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Localization of Impacted Maxillary Canine using Different Radiographic Methods

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Abstract

Introduction: *Maxillary canine impaction has an incidence of 1 in 100 in the general population and has been reported as much higher in orthodontic patient. Because patients ,it take longer treatment times, depending on the location of the impacted tooth, so early identification of impaction is of critical interest to the orthodontist.*

Aim of the work*: The purpose of this study was to correlate and evaluate the radiographic diagnosis of three-dimensional (3D) cone beam computed tomography (CBCT) scans with that of panoramic (2D) radiograph for localization of impacted maxillary canines.*

Materials and methods*: The sample enrolled in this study consisted of seventy cases randomly selected with impacted maxillary canine with age above 12 years old (40 female and 30 male) involved 40 bilaterally impacted canine and 30 unilateral impacted canine with 18 at right side and 12 at left side.*

Results: *In comparison of CBCT to panoramic group patients, a statistically significant difference were observed in ; angles of canine to midline, and occlusal plane in both uni or bilateral impaction in relation to gender.*

Conclusion: *CBCT is a reliable method for detecting canine impaction . It establishes the link between 2D and 3D imaging and is more accurate for the different diagnostic tasks in canine impaction than panoramic radiography. Using CBCT with the maximum data available would help reduce unnecessary radiation exposure.*

Key words: *Canine impaction- Panoramic radiographs and cone beam computed tomography*

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I. Introduction

Impacted teeth are those with a delayed eruption time or that are not expected to erupt completely based on clinical and radiographic assessment.[1,2] Palatal displacement of the maxillary canines is defined as the developmental dislocation to a palatal site often resulting in tooth impaction requiring surgical or orthodontic treatments. [3,4]Impaction is defined as eruption failure of a tooth to its normal site in occlusion during its normal growth period because of malposition, lack of space, abnormal habit or mechanical obstruction in its eruption trajectory. The precise localization and diagnosis of an impacted tooth is required for proper surgical access and treatment planning.[5]

Permanent canines are considered strategic because of their roles in establishing the dental arch form, involvement in the esthetic smile, and contribution to the functional occlusion They are the second most frequently impacted or displaced teeth after the third molars. Panoramic radiography has been used as an essential diagnostic tool in dentistry for more than half a century. [6,7] Although, with several limitations, such as geometric distortion and super imposition of anatomic structures.[8,9]

Impaction of maxillary canines is a common finding. The canine is the second most frequently impacted tooth [10] after the third molar, and has an incidence of approximately 1 to 3 percent in Caucasions.[11,12] In the case of the maxillary canine, more impactions are found in females than males and palatal impactions are twice or more as likely as buccal impactions in Caucasian populations. On the other hand, this could also be due to more females than males seeking orthodontic treatment. [10,11,12]

The identification of an impacted canine is only the first step in the proper diagnosis of such a case. After examining complicating factors such as pathologic findings and possible root resorption of adjacent teeth, the orthodontist’s focus quickly turns to the localization of the impacted tooth. Visualization of the correct location[13] and orientation is essential for determining the proper course of treatment, which may consist of observation ,extraction, or attempted alignment of the impacted tooth in conjunction with limited or comprehensive orthodontics.

Panoramic radiographs are still generally used in orthodontic treatment planning, in oral surgery and in almost all dental specialties for overall screening.Three-dimensional (3D) computed tomography (CT) images were introduced to dentistry in the 1990, but in view of the high radiation dose, their use has been rather controversial and not widely accepted[14].

In recent years, the use of cone beam computed tomography (CBCT) has gained acceptance in orthodontic, especially in cases involving impacted teeth. The distortion-free, three-dimensional data this technology provides has greatly improved the ability of orthodontists to precisely localize impacted canines so the present study aimed to correlate and evaluate the radiographic diagnosis of three-dimensional (3D) cone beam computed tomography (CBCT) scans with that of panoramic (2D) radiograph for localization of impacted maxillary canines.

II. Material And Methods

This cross-sectional study was done at Orthodontic Department, Faculty of Dentistry, Tanta University, Egypt sample enrolled in this study consisted of seventy cases randomly selected with impacted maxillary canine with age above 12 years (40 female and 30 male) involved 40 bilaterally impacted canine and 30 unilateral impacted canine with 18 at right side and 12 at left side.

Inclusion criteria:
1) Unerupted maxillary canine (unilateral or bilateral).
2) Whether space is available in the arch or not for canines.[15]

Exclusion criteria:
1) Patient with dental or skeletal abnormalities .
2) Patient with systemic and bone diseases.
Approval for this research was obtained from Faculty of Dentistry, Tanta University Research Ethics Committee.
For each patient, panoramic radiographs was made using a Proline XC[*]radiography unit and CBCT scans was acquired with a DCT Pro[**] . Scanning parameters was 90 kVp, 24 s, 4 mA, voxel size 0.4 mm and field of view 20×19 cm.[16]

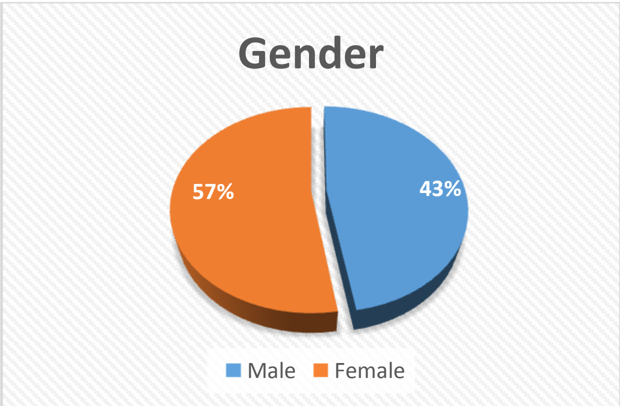

Fig (1) Sexual distribution of the study sample

On analysis of the sample figure (1) showed 57% was female while the male was 43% .
The panoramic radiographs and CBCT of the selected samples were analyzed with the following parameters fig.(2-6):
(a) Canine angulation to the lateral incisor.
(b) Canine angulation to the midline.
(c) Canine angulation to the occlusal plane.
(d)Linear measurement through a perpendicular from tip of canine to occlusal plane.
(e) The amount of space present or left after extraction of retained deciduous canine (space measured between proximal contacts of lateral and first premolar).

[*] (Planmeca, Helsinki, Finland)
[**] (Vatech Co., Hwasung, Republic of Korea)

The CBCT data volumes were constructed using Ez3D2009 CBCT software [16] (Vatech Co.).A statical analysis with SPSS version 18.
(A) Angle of impacted canine to the lateral incisor.
(B) Angle of impacted canine to midline.
(C) Angle of impacted canine to occlusal plane.
(D)Linear measurement through a perpendicular from tip of canine to occlusal plane.
(E) Space measured between proximal contacts of lateral and first premolar.

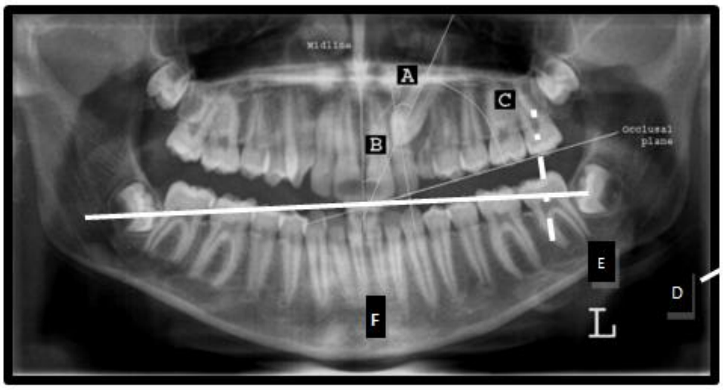

Fig.(2) Panoramic view illustrating reference lines and angular measurements.

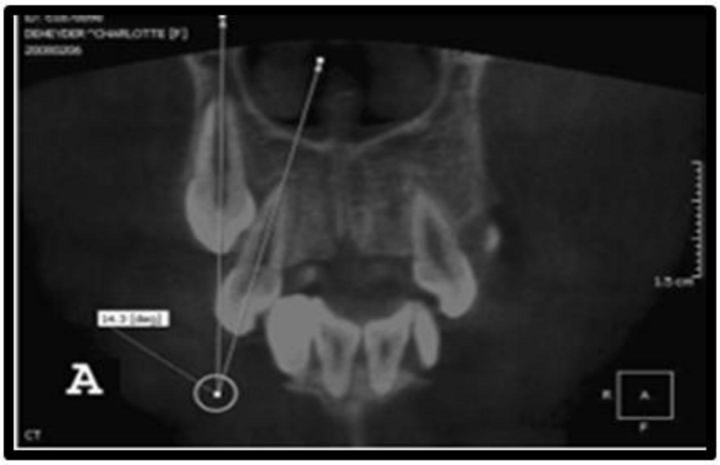

Fig-(3) (CBCT) illustrating (a) Canine angulation to the lateral incisor

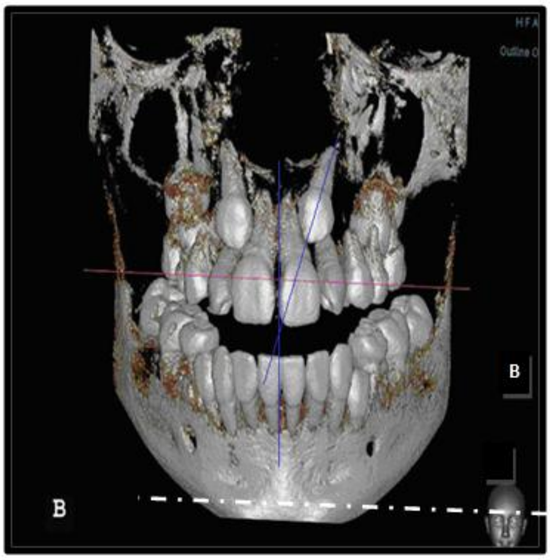

Fig (4) (CBCT) illustrating (b) Canine angulation to the midline

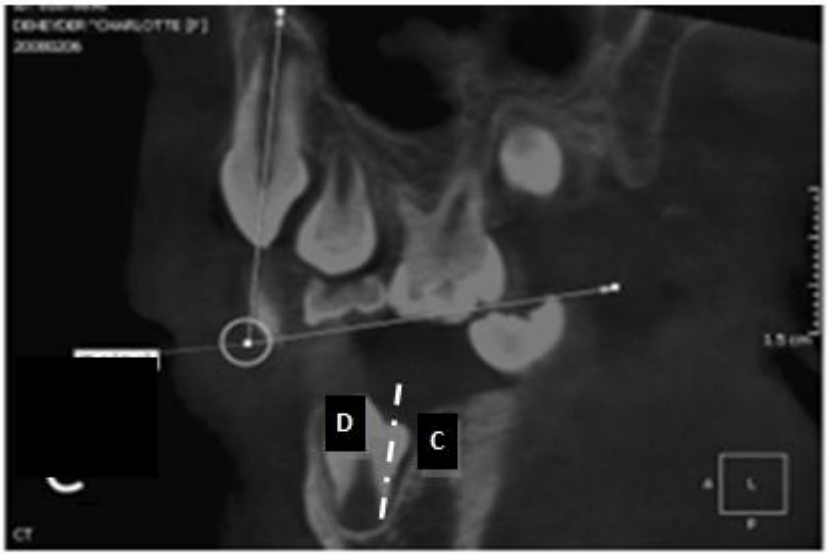

Fig (5) (CBCT) illustrating:

(c) Canine angulation to the occlusal plane
(d) Linear measurement through a perpendicular from tip of canine to occlusal plane

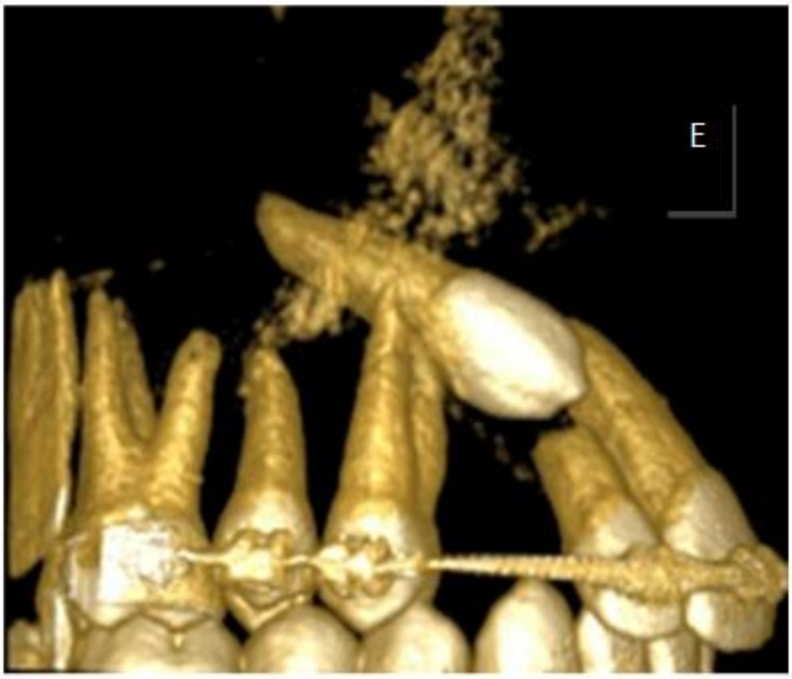

Fig (6) (CBCT) illustrating:

(e) The amount of space present or left after extraction of retained decidous canine (space measured between proximal contacts of lateral and first premolar).

III. Results

The results of study was statistically analyzed using dependent test and registed in 14 tables the analysis showed in comparison of CBCT to panoramic group patients a statistically significant difference were observed in ; angle of canine and midline, canine and occlusal plane , space from lateral incisor to first premolar and horizontal size from distal surface of upper right 1st molar to distal surface of upper left 1st molar. At the same time ,astatistically significant difference were observed in comparison of CBCT to panorama xray in relation to gender in both uni lateral or bilateral impaction

Table (1) Descriptive statistics and dependent t-test of angular measurments between CBCT & Panorama radiography at angle size.

Angle between	Device name	Mean ±S.D	S.E	T	p-value
Canine and midline	CBCT	22.63 ± 16.72	1.99	5.520	0.000**
	Panorama radiographic	28.74 ± 18.58	2.22		
Canine and Lateral incisor	CBCT	39.33 ± 23.97	2.86	1.897	0.062
	Panorama radiographic	41.70± 22.78	2.72		
Canine and Occlusal plane	CBCT	64.39 ± 17.41	2.08	8.068	0.000**
	Panorama radiographic	54.45 ± 19.08	2.28		

Table (2) Descriptive statistics and dependent t-test of linear measurments between cone beam computed tomography & Panorama radiography.

Space between	Device name	Mean ±S.D	S.E	T	p-value
Tip of Canine and Occlusal plane	CBCT	7.52 ± 2.73	0.327	11.063	0.000**
	Panorama radiographic	11.42 ± 3.88	0.464		
Lateral incisor and 1st premolar	CBCT	5.09 ± 2.15	0.257	7.824	0.000**
	Panorama radiographic	3.86 ± 2.30	0.275		
Horizontal size from distal surface of upper right 1st molar to distal surface of upper left 1st molar	CBCT	94.72 ± 5.87	0.706	6.665	0.000**

Table (3) Bi-gender , descriptive statistics and dependent t-test of angular measurments between male and female in cone beam computed tomography.

Cone beam Computed tomographic					
Angle between	**Gender**	**Mean ±S.D**	**S.E**	**t**	**p-value**
Canine and midline	Male	13.58 ± 7.22	1.42	3.528	0.001*
	Female	27.91 ± 18.64	3.80		
Canine and Lateral incisor	Male	28.19 ± 19.62	3.85	3.300	0.002*
	Female	50.43± 27.65	5.64		
Canine and Occlusal plane	Male	72.07 ± 13.98	2.74	2.702	0.020*
	Female	59.00 ± 19.51	3.98		

Table (4) Bi-gender, descriptive statistics and dependent t-test of linear measurments between male and female in cone beam computed tomography.

Cone beam Computed tomographic					
Space between	**Gender**	**Mean ±S.D**	**S.E**	**t**	**p-value**
Tip of Canine and Occlusal plane	Male	7.25 ± 1.77	0.347	0.987	0.328
	Female	6.63 ± 2.66	0.543		
Lateral incisor and 1st premolar	Male	4.82 ± 2.15	0.421	0.337	0.738
	Female	5.01 ± 1.96	0.401		
Horizontal size from distal surface of upper right 1st molar to distal surface of upper left 1st molar	Male	97.74 ± 4.88	0.976	1.983	0.054
	Female	94.84 ± 3.63	0.740		

Table (5) Bi-gender, descriptive statistics and dependent t-test of angular measurments between male and female in panorama radiography.

Panorama radiographic					
Angle between	**Gender**	**Mean ±S.D**	**S.E**	**t**	**p-value**
Canine and midline	Male	20.91 ± 13.51	2.65	3.127	0.003*

	Female	35.54 ± 19.28	3.93		
Canine and Lateral incisor	Male	32.35 ± 16.10	3.16	3.479	0.001*
	Female	53.47± 26.05	5.32		
Canine and Occlusal plane	Male	64.64± 14.83	2.91	3.766	0.000**
	Female	47.01 ± 18.20	3.72		

Table (6) Bi-gender, descriptive statistics and dependent t-test of linear measurments between male and female in panorama radiographic.

Panorama radiographic					
Space between	**Gender**	**Mean ±S.D**	**S.E**	**t**	**p-value**
Tip of Canine and Occlusal plane	Male	10.47 ± 2.59	0.508	0.848	0.402
	Female	11.33 ± 4.34	0.887		
Lateral incisor and 1st premolar	Male	3.69 ± 2.65	0.521	0.193	0.848
	Female	3.83 ± 1.99	0.406		
Horizontal size from distal surface of upper right 1st molar to distal surface of upper left 1st molar	Male	91.74 ± 8.62	1.69	0.783	0.437
	Female	90.08 ± 5.96	1.22		

Table (7) Uni-gender, descriptive statistics and dependent t-test of angular measurments between male and female in cone beam computed tomography.

Cone beam Computed tomographic					
Angle between	**Gender**	**Mean ±S.D**	**S.E**	**t**	**p-value**
Canine and midline	Male	11.36 ± 5.13	2.29	4.257	0.000**
	Female	33.65 ± 18.22	4.71		
Canine and Lateral incisor	Male	27.20 ± 11.32	5.06	2.577	0.025*
	Female	44.91± 17.99	4.65		
Canine and Occlusal plane	Male	76.40 ± 5.22	2.34	4.161	0.000**
	Female	55.72 ± 14.83	3.83		

Table (8) Uni-gender, descriptive statistics and dependent t-test of linear measurments between male and female in cone beam computed tomography.

Cone beam Computed tomographic					
Space between	**Gender**	**Mean ±S.D**	**S.E**	**t**	**p-value**
Tip of Canine and Occlusal plane	Male	5.76 ± 2.18	0.975	2.898	0.010*
	Female	10.01 ± 3.01	0.775		
Lateral incisor and 1st premolar	Male	3.50 ± 2.39	1.07	2.499	0.022*
	Female	6.23 ± 2.03	0.524		
Horizontal size from distal surface of upper right 1st molar to distal surface of upper left 1st molar	Male	89.80 ± 8.64	3.87	0.536	0.598
	Female	91.93 ± 7.41	1.91		

Table (9) Uni-gender, descriptive statistics and dependent t-test of angular measurments between male and female in panorama radiography.

Panorama radiographic					
Angle between	**Gender**	**Mean ±S.D**	**S.E**	**t**	**p-value**
Canine and midline	Male	10.74 ± 7.13	3.19	4.569	0.000**
	Female	37.47 ± 18.99	4.90		
Canine and Lateral incisor	Male	19.64 ± 8.43	3.77	4.330	0.001*

	Female	46.47± 19.03	4.91		
Canine and Occlusal plane	Male	74.20± 4.71	2.11	6.856	0.000**
	Female	42.13 ± 16.17	4.17		

Table (10) Uni-gender, descriptive statistics and dependent t-test of linear measurments between male and female in panorama radiographic.

Panorama radiographic					
Space between	**Gender**	**Mean ±S.D**	**S.E**	**t**	**p-value**
Tip of Canine and Occlusal plane	Male	9.00 ± 4.64	2.07	2.484	0.023*
	Female	14.07 ± 3.73	0.963		
Lateral incisor and 1st premolar	Male	3.00 ± 2.45	1.09	1.310	0.207
	Female	4.50 ± 2.14	0.554		
Horizontal size from distal surface of upper right 1st molar to distal surface of upper left 1st molar	Male	84.40 ± 5.32	2.38	1.690	0.108
	Female	89.60 ± 6.13	1.58		

Table (11) Descriptive statistics and independent t-test between cone beam computed tomography & Panorama radiography at angle size (right side).

Angle between	**Device name**	**Mean ±S.D**	**S.E**	**t**	**p-value**
Canine and midline	CBCT	30.43 ± 18.44	5.32	0.867	0.395
	Panorama radiographic	36.83 ± 17.73	5.11		
Canine and Lateral incisor	CBCT	44.05 ± 17.52	5.06	0.243	0.810
	Panorama radiographic	45.75± 16.74	4.83		
Canine and Occlusal plane	CBCT	56.98± 13.37	3.86	2.102	0.057
	Panorama radiographic	44.25 ± 17.37	5.02		

Table (12) Descriptive statistics and Dependent t-test between CBCT & Panorama radiographic at Space (right Side).

Space between	**Device name**	**Mean ±S.D**	**S.E**	**t**	**p-value**
Tip of Canine and Occlusal plane	CBCT	9.31 ± 2.74	0.791	2.020	0.056
	Panorama radiographic	12.50 ± 4.74	1.37		
Lateral incisor and 1st premolar	CBCT	6.21 ± 1.88	0.544	1.603	0.123
	Panorama radiographic	4.96 ± 1.94	0.559		
Horizontal size from distal surface of upper right 1st molar to distal surface of upper left 1st molar	CBCT	94.58 ± 6.39	1.84	1.502	0.147
	Panorama radiographic	91.00 ± 5.24	1.51		

Table (13) Descriptive statistics and independent t-test between CBCT& Panorama radiography at angle size (left side).

Angle between	**Device name**	**Mean ±S.D**	**S.E**	**t**	**p-value**
Canine and midline	CBCT	24.54 ± 19.68	6.96	0.393	0.700
	Panorama radiographic	20.46 ± 21.77	7.69		
Canine and Lateral incisor	CBCT	35.25 ± 18.87	6.67	0.419	0.682
	Panorama radiographic	30.78± 23.58	8.34		
Canine and Occlusal plane	CBCT	66.75± 18.39	6.50	0.774	0.452
	Panorama radiographic	59.00 ± 21.52	8.34		

Table (14) Descriptive statistics and independent t-test between cone beam computed tomography & Panorama radiography at Space (left Side).

Space between	Device name	Mean ±S.D	S.E	t	p-value
Tip of Canine and Occlusal plane	CBCT	8.42 ± 4.25	1.50	2.271	0.039*
	Panorama radiographic	13.25 ± 4.27	1.51		
Lateral incisor and 1st premolar	CBCT	4.59 ± 2.88	1.02	1.330	0.205
	Panorama radiographic	2.88 ± 2.23	0.789		
Horizontal size from distal surface of upper right 1st molar to distal surface of upper left 1st molar	CBCT	86.63 ± 6.89	2.43	0.757	0.462
	Panorama radiographic	84.25 ± 5.59	1.98		

IV. Discussion

Over recent years, there have been many publications concerning the application of CBCT. Therefore , radiographic evaluation of CBCT and the potential influence of 3D information in vivo for diagnostic and preventive measures needs to be ascertained and requires validation through comparison with conventional methods.

Panorama were chosen as the conventional radiographs , because the panoramic radiograph is a common choice for the diagnosis and treatment planning of impacted canines for most patients undergoing routine orthodontic screening

Orthodontic treatment methodology for impacted canines depends on various factors, such as location of the impacted canine in the dental arch relative to adjacent incisors, the distance from the occlusal plane, canine crown overlaps, and canine angulations. [17,18]

Linear and angular measurements are frequently used as comparative parameters for radiological assessment. They were used in the present study due to their relative use as predictors of canine eruption[15,19,20]

Several authors have suggested that the linear measurement is a reliable method for panoramic radiographs, considering the magnification factors and correct patient position[21,22,23]. Since the vertical distance of the tip of the maxillary canine from the occlusal plane as evident on a panoramic radiograph was considered a good predictor of impaction of a maxillary canine [24,25], so it was used in this study to evaluate the vertical position of the maxillary canine.

On the other hand, Canine angulation to the midline was selected for the current study as a predictor for probable canine impaction ,[19,26,27] as considered canine angulation as a good indicator of canine impaction.

In the present study, radiographic variables were evaluated in pre-treatment panoramic and CBCT radiographs. As both groups had panoramic images, the angulation measurements, overlaps, and vertical canine height determinations were performed on panoramic radiographs rather than on CBCT images. Linear measurements were not performed on panoramic radiographs, due to the amount of distortion and magnification. [28,29]

CBCT images were less influenced by patient position and free from the influence of the pattern of superimposition of the anatomical structures, which may have a significant influence on the measurement. Moreover, CBCT reconstruction allows greater accuracy and reliability for linear measurements[30] with improved visualization of the anatomical situation of the impacted maxillary canine.

The result of the current study shows that the linear measurement of the two imaging modalities was statistically different . This may occur because every system has various sources of display and measurement error. In panorama images, structures closer to the X-ray source appear more magnified than those closer to the detector, such as palatally impacted canines. The canine angle to the midline was statistically different between the CBCT and panorama images. [31]

The determination of canine location was highly significantly different between the panorama and CBCT systems because CBCT images provide applicable diagnostic information for canine location in the sagittal, axial, and coronal planes without overlap. This is in agreement with the study of Nagpal . [32]

Previous investigations have compared treatment planning differences between use of 2D images and CBCT images. [33,34,35] The results in two studies showed that there was a difference in treatment planning [34,35]. However, it has been found that the treatment proposal for impacted canines did not differ whether based on 2D or 3D information, which is in agreement with our findings. [35]

In the present study the impacted maxillary canine in female is 57% which was found to be similar to Hossein et al [36] ,where the majority of patients were female (80%), this may be due to the differences of craniofacial growth and development factors between both sexes or even may be a result of frequent orthodontic visits among females with aesthetic purposes.

The most important challenge for a maxillofacial surgeon in keeping or removing the impacted canine is the buccopalatally localization of the tooth crown. Although 2D imaging techniques could accurately localize the majority of impacted teeth sometimes they show weaknesses in the accurate detection of buccolingual location of the impacted tooth and its adjacent structures. Ericson and Kurol . [37] reported that 8% of impacted maxillary canines could not be accurately localized in periapical radiographs.

Haney et al [33] showed that treatment plan is significantly influenced by the imaging technique. They reported that 36% agreement between 2D and 3D imaging techniques regarding treatment planning. In this study 80% agreement in treatment planning between the two techniques was found.

The result of this study considered the maxillary canine to be at high risk for impaction if its angulation to the midline is above 31 degree. This result is in agreement with [15,19,38] who found that the majority of impacted canine were angulated to the midline with angles greater than 31 degree. Also the finding of this study was confirmed by the finding of Warford, [20] who used a different method for measuring canine angulation as they measured it in relation to the bicondylar horizontal line. These findings are also supported by the finding of [32] found that the impacted canine was mesially tilted at angle of approximately 30 degree and the unimpacted canine was almost vertical.

The finding of the current study showed a higher incidence in right side than on the left. These findings are in agreement with Grande[39]. This disagrees with the finding of [24,40] who found that there is no significant statistical difference between right and left side regarding angulation and vertical distance at different age group.

V. Conclusion

CBCT may be a reliable method for detecting canine impaction and root resorption of adjacent teeth. A CBCT image establishes the link between 2D and 3D imaging and is more accurate for the different diagnostic tasks in canine impaction than panoramic radiography. Using CBCT with the maximum data available would help reduce unnecessary radiation exposure.

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