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RESEARCH ARTICLE

EVALUATION OF ROOT AND CANAL MORPHOLOGY OF MAXILLARY PERMANENT PREMOLARS IN AN EGYPTIAN POPULATION BY CONE-BEAM COMPUTED TOMOGRAPHY.

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Abstract

Introduction: The purpose of this study was to evaluate the number of roots and canal morphology of maxillary permanent premolars in Egyptian population.

Methods: seven hundred and eighteen cases were included in this study. Digitized images from cone-beam computed tomography were assessed by 2 endodontists. Number of roots and canals configuration according to Vertucci were tabulated.

Results: Most of maxillary first premolars showed two-root configuration, while most of maxillary second premolars showed single root configuration. For maxillary first premolar ,The most common Vertucci classifications for the single root were type II (62.6%) and III (12.6%). While the most common Vertucci classifications for single rooted maxillary second premolar were I (44%) followed by II (29.8%) and III (17.9%)

Conclusions: Under the condition of this study, the root canal configurations of an Egyptian population showed that most maxillary first premolars were two-rooted with 2 root canals, whereas maxillary second premolars tended to be single-rooted with one or two root canals more or less equally distributed. In vivo CBCT imaging is a clinically effective tool for providing comprehensive information about the root canal morphology of various teeth.

Introduction:-

Knowledge of the complex three-dimensional root canal anatomy is considered crucial for the success of root canal therapy(1,2).

Lack of knowledge and/or technical skill may result in a failure to identify all root canals and hence inadequate instrumentation leading to treatment failure.

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In vitro studying of the complexity of internal anatomic variations of roots and root canals has been documented using different methods including canal staining and tooth clearing techniques (3), contrast medium-enhanced radiography (4) and micro computed tomography (5). However, these techniques are limited to extracted teeth restricting the application of these techniques in routine clinical practice.

In clinical point of view, Identifying the root canal morphology is achieved using either conventional radiography (6) or cone-beam computed tomography (CBCT) (7–10). Conventional radiography yield only two dimensional images resulting in the distortion and structures superimposition. With the introduction of cone beam computed tomography (CBCT), 3D root canal anatomy is now visible. with unquestionably lower radiation doses and better image resolution than conventional computed tomography rendering it applicable for clinical use(11).
The variation of internal root canal anatomy is genetically determined justifying the importance of ethnic variations during clinical practice.

The aim of this study was to identify the root and canal morphology of the maxillary first and second premolars in an Egyptian population using Cone Beam Computed Tomography.

Materials and Methods:-

Based on data from a previous studies(12,13), power calculation was performed using G*Power 3.1 software(14) (Heinrich Heine University, Dusseldorf, Germany) . The calculation indicated that the recommended sample size should be of a minimum of 648. Digital CBCT images of the maxillary first and second premolars were collected from patients who had undergone CBCT scanning for diagnosis purposes at Misr International University from January 2017 to September 2018. The CBCT images of 718 patients were selected according to the following inclusion criteria:

1. Age between 16 and 75 years
2. Presence of the maxillary first and/or second premolar.
3. Maxillary premolars with fully matured apices and without apical periodontitis
4. No root canal fillings, posts, or full crown restorations

The CBCT images were obtained using a Cranex 3D (Soredex,Tuusula, Finland) with the following parameters: 80 kVp, 9.0 mA, and 133 µm voxel size. Serial axial, coronal, and sagittal CBCT images were acquired by an qualified radiologist. All the images were assessed independently by 2 endodontists, and any disagreement between them was discussed until a consensus was reached.

The number and configuration of the roots, the number of root canals, the canal configurations according to Vertucci's classification (3).

Demographic data including the sex, tooth position (right or left side), and age were recorded. Statistical analysis was performed using SPSS (Version 20.0; SPSS Inc, Chicago, IL) software.

Results:-

A total of 671 maxillary first premolars and 678 maxillary second premolars in 718 patients comprising 51.3% females and 48.7 % men were assessed (table 1).

Number and Morphology of Roots

Regarding the maxillary first premolars (table 2), two-root configuration was recorded in 62.6% of the patients, One-root configuration was recorded in 36.7% whereas three-root configuration was recorded in 0.7% .

While for the maxillary second premolars (table 3), the most common configuration was one-root (93% of the cases) followed by two-root configuration (7%)

Number and Configuration of Root Canals

The number and configuration of root canals are shown in Table 4-5

The canal morphology was analyzed using Vertucci's classification for each root. Example is shown in Figure 1

Table 1:-Prevalence of Roots According to Gender:

		One-root	Two-root	Three-root	Total
Maxillary first premolar	Male	124 (37.9%)	201 (61.5%)	2(0.6%)	327
	Female	122(35.5%)	219(63.6%)	3(0.9%)	344
	Total	246 (36.7%)	420 (62.6%)	5 (0.7%)	671
Maxillary second premolar	Male	307 (92.7%)	24 (7.3%)	0 (0%)	331
	Female	323 (93.1%)	24 (6.9%)	0 (0%)	347
	Total	630 (93%)	48 (7%)	0 (0%)	678

Table 2:-Root canal configuration in the maxillary first premolars:

Molar configuration	**root**	**Type I (1)**	**Type II (2-1)**	**Type III (1-2-1)**	**Type IV (2-2)**	**Type V (1-2)**	**Type VI (2-1-2)**
Two-root	B	407	7	0	6	0	0
		96.9%	1.7%	0.0%	1.4%	0.0%	0.0%
	P	420	0	0	0	0	0
		100%	0.0%	0.0%	0.0%	0.0%	0.0%
One-root		6	154	31	18	37	0
		2.4%	62.6%	12.6%	7.3%	15.0%	0.0%
Three-root	MB	5	0	0	0	0	0
		100%	0.0%	0.0%	0.0%	0.0%	0.0%
	DB	5	0	0	0	0	0
		100%	0.0%	0.0%	0.0%	0.0%	0.0%
	P	5	0	0	0	0	0
		100%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 3:-Root canal configuration in the maxillary second premolars:

Molar configuration	**root**	**Type I (1)**	**Type II (2-1)**	**Type III (1-2-1)**	**Type IV (2-2)**	**Type V (1-2)**	**Type VI (2-1-2)**	**Type VII**
One-root		277	188	113	12	34	0	6
		44.0%	29.8%	17.9%	1.9%	5.4%	0.0%	1.0%
Two-root	B	41	0	0	0	7	0	0
		85.4%	0.0%	0.0%	0.0%	14.6%	0.0%	0.0%
	P	48	0	0	0	0	0	0
		100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 4:-Root Number of Maxillary First Premolars in Various Studies:

Author	year	Sample size	Population	One-root percentage	Two-root percentage	Three-root percentage
Pineda and Kuttler	1972	259	USA	43	54.6	2.4
Carms and Skidmore	1973	100	USA	22	72	6
Walker	1987	100	Chinese	60	40	0
Pecora et al	1992	240	Brazilian	55.8	41.7	2.5
Loh	1998	957	Singaporean	49.4	50.6	0
Kartal et al	1998	300	Turkish	37.3	61.3	1.3
Chaparro et al	1999	150	Spanish	40	56.7	3.3
Lipski et al	2003	142	Polish	15.5	75.4	9.2
Atieh	2008	246	Saudi	17.9	80.9	1.2
Awawdeh	2008	600	Jordanian	30.8	68.4	0.8
Neelakantan	2011	350	Indian	11.7	86	2.3
Ozcan et al	2012	653	Turkish	45.2	55.7	1.1

Tian et al	2012	300	Chinese	66	33	1
Abella et al	2015	430	Spanish	46	51.4	2.6
Burklein et al	2017	644	German	36.4	62.4	1.2
Present study	2018	671	Egyptian	36.7	62.6	0.7

Table 5:-Root Number of Maxillary Second Premolars in Various Studies:

Author	year	Sample size	Population	One-root percentage	Two-root percentage	Three-root percentage
Pecora et al	1992	435	Brazilian	90.3	9.7	0
Kartal et al	1998	300	Turkish	69.6	29.7	0.7
Yang et al	2014	392	Chinese	86.5	13.5	0
Abella et al	2015	374	Spanish	82.9	15.5	1.6
Burklein et al	2017	512	German	82.6	17	0.4
Present study	2018	678	Egyptian	93	7	0

Discussion:-

Due to high rates of variation in maxillary molars, thorough understanding of root canal morphology is essential for successful root canal therapy. The aim of this study was to investigate the root and root canal morphology of maxillary first and second premolars in an Egyptian population using CBCT imaging.

The present study included CBCT scans of 718 patients resulting in a satisfactory number of teeth for comparison with results obtained from other studies in other populations(6,12,13,15–27).

Many in-vitro methods have been advocated for investigating the root canal morphology including, tooth-clearing technique with or without the use of microscope (28–31) and Micro–computed tomography (32–36). Unfortunately, all in vitro techniques are only applicable to extracted teeth and hence limiting the sample size. CBCT is considered a dependable yet non-destructive method for evaluation of root canal morphology providing high resolution images with definite lower radiation dose and lower cost compared with micro computed tomography.

Domark et al (5) found that there was no significant difference between CBCT and micro computed tomography in canals identification for maxillary molars. Blattner et al (37) compared CBCT results with tooth sectioning results and concluded that there was no difference regarding the accuracy of CBCT.

In our study, A total of 718 CBCT scans were evaluated for bilateral maxillary premolars. 671 maxillary first premolars and 678 maxillary second premolars were included in the study.

Among the evaluated maxillary first premolars, two-root configuration was the most predominant configuration (62.6%). These findings were very similar to many previous studies conducted in other populations (12,16,17,25) as shown in table 4. However other studies showed that the frequency of single rooted maxillary premolars was higher than double rooted(19,22,23). These differences in root canal morphology highlight the influence of ethnic origins on the teeth morphology. The three-root configuration appeared to be rare in most of the studies(6,12,13,15–19,23,25,26).

For the three and two-root configurations, Type I is by far the most common configuration (table 2). However for single-rooted maxillary first premolars, type II constitute 62.6% of the examined scans which is considerably higher than previous studies(3,6,12,38).

Regarding the maxillary second premolar, one-root configuration recorded 93% of the examined scans (table5) which is slightly higher than previous records(12,13,20,23,25). However type I and II were prevailing (table 3). This shows that maxillary second premolars have two canals in more than half of the cases regardless of the root configuration. This was in agreement with most of the previous studies(12,13,20,23,25).

Overall root morphology is not affected by gender and side which was in agreement with previous studies (7,9). These findings were contradicting with another two studies (12,39) who stated that male patients had significantly more roots and root canals compared with female patients

Under the condition of this retrospective study, the root canal configurations of an Egyptian population showed that most maxillary first premolars were two-rooted with 2 root canals, whereas maxillary second premolars tended to be single-rooted with one or two root canals more or less equally distributed. In vivo CBCT imaging is a clinically effective tool for providing comprehensive information about the root canal morphology of various teeth which in turns might improve the outcome of endodontic treatment.

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"The authors deny any conflicts of interest"

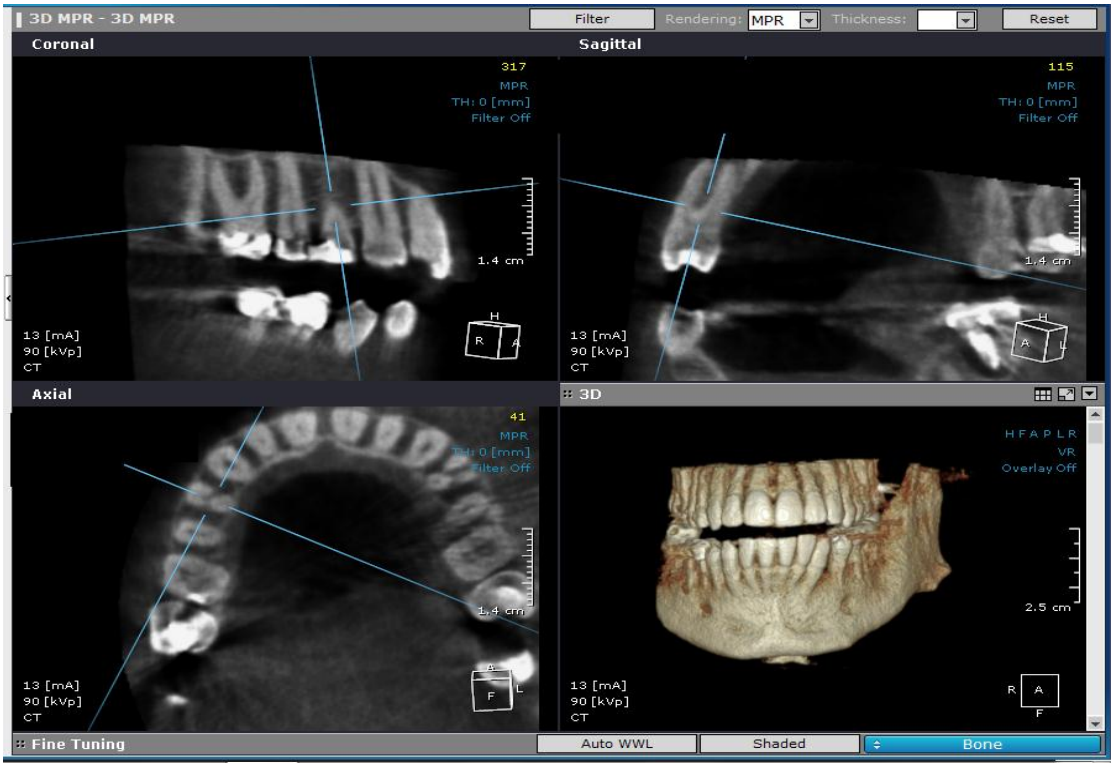

Figure 1:-Axial and sagittal section in a three-rooted maxillary first premolar.

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