber reduced the root canal failure.

Key words: First Molar, Bitewing Radiography, Pulp Chamber

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INTRODUCTION

A very important issue during dental repair is protecting the health of dental pulp tissue [1]. Knowledge of dental pulp anatomy (such as the location of pulp horns and pulp chamber roof) is very effective in preventing random dental pulp exposure while performing repair procedure [2]. One of the irreversible consequences during endodentical works is perforation of molar teeth while providing an access cavity. These perforations sometimes repair, but often lead to tooth extraction [3]. Preparing an access cavity is often done by a series of qualitative methods, including the dentist's sense of touch and his knowledge of the tooth anatomy. However, the mere reliance on sense of touch can lead to adverse outcomes, including the pulp chamber perforation [4]. Pulp chamber calcification can reduce a sense of touch and may lead to furcal perforation and technical errors [5, 6]. Because first molar teeth are the first permanent teeth that grow, in many cases decay in these teeth occurs sooner than the rest, therefore the first molars are the most common tooth that undergo root canal [7]. Bitewing radiography is a kind of intraoral radiography that simultaneously records the maxillary and mandibular crowns with adjacent alveolar crust on a receptor [8]. Dentists often use this radiography to perform periodic examinations as well as to detect dental decays. However, as with other usual radiographic images, the limitation of the bitewing images is the two-dimensionality of images prepared by a 3D object, but it should be borne in mind that due to the geometry of the radiation, these images provide a

very good view of the pulp chamber because in this imaging, the beam shines with an angle perpendicular to the longitudinal axis of the teeth, and this is effective in preventing the perforation of the molar pulp chamber floor during the formation of the endodontic access cavity [9]. Chandler et al., in their study on coronal pulp dimensions in the first molar teeth concluded that pulp chamber morphology was considerably better seen in bitewing than periapical radiography [10]. The study aimed to determine and compare the dimensions of the pulp chamber and the distances between the contours of the tooth to the pulp chamber in the maxillary and mandibular molars on the bitewing images prepared from the patients referring to an orofacial radiology center.

MATERIALS AND METHODS

The present study is a descriptive cross-sectional one performed on 62 bitewing radiographies in the archives of Orofacial Radiology of Khatam-al-Anbia Clinic in Yazd, Iran, in the age group 25-35. Patients' age was recorded from their dental records. Bitewing images by the PSP Receiver (Digora, Sordex, Helsinki, Finland) No. 2, which was held at the XCP Bitewing Film Store (Tehran, Iran) and prepared by the Minray Oral X-ray machine (Sordex, Helsinki, Finland) with exposure condition of 70 kvp, 10 mA and 0.016 S, and then scanned by Digora (Digora, Helsinki, Finland) and processed by Scanora (Digora, Helsinki, Finland) and saved in JPG format. These images were transferred to another computer, and were observed on a Dell computer monitor (Trinitron, Round Rock, Tx) after entering into Image Processing program in Matlab R2015b (Figs. 1 and 2).

Inclusion criteria

Inclusion criteria included the presence of fully developed tooth, second premolars, first molars and permanent maxillary and mandibular molars, crowns and any restorations as well as non-root canal teeth in bitewing images.

Exclusion criteria

Images on which some measurements were not possible, as well as teeth with some anomalies (such as taurodontism) as well as overlap graphy were excluded.

Measurements were performed by the ruler in image processing program and recorded on a checklist. To obtain the actual dimensions of a metal wire of 10 mm on image receiver was glued by a plastic adhesive tape, and by doing this, a bitewing radiography was prepared from a patient (with his consent) and after image processing by the ruler in Image Processing, the length of this wire was measured, based on the obtained number (100), the result was that the obtained sizes by the software is 10 times larger than the actual size and to obtain the actual size, all the numbers obtained in the software should be divided into 10. Seven types of measurements on bitewing images were performed by a student trained by an orofacial radiologist who did not know the patient's demographic information, it was done on maxillary and mandibular molar teeth by ruler in image processing in Matlab. These measurements include:

A) The distance between mesial pulp horns to the distal pulp horn
B) The distance between mesial cusp tip to the mesial pulp horn
C) The distance between distal cusp tip to the distal pulp horn
D) The height of the pulp chamber
E) The distance between the pulp chamber floor to the tooth furcation
F) The distance between the pulp chamber roof to the tooth furcation
G) The distance between the cusp tip to the tooth furcation

The obtained data were analyzed by SPSS17 and t-test was used for statistical analysis.

RESULTS

In this study, 7 measurements were performed on 124 permanent human molars, depicted on 62 bitewing radiographies, which included values related to mean, standard deviation and coefficient of variation (CV) for each of the variables of this study for maxillary and mandibular molars are reported in Table (1). As shown in Table 1, the results of t-test showed that there was a significant difference between the pulp horns, the height of the pulp chamber, the pulp chamber roof to the furcation and the cusp tip to the furcation in the maxillary and mandibular molars in the patients (P-value = 0.000).

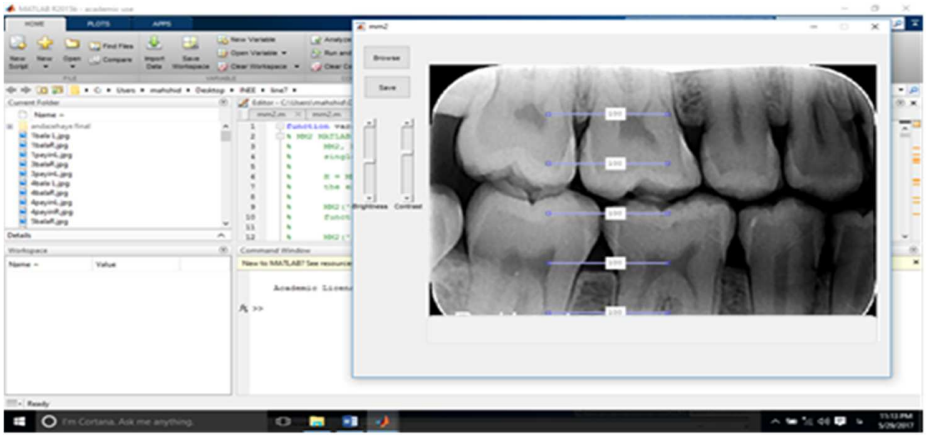

Figure 1: Bitewing image after entry to Matlab R2015b

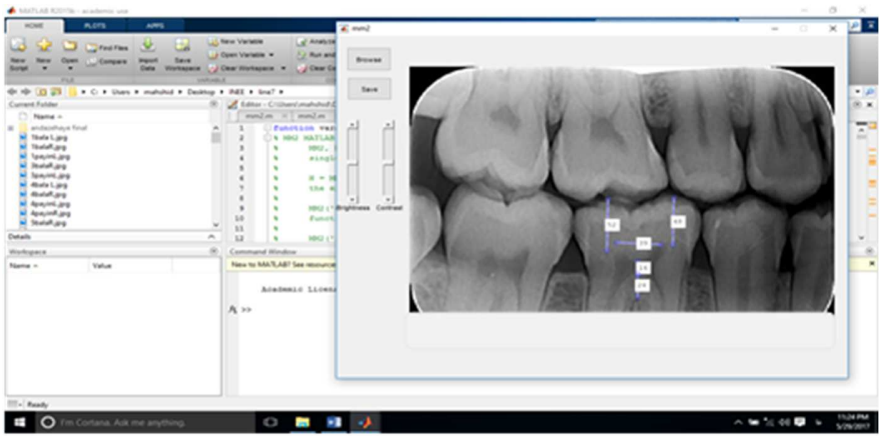

Figure 2: Bitewing image in Matlab after measuring the desired landmarks

Table 1. Mean, standard deviation and coefficient of variation of variables in study

Variable	Jaw	Number	Mean	SD	Min	Max	CV	P-value
Distance between pulp horns	Maxillary	62	2.820	0.5785	1.5	3.9	20.5	0.000
	Mandibular	62	3.561	0.5691	1.4	4.5	15.6	
Distance between the mesial cusp tip to the mesial horn	Maxillary	62	4.992	0.7982	3.3	6.6	15.98	0.822
	Mandibular	62	4.960	0.7591	3.5	6.8	15.3	
Distance between distal cusp tip to distal horn	Maxillary	62	5.590	0.8439	4.0	7.3	15.09	0.050
	Mandibular	62	5.305	0.7707	3.6	6.9	14.52	
Height of pulp chamber	Maxillary	62	2.118	0.7304	0.7	3.9	34.48	0.000
	Mandibular	62	1.156	0.4954	0.4	2.2	42.85	
Distance between the pulp chamber floor to furcation	Maxillary	62	2.303	0.5526	0.8	3.6	23.99	0.014
	Mandibular	62	2.557	0.5855	1.0	3.9	22.89	
Distance between the pulp chamber roof to the furcation	Maxillary	62	4.489	0.9281	2.4	6.1	21.85	0.000
	Mandibular	62	3.713	0.5743	2.7	4.7	15.46	
Distance between the cusp tip to the furcation	Maxillary	62	10.967	0.7529	9.3	12.6	6.8	0.000
	Mandibular	62	10.316	0.7802	8.9	11.9	7.56	

Also, there was a significant difference between the distal cusp tip to the distal horn (P-value = 0.050) and the pulp chamber floor to the furcation (P-value = 0.014) in the maxilla and mandible jaw, and there was no statistically significant difference between the two jaws only at a distance between the mesial cusp tip and the mesial horn, (P-value = 0.822). The variation in CV was reported 6 to 43% about sizes of maxilla and mandible teeth.

DISCUSSION

Phillipas was the first person to report quantitatively the pulp chamber dimensions in a

radiographic survey in 1961 (Christie & Thompson, 1994). After him, many studies were done to measure the size of the dental pulp chamber on various radiographs. Because in bitewing radiography, X-ray radiation angle to the teeth is such that the morphology of the pulp chamber is better shown than periapical radiography [10], the present study examines the size of dental crowns and pulp chamber on the oral radiography.

The presence of many variations in the size and shape of the molar teeth may suggest that the dimensions of the pulp chamber of these teeth also have such variances that the study to obtain these sizes is shown useless clinically in practice.
In the present study, we calculated the variance coefficient as a percentage of mean (CV = SD/mean). The variation range of CV was reported 6 to 43% for sizes of maxilla and mandible teeth. Both maxilla and mandible molars were found to have the highest CV in size "d" in Table 1 and 2 (height of pulp chamber). This high variation is probably due to secondary dentin sedimentation.
However, according to a Philipas who reported dentin thickness in the pulp chamber floor increases clearly with increasing age [10] and the study by Shaw et al., who knows that significant reduction of the height of the pulp chamber in mandibular molars is mainly due to the increase in the thickness of the pulp chamber floor [11], it should be noted that dentin sediment on the pulp chamber floor for entering into the root canals by the endodontist is important [12].
In the first place, it may seem that as this is a radiographic study, the size may vary with the anatomical sizes between the different groups, but it should be noted that Scotti et al., in their study showed that the average relative error (which results from the division of the anatomical and radiographic sizes into anatomical sizes) is 4.46% which in the metric system is equal to 0.12 mm [13], which is smaller than all SDs obtained in our study. Therefore, in our opinion, this problem has more a theoretical aspect, and has no effect on the results obtained in our study.

The distance between the pulp chamber floor and the place of furcation in the present study was reported for maxillary molar teeth as 2.30 mm (with a standard deviation of 0.55) and 2.55 mm for the mandibular molars (with a standard deviation of 0.58) that according to the results of Majzoub and Kon [14], who reported this distance in 86% of maxillary molar teeth equal to or less than 3 mm, and is consistent also with the results of Khojastepour *et al*., [15] (2.86 ± 0.57 for the first maxillary molar and 2.89 ± 0.61 for the first mandibular molar), which was performed on the bitewing images. Also, the result of the present study about distance between the pulp chamber floor to the furcation site is consistent with study by Velmurgan *et al*., [16] on radiographs of maxillary molar teeth (2.7 ± 0.63).

Also, Deutsch et al., reported in their study on radiographic images of 200 primary maxillary and mandibular molars that the average distance between the pulp chamber floor to the furcation site was 3.05 and 2.96 mm, respectively [17] that these values are relatively higher in comparison with the results of the present study, which can be attributed to the difference in the number of samples, race, or difference in age and method of study, because Deutsch used extracted teeth (in vitro condition) in his study.

The distance between the pulp chamber roof and the location of furcation of the first mandibular molar teeth was obtained 3.71 mm in the present study (with a standard deviation of 0.57), which is consistent with the results of the study by Lokade *et al*., [18]which was done on the Indian population (3.80 ± 0.77 mm). However, this distance in the study by Khojestpour *et al*., in the maxillary molars was 6.02 ± 0.84 and in the case of mandibular molars was 5.22 ± 0.85 [15] that compared to the numbers obtained in our study (4.84 ± 0.92 for maxillary molars and 3.71 ± 0.57 for mandibular molars), are greater than the number of samples that the difference can be related to the difference in the number of samples.
In our study, the mean distance between the cusp tip and the furcation in the case of maxillary molars was 10.96 mm (with a standard deviation of 0.75), which is similar to the results of Deutsch studies [16], Velmorgan et al., [16], Khojastepour et al., [14] (11.15 ± 1.21, 11.58 ± 1.01, 11.54 ± 1.20 mm, respectively).

During the preparation of the mesial and distal surfaces of a tooth for repair treatment or placement of pins, there is a possibility of damage to the pulp horns, so knowing the depth of penetration until reaching the location of the pulp horns to prevent the injury to them is useful and necessary. Of course, guessing these distances is difficult because of the different dimensions of the pulp chamber from person to person and from tooth to tooth [18].

In the present study, the mean distance between the distal cusp tip and the distal pulp horn on the maxillary and mandibular first molar was 5.59 (with a standard deviation of 0.84) and 5.30 mm (with a standard deviation of 0.77), respectively, which the sizes are consistent with the sizes obtained in study by Khojastepour *et al*., [15] (5.90 ± 0.89 and 5.41 ± 0.96 mm).

The mean pulp chamber height in the study of Deutsch *et al*., [17] in the case of maxillary and mandibular molars was 1.88 ± 0.69 and 1.57 ± 0.68 mm, respectively, and also in the study by Lokade et al., [19], this size was reported to be 1.48 ± 0.66 mm for mandibular first molar, which corresponds to the values of the present study (2.11 ± 0.73 mm for maxillary molars and 1.15 ± 0.49 mm for mandibular molars)

From the sizes obtained in the study and its similarity to the sizes in other studies, root canal therapy can be done with greater awareness of the size and reduce the risk of dangers during repair and root treatments (such as pulp perforation and perforation of the pulp chamber floor while preparing the access cavity in the molars).

CONCLUSION

There are significant differences between the distances between the pulp horns, the height of pulp chamber, pulp chamber roof to the furcation and the cusp tip to the furcation in the maxilla and mandible jaws in the patients (P-value = 0.001). Also, there was a significant statistical difference in the distance between the distal cusp tip to the distal horn (P-value = 0.050) and the pulp chamber floor to the furcation (P-value = 0.014) in the maxilla and mandible jaw. There was no statistically significant difference between two jaws only between the mesial cusp tip and the mesial horn (P-value = 0.822). Finally, it is suggested to perform further studies with more samples, as well as with other methods, to help strengthen the database on dental pulp chamber sizes in Iranian race.

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