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Reliability of CBCT Dataset in Determination of Surgical Approaches of Maxillary Impacted Canine Teeth

Huner Hussein Rasheed[1*], Nazar Abdulqadir Hama Amin[2]

[1]*College of Dentistry, University of Sulaimani, Sulaimani, Kurdistan Region, Iraq*

[2]*College of Dentistry /Oral and Maxillofacial Surgery, University of Sulaimani, Sulaimani, Kurdistan Region, Iraq*

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ABSTRACT

Background: One of the most commonly impacted teeth is the maxillary canine, right after the third molar. Many potential difficulties might arise before, during, and after the extraction of impacted maxillary teeth. Performing thorough radiographic exams can be beneficial. The information needed for a two-dimensional (2D) examination is provided by the periapical and panoramic radiographs (OPG) utilized in conventional dental radiography. Cone beam computed tomography (CBCT) is a novel imaging technology developed in response to the shortcomings of traditional (2-D) imaging methods. Everyone will gain from these problems being resolved.

Objectives: This study aims to evaluate two types of 2D (OPG) and 3D imaging (CBCT) approaches for diagnosing and treating maxillary impacted canines. Furthermore, to determine the best approach selection option for surgical removal procedures utilizing OPG and CBCT, focusing on the sagittal section for increased safety and efficiency.

Materials and Methods: This study is a prospective radiographic investigation of 80 patients with CBCT radiographic evaluation. Eighteen cases (22.5%) of men and 62 (77.5%) of women were reported. Version 27 of SPSS was used to analyze the data. The independent t-test offered information on the reliability of the quantitative variables. We utilized a Chi-square test for the qualitative analysis, and for the quantitative analysis, we used a cross-tabulation to determine the level of agreement.

Results: The t-test result, depending on surgical approach time, was 8.4; there is a significant difference between the two radiography prognoses, with p-values of (0.000) at the significant level (0.05). The % age of agreement between impactions and surgical techniques ranged from 87.5% to 100%.

Conclusion: This study shows that the CBCT guide can provide accurate, reliable, and reproducible results in assessing and predicting the kind of impaction and surgical approach in a simple, time-saving manner.

Keywords: Canine, Maxillary, Impacted teeth, CBCT (Cone Beam Computed Tomography), OPG (panoramic radiography).

1. Introduction

When a tooth does not erupt at the expected time, it is said to be "impacted"[1]. After the wisdom teeth, the upper canine and the lower premolars are the most common teeth to become impacted[2]. After the maxillary and mandibular third molars, the maxillary canines are the most commonly affected teeth when eruptions occur[3].

One to three % of the population is known to have maxillary canine impaction. There is a roughly 2:1 ratio of females to males in occurrence[4, 5]. In addition, the %age of canines influenced by both the mouth and the jaw varies substantially. Most impacted canine teeth are placed labially, whereas the remaining two-thirds are located on the palatal side of the upper jaw[6, 7]. It is more common for the canine to become impacted in the maxilla than the mandible[8].

There are two types of maxillary canine impaction: unilateral and bilateral. The canine disease's etiology is attributed to generalized and localized variables. In generalized causes, abnormal muscular pressure, vitamin D deficiency, radiation, fever, and a lack of endocrine hormones are just a few more common causes. Dental arch size discrepancies-longer or lost deciduous canine, incorrect position of tooth buds, presence of alveolar clefts,

* Corresponding author
E-mail address: huner.rasheed@univsul.esu.iq (Instructor).
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ankylosis or tumors, and root deformity are all localized causes[9]. Canine impactions are also connected with illnesses like malnutrition, anemia, rickets, and cleft lip and palate. They are also linked to disorders such as cleidocranial dysplasia, chondrodysplasia, progeria, and Down syndrome[10]. It has recently been suggested that there may be a connection between how the face develops and the likelihood of canine impaction. Additionally, it has been noted that individuals who have deep bites have an increased risk of canine impaction[11].

The maxillary canines are an essential component in the overall facial attractiveness and the formation of the dental arch and occlusion. Canines that are only partially erupted or impacted that are left untreated can lead to several complications. These issues include dental arch shortening, follicular cyst formation (Dentigerous cysts), canine tooth ankylosis, recurring infections, discomfort, internal resorption, external resorption of the canine and surrounding teeth, or a combination of these[12, 13]. As a result, a more precise diagnosis and treatment plan can be developed, reducing the risk of problems related to the disease's occurrence or treatment[14].

Preliminary diagnoses might be made via clinical examination and palpation or radiological means. It is possible to begin treatment as early as age eight if a diagnosis is made. It takes 9.3 and 13.1 years for the maxillary canine to erupt[15].

Periapical, occlusal, Orthopantomagraph (OPG), and cephalometric radiographs can be used to determine the location of impacted teeth and their associations with neighboring structures. However, Orthopantomagraph or Panorex may be insufficient in cases of superpositions caused by distant locations of impacted teeth. Employing cone beam computed tomography (CBCT) is preferable since it can examine teeth in three different directions without superimpositions[16]. In contrast to conventional C.T. scans, which expose patients to significant doses of radiation, this method provides patients with clear, three-dimensional images of their teeth without distortion. CBCT does not distort images of impacted teeth, unlike panoramic radiography (OPG)[17]. An impacted canine's labio palatal and incisor root resorption might be difficult to evaluate on an OPG due to blurring of the image, mistake of distortion projection, and overlap of adjacent tissues[20].

High-resolution pictures produced by CBCT scanning and 3D rendering techniques have proven effective in the diagnosis of impacted canines and treatment planning, as well as the detection of related problems, such as root resorption, in adjacent incisors[18]. For example, CBCT scans are quick, precise, and low-dose while providing high-resolution images and low artifacts and magnification[2].

Before any surgical surgery, a thorough preoperative assessment is required to minimize difficulties and take essential safety precautions. It is also possible to reduce bone loss by showing the precise position and surgical entryway. The discovery of tiny neurovascular bundles should be given more attention to limit the risk of harm. Hemorrhage and nerve impairments such as paranesthesia, anesthesia, and pain can result from surgical manipulation of these bundles[7].

A maxillary canine is extracted if it is ankylosed and cannot be transplanted if its root is severely dilacerated, if there is severe impaction, if the occlusion is good with the first premolar in the canine's position, or if there are pathologic changes (such as cystic formation or infection), and if the patient does not want orthodontic treatment[19]. In cases where the impacted maxillary canines are in an uncomfortable situation or cannot be re-implanted, surgical extraction is the most effective treatment[3]. The goal of this study is to determine the benefit of CBCT especially sagittal section in the pre-evaluation of surgical removal or exposure of maxillary impacted canine teeth in order to avoid any pre or post-surgical complications during surgery for more safety and time management, rather than incidental findings.

2. Materials and Methods

On November 17, 2021, the College of Dentistry at the University of Sulaimani's Ethical and Scientific Committees accepted and decided on this study. In this prospective cross-sectional clinical and radiographic study, we gathered information from patients who visited the UoS postgraduate department between 1.12.2021 and 1.7.2022, some of whom required pre-prosthetic or orthodontic treatment due to missing maxillary canines. They have had surgery, some have had surgical exposure, and others have had surgical extraction for the maxillary impacted canine. Additionally, this research aims to demonstrate the value of CBCT in assessing maxillary impacted canine teeth before surgical exposure, particularly in the sagittal section.

It is essential to get the most out of CBCT since it has the potential to significantly impact treatment planning, allowing clinicians to make better decisions about surgical strategy, which saves both time and money when treating maxillary canine impaction. Eighty cases of maxillary impacted canines previously diagnosed by patients who visited my private dental clinic or the postgraduate dental clinic at Sulaimani University were taken. For each patient to satisfy the sample's requirements, the clinical impaction diagnosis required an intraoral examination in conjunction with the first radiographs. When clinically indicated, we performed CBCT imaging (sagittal section) on 40 of these patients, while the remaining 40 relied solely on clinical and standard radiography pictures (such as OPG) without CBCT.

All of the 80 impacted maxillary impacted canines included in this study are between 12 and 40 years old, whether they have bilateral or unilateral impactions, without regard for the gender of the patients, and fulfill the following inclusion criteria:

- Absence of any maxillofacial syndrome, cleft lip and palate, trauma, or tumor
- Patients who are not pregnant
- No previous orthodontic treatment
- Not have history orthognathic surgery
- Not have dentofacial anomalies

Eighty patients had maxillary canines affected on both sides: ten had left-sided canines, forty had left-sided canines, and thirty had right-sided canines. 18 (22.5 %) men and 62 (77.5 %) women made up our study's total number of participants. There were 62

palatal cases (77.5 %) and 18 buccal cases (22.5 %) of impacted canine teeth out of 80 patients. During surgery, every patient is evaluated to see how different evaluations and time management change from one operation to the next.

Figure 1: OPG taken from a patient.

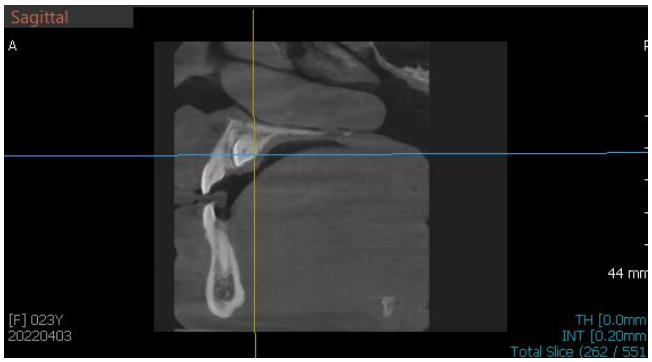

Figure 2: Patient's CBCT. Sagittal section.

Figure 3: clinical operation image (surgical exposure of upper right canine impaction).

3. Results

In our study, we performed surgery on 40 patients with OPG and 40 patients with CBCT, a total of 80 patients, for surgical approaches or surgical extraction for 80 maxillary impacted canine teeth that indicated extraction or surgical approaches for prosthetic purposes or orthodontic appliance purposes. The surgery was then carried out once we had evaluated them. We also compared the amount of time and found that only roughly three patient approach paths were wrongly predicted using only OPG. Fortunately, none of the patients who received CBCT experienced difficulties or mistakes when finding their teeth.

Table 1: Demographic and Clinical Characteristics.

Variables	N(%) or Mean (S.D.)
Sex-Female(%)	62(77.5)
Age in Years (SD)	24.52(8.168)
Sides-Left(%)	40(50)
Radiographic Tools-CBCT(%)	40(50)
Upper Deciduous Exfoliated(%)	44(55)
Types Impactions Palatally(%)	59(73.75)
Surgical Approach Palatally(%)	62(77.5)
Positive – Negative - Positive(%)	77(96.2)
Time Surgical Approach in Minutes(SD)	32.18(11.714)

Continuous variables are presented as Mean (S.D.); Categorical Variables as Frequency (%)

The above tables show that this study had a total of eighty participants. The average age of the participants was 24.52 years. Our patients ranged in age from 13 to 40 years old. Sixty-two female patients (77.5 %) and 18 male patients (22.5 %) were included in the study's gender analysis, which revealed the incident's evident superiority in females compared to males. Ten occurrences of bilateral impact and 70 cases of unilateral impact were discovered. There was a total of 80 canines studied. 37.5 % were found on the right, 50% on the left, and 12.5 % on the right and the left (bilateral). Fifty-nine incidences of palatally impactions and 21 cases of labial impactions were recorded. However, 61 incidences of palatally impaction and 18 cases of labial impaction were established during surgery. There were 77 correctly predicted cases and three incorrect ones.

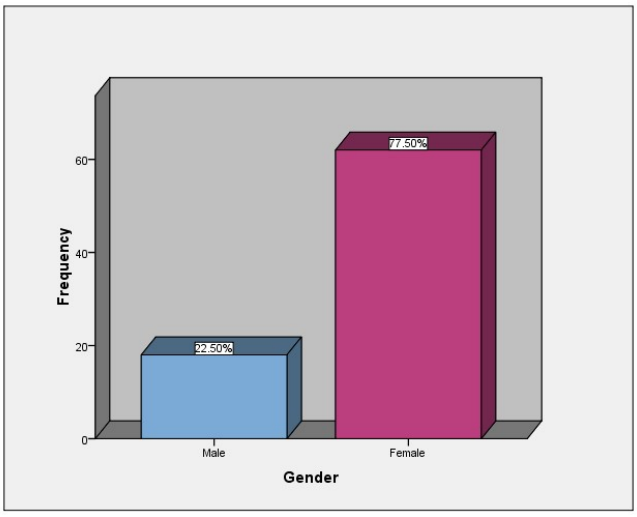

Figure 4: Bar Chart of Gender Variables The Males are 22.5%, and The Females are 77.5%.

Table 2: Distribution of Types Impactions of Surgical Approach.

			Surgical_Approach			(P-Value*)
			Labially	Palatally	Total	
Types_Impactions	Labiall	Count	18	3	21	(0.001)
		%	85.70%	14.30%	100.00%	
	Palatally	Count	0	59	59	
		%	0.00%	100.00%	100.00%	
Total		Count	18	62	80	
		%	22.50%	77.50%	100.00%	

*: chi-square test

Table (2) depicts the distribution of impaction types by surgical method. In the surgical procedure, 85.70 % of impacted canines were positioned labially and were accurately guessed with kinds of impaction. Comparatively, all types of impactions correctly predicted where impacted canines were located palatally, while 14.3% of impacted canines were located palatally but moved in a way that OPG did not predict.

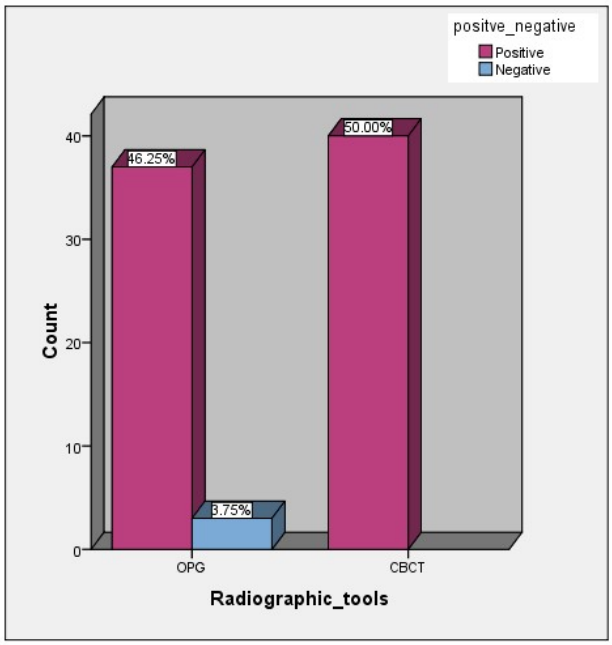

Figure 5: Bar Chart of Radiographic Variables Shows the Distribution of CBCT and OPG Diagnoses Positively or Negatively.

Table 3: Descriptive Statistics.

Group Statistics							T-test for Equality of Means	
Time surgical approach	Variables	Group	N	Mean	Std. Deviation	Std. Error Mean	T	P-Value*
	Gender	Male	18	36.89	9.273	2.186	1.975	0.052
		Female	62	30.81	12.053	1.531		
	Radiographic Tools	OPG	40	40.20	11.039	1.745	8.406	0.001
		CBCT	40	24.15	4.897	.774		

*: independent t-test

Table (3) shows the overall time allocated for males was 36.89 minutes. However, the time allocated for females was 30.81 minutes compared to the time for the surgical method based on gender. In comparison, the overall time allocated for all those who received OPG was 40.2 minutes. However, the time allocated for those who received CBCT took 24.15 minutes and compared surgical approaches based on radiographic tools. The result was examined using a parametric test to indicate the importance of the differences. The test result revealed a low statistically significant difference between the mean surgical approach depending on gender at the level of ($\alpha = 0.1$). It is worth noting that the P-value (Sig.) for the above test is equal to (0.052), which is less than the level of significance ($\alpha = 0.1$), indicating that there is a low statistically significant difference between the means of the two samples. And suggests that female operatives take less time than male operatives. The test result revealed a highly statistically significant difference between the mean time surgical approach depending on CBCT and OPG at the level of ($\alpha = 0.05$). It is worth noting that the P-value (Sig.) for the above test is equal to (0.000), which is less than the level of significance ($\alpha = 0.05$), indicating that there is a highly statistically significant difference between the means of two samples. And suggests that people who received CBCT needed less time than those who received OPG. Compared to OPG, CBCT has a 16-minute lower average operating time.

Discussion

After the third molars, the maxillary canine is the most often impacted tooth. Multiple studies have found a higher prevalence of MCI in these individuals compared to other groups. Radiographic examination through cone beam computed tomography (Sagittal section) is the gold standard for diagnosing impacted canines and is crucial in treating these cases. Proper diagnosis is required for successful treatment. Since orthodontists and maxillofacial surgeons may need to take completely different approaches to treat impacted maxillary canines, accurate diagnosis is of the utmost importance. The surgical approach or removal of maxillary impacted canine teeth needed accurate knowledge of their location in the jaw and its relation to other structures. Checking the tomographic relationship between anatomical components and their spaces before beginning patient preparation is essential for a successful impacted tooth extraction.

The rotation, root resorption, and location of the impacted canine also play a role in treatment decisions. As a result, radiological assessments are crucial to diagnosing and treating many diseases. Meanwhile, CBCT is now widely accessible, and it has the potential to revolutionize how we assess afflicted dogs. Recent research has shown that this method can be used effectively and that 3D imaging techniques have promising applications in diagnosing impacted teeth. Therefore, this study aims to (1) compare the effectiveness of CBCT and panoramic radiography in identifying impacted maxillary canines and (2) assess how these methods affect treatment strategies.

Recent research has shown that the incidence of impacted maxillary canines ranges from 0.9% to 3%, with females being more likely to experience this condition than males. Among our patient population, we find that females are significantly more common. This study found that females made up 77.5% of the participants compared to 22.5% of the male participants. It could be because of differences in craniofacial growth and development between the sexes or because women seek orthodontic treatment more frequently for cosmetic reasons.

Mah and Alexanderiani reported that palatally impacted canines (64%) are more common than buccally impacted canines (32%)[21]; when it comes to European participants, canines are impacted palatally at least twice as often as they are labially[22]. It has been found that the prevalence ratio of Europeans to Asians for a palatal location is 5:1[23]. In Asian patients, on the other hand, impacted canines were typically mid-alveolus or labial. In our study, 77.5% of impacted canines were located palatally, followed by labial impactions, which accounted for 22.5%. Indicating a higher number of maxillary canine impactions located palatally than buccally.

Our analyses revealed that each parameter's outcomes vary between panoramic and CBCT pictures. Some variations, like root resorption, rotation, and Bucco palatal crown localization, were important, though not all.

When deciding whether or not to save an impacted canine, maxillofacial surgeons must consider where the crown of the tooth is positioned. Bucco on the palate, even though 2D imaging techniques (OPG) could accurately locate most impacted teeth, periapical radiographs could not accurately locate 8% of impacted maxillary canines because of errors in detecting the buccolingual location of the impacted tooth and its neighboring structures[17]. It has been shown that females are disproportionately impacted[24- 27]. Our study found that the incidence ratio in females was higher than in male-female patients (77.5%) and male patients (22.5%) of the total sample. Moreover, the majority of patients had unilateral surgery. There were 12.5% of cases with bilateral and 87.5% with unilateral impacts. The rate of wrongly guessed assessment for OPG images by the three patients of the 40 cases in which OPG was taken is 7.5%, there were no errors in the cases that underwent CBCT, and the error rate due to CBCT was 0%.

The overall average time taken for cases of OPG was 40.2 minutes, whereas the time was reduced for cases receiving CBCT by 24.53 minutes, which is approximately half the time taken for cases of OPG. Our study shows that CBCT is more accurate than a 2D panoramic radiograph (OPG) in the localization of maxillary impacted canines.

Conclusion

This research reveals that CBCT guidance can provide precise, reliable, and reproducible data in assessing and predicting the kind of impaction and surgical strategy in a streamlined, efficient manner. Compared to traditional radiography, CBCT allows for a more accurate diagnosis, shorter treatment times, and higher success rates when dealing with impacted teeth. This study demonstrates that the CBCT guide can deliver accurate, dependable, and reproducible findings in assessing and predicting the kind of impaction and surgical approach in a straightforward, time-saving manner. It is recommended that further research be conducted with a bigger sample size and that additional practice be undertaken.

Conflict of interests

None

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