RESEARCH PAPER

Two-Dimensional Versus Three-Dimensional Imaging in the Evaluation of Impacted Maxillary Canines.

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Abstract:

Background: Accurate localization of impacted maxillary canines is critical for diagnosis, treatment planning, and prevention of complications such as root resorption of adjacent teeth. Conventional two-dimensional imaging using orthopantomograms (OPG) is routinely employed; however, cone beam computed tomography (CBCT) provides three-dimensional visualization that may enhance diagnostic accuracy.**Aim:** To compare and evaluate the positional assessment of impacted maxillary canines using OPG and CBCT imaging. **Materials and Methods:** This observational study evaluated patients presenting with impacted maxillary canines. Each impacted canine was assessed using both OPG and CBCT. Parameters evaluated included angulation to the midline, mesiodistal position, vertical position, buccolingual position, and root apex location. Data were analyzed to compare the diagnostic findings obtained from OPG and CBCT imaging modalities.**Results:** CBCT demonstrated superior accuracy in determining the three-dimensional position of impacted maxillary canines compared to OPG. Significant discrepancies were observed between the two modalities, particularly in buccolingual localization, root apex position, and detection of proximity to adjacent tooth roots. CBCT provided additional clinically relevant information not evident on OPG. **Conclusion:** While OPG remains a valuable initial diagnostic tool due to lower radiation dose and accessibility, CBCT offers a more precise assessment of impacted maxillary canine position. CBCT should be considered in cases where detailed localization is required for treatment planning or when OPG findings are inconclusive.

Keywords: Impacted maxillary canine, Orthopantomogram, Cone beam computed tomography, CBCT, Orthodontic diagnosis

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Introduction:

Tooth eruption is the movement of a developing tooth from its initial non functional position within the alveolar bone to its functional position in the oral cavity. Eruption starts once the crown is fully developed and root formation begins, with bone resorption creating a path for the tooth to emerge. (1) When the cusps reach the alveolar crest, eruption speeds up but gradually slows as the tooth nears the occlusal plane.(2)

Disruptions in normal tooth eruption process present frequent challenges in dental practice, such as delayed eruption, submerged teeth, premature eruption, primary failure of eruption, intraosseous ectopic migration of unerupted teeth etc. Tooth impaction is among the most frequently observed dental anomalies.

An impacted tooth is the one that fails to erupt at its appropriate location in dental arch within its normal period of development.[3]An impacted tooth may result due to variety of reasons such as inadequate space, some physical barrier like bone, mucosa, retained deciduous tooth, supernumerary tooth etc. in the eruption path or lack of eruptive force.

The teeth most frequently affected by impaction, in descending order, are third molars, maxillary canines, mandibular premolars, and maxillary central incisors.[4,5] The reported incidence of impaction for mandibular and maxillary third molars is 20% and 18%, respectively, while maxillary canine impaction has an incidence of 0.82%-2.8%.[5,6]

Among patients with impacted maxillary canines, around 8% experience bilateral impaction. Palatal impactions are more common than buccal canine impaction, with a ratio of approximately 2:1 or 3:1.[7] Maxillary canine impactions occur about twice as often in females compared to males and are most commonly located on the palatal side.[4] The incidence of mandibular canine impaction is 0.35%. Mandibular canine impaction is less frequent and the incidence has been reported to be 20 times lower than that for maxillary canines.[8]

Radiographs are essential for assessing the position of impacted canines in three dimensions, determining their relation to the midline and adjacent teeth, and detecting any root resorption. Several radiographic methods can be employed to assess the location, presence, and any pathological changes associated with impacted canines. These include intraoral periapical radiographs (IOPA), occlusal radiographs, panoramic radiographs, computed tomography (CT), and cone-beam computed tomography (CBCT)

OPGs are crucial in identifying potential complications linked to impacted canines. They provide a comprehensive view of the entire dental arch, enabling orthodontists to assess other underlying factors, such as crowding or a lack of space for the impacted tooth, that could influence the treatment approach. [9]OPGs continue to be a crucial component of the initial diagnostic evaluation due to their simplicity, lower radiation exposure, and ability to swiftly provide a comprehensive overview of the relevant area.

Parameters Assessed

Another tool for diagnosis and management of impacted canines includes Cone Beam Computed Tomography (CBCT) which provides detailed 3D imaging that enhances treatment planning. While OPG remains useful for initial detection of impacted canines, the addition of CBCT significantly improves the diagnostic process. Role of CBCT in Diagnosis includes: Accurate Localization, Assessment of Tooth Position and Path, Evaluation of surrounding structures, Pre-surgical Planning

Despite the growing use of CBCT, its routine application remains controversial due to concerns regarding radiation exposure and cost. Therefore, a comparative evaluation of OPG and CBCT is necessary to determine the clinical relevance and added diagnostic value of CBCT in assessing impacted maxillary canines.

Materials and methodology:

This observational study was conducted on 23 patients of age group 13-40 years presenting with impacted maxillary canines who reported to the Department of Orthodontics and Dentofacial Orthopaedics. Ethical clearance was obtained prior to the commencement of the study, and informed consent was acquired from all participants.

Sample Selection

Patients with radiographically confirmed impacted maxillary canines were included in the study. Patients with syndromic conditions, craniofacial anomalies, or a history of previous orthodontic or surgical intervention related to impacted canines were excluded.

Imaging Protocol

Each patient underwent panoramic radiography followed by CBCT imaging. OPGs were evaluated for angulation of the canine to the midline, mesiodistal overlap, and vertical position. CBCT scans were analysed in axial, sagittal, and coronal planes to assess the exact three-dimensional position of the impacted canine, including buccolingual position and root apex location.

Fig 1: Angulation of the canine to the midline

Fig 2: Horizontal (mesiodistal) position

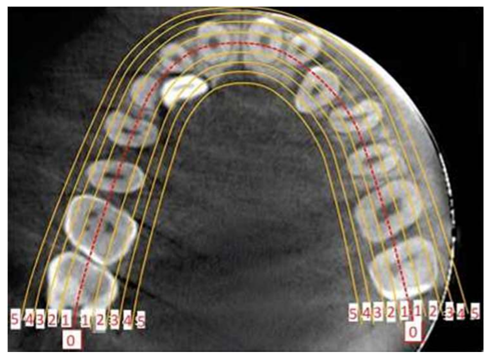

Fig 3: Vertical position relative to adjacent teeth

Fig 4 : Buccolingual Position

Fig 5: Root apex location

Statistical Analysis:

Data obtained from OPG and CBCT evaluations were statistically analyzed using appropriate tests to assess differences between the two imaging modalities. A p-value of <0.05 was considered statistically significant.

RESULTS:

Sample Characteristics

A total of **23 patients** (13 females, 10 males) with maxillary impacted canines were included in this observational study. The age of the participants ranged from **13 to 40 years**.

Among the impacted canines:

- **12 cases** were in the right quadrant
- **11 cases** were in the left quadrant
- **13 patients** presented with unilateral impaction
- **10 patients** presented with bilateral impaction

Each patient underwent both **Orthopantomogram (OPG)** and **Cone-Beam Computed Tomography (CBCT)** imaging. The severity of impaction was categorized as **mild, moderate, or severe** based on predefined criteria.

Categorical data were analyzed using the Chi-square test. Statistical significance was set at $P < 0.05$.

Severity	OPG (n=23)	CBCT (n=23)	χ^2value	p-value
Mild	2 (8.7%)	8 (34.8%)	5.123	0.077
Moderate	10 (43.5%)	9 (39.1%)		
Severe	11 (47.8%)	6 (26.1%)		

Table I:Overall Comparison Between OPG and CBCT

CBCT demonstrated a numerical trend toward classifying impacted canines as less severe compared with OPG; however, the difference was not statistically significant ($P > 0.05$).

- Mild impaction was identified in **8 cases (34.8%)** using CBCT compared with **2 cases (8.7%)** using OPG.
- Moderate impaction was identified in **9 cases (39.1%)** using CBCT compared with **10 cases (43.5%)** using OPG.
- Severe impaction was identified in **6 cases (26.1%)** using CBCT compared with **11 cases (47.8%)** using OPG.

CBCT reduced the proportion of cases classified as severe by 21.7% compared with OPG.

Quadrant	Severity	OPG	CBCT	χ^2value	p-value
Right (n=12)	Mild	1 (8.4%)	3 (25%)	1.929	0.381
	Moderate	4 (33.3 %)	5 (41.7 %)		
	Severe	7 (58.3 %)	4 (33.3 %)		
Left (n=11)	Mild	1 (9.1%)	5 (45.4 %)	3.733	0.155
	Moderate	6 (54.5 %)	4 (36.4 %)		
	Severe	4 (36.4 %)	2 (18.2 %)		

Table II: Quadrant-wise Comparison

Right Quadrant (n = 12) CBCT showed: Increased mild cases (25% vs. 8.4%),Reduced severe cases (33.3% vs. 58.3%) However, the difference was not statistically significant ($P = 0.381$).

Left Quadrant (n = 11) CBCT showed: Substantial increase in mild cases (45.4% vs. 9.1%)

- Reduction in severe cases (18.2% vs. 36.4%)

The difference was not statistically significant ($P = 0.155$).

	Severity	OPG	CBCT	χ^2value	p-value
Unilateral (n=13 teeth)	Mild	1 (7.6 %)	5 (38.5 %)		

	Moderate	6 (46.2%)	5 (38.5%)	3.758	0.153
	Severe	6 (46.2%)	3 (23%)		
Bilateral(n=10 teeth)	**Mild**	1 (10%)	3 (30%)	1.500	0.472
	Moderate	4 (40%)	4 (40%)		
	Severe	5 (50%)	3 (30%)		

Table III: Unilateral vs Bilateral Impaction

Gender	Severity	OPG	CBCT	χ^2value	p-value
Female (n=13)	**Mild**	1 (7.6%)	5 (38.5%)	4.667	0.970
	Moderate	6 (46.2%)	6 (46.2%)		
	Severe	6 (46.2%)	2 (15.3%)		
Male (n=10)	**Mild**	1 (10%)	3 (30%)	1.254	0.534
	Moderate	4 (40%)	3 (30%)		
	Severe	5 (50%)	4 (40%)		

Table IV: Gender-wise Comparison

Unilateral Impaction (n = 13)

CBCT demonstrated: Higher mild classification (38.5% vs. 7.6%),Lower severe classification (23% vs. 46.2%), The difference was not statistically significant (P = 0.153).

Bilateral Impaction (n = 10) CBCT showed: Increased mild cases (30% vs. 10%),Reduced severe cases (30% vs. 50%),No statistically significant difference was observed (P = 0.472).

Females (n = 13) CBCT showed: Higher mild cases (38.5% vs. 7.6%)Marked reduction in severe cases (15.3% vs. 46.2%),The difference was not statistically significant (P = 0.970).

Males (n = 10) CBCT demonstrated: Increased mild cases (30% vs. 10%) Slight reduction in severe cases (40% vs. 50%)

The difference was not statistically significant (P = 0.534).

Agegroup	Severity	OPG	CBCT	χ^2value	p-value
13-25years(n=19)	**Mild**	1 (5.2%)	7 (36.8%)	5.700	0.058
	Moderate	9 (47.4%)	6 (31.6%)		
	Severe	9 (47.4%)	6 (31.6%)		
26-40years(n=4)	**Mild**	1 (25%)	1 (25%)	3.000	0.223
	Moderate	1 (25%)	3 (75%)		
	Severe	2 (50%)	0		

Table V: Age-wise Comparison

13–25 Years (n = 19) CBCT showed: Higher mild cases (36.8% vs. 5.2%),Reduced moderate and severe classifications The difference approached statistical significance (P = 0.058).

26–40 Years (n = 4) CBCT demonstrated:No severe cases (0%) compared with 50% severe cases in OPG,Increased moderate cases (75% vs. 25%)

The difference was not statistically significant (P = 0.223), likely due to small sample size.

Overall Interpretation of Results

Although none of the comparisons reached statistical significance ($P>$ 0.05), CBCT consistently demonstrated a **numerical trend toward reduced severity classification**, particularly:

- Increased identification of mild impactions
- Decreased classification of severe impactions
- Strongest trend observed in younger age group (13–25 years)

The findings suggest that CBCT may provide a more precise three-dimensional assessment, potentially reducing overestimation of impaction severity seen with OPG.

Discussion :

The primary objective of this study was to compare and evaluate the positional assessment of impacted maxillary canines using two imaging modalities: Orthopantomography (OPG) and Cone-Beam Computed Tomography (CBCT). The study aimed to determine the diagnostic accuracy of each method and assess whether CBCT offers a clinically significant advantage over OPG in localizing impacted maxillary canines.[7]

Although no statistically significant differences were found in severity distribution between the two modalities ($p > 0.05$), a consistent numerical trend was observed in which CBCT classified a greater proportion of cases as mild and fewer as severe compared with OPG.

The complex eruption path of the maxillary canine and its susceptibility to displacement underscore the importance of accurate radiographic localization [1,2,10,11]. Etiologically, both the guidance theory proposed by Becker [12] and the genetic theory described by Peck [13] emphasize the developmental complexity of canine impaction. Given the risk of complications such as adjacent root resorption and cystic changes [14], precise imaging is essential for treatment planning.

In the present study, CBCT identified 34.8% of cases as mild compared with 8.7% on OPG, while OPG categorized 47.8% as severe versus 26.1% on CBCT. Similar numerical trends were observed across quadrant, gender, unilateral/bilateral, and age-based comparisons. These findings suggest that OPG may overestimate severity due to inherent limitations such as magnification errors and superimposition (15). CBCT, by providing three-dimensional visualization, improves spatial localization and reduces ambiguity [16].

Our results align with Haney et al. [17] and Walker et al. [18],who reported greater diagnostic accuracy and treatment planning changes when CBCT was used. However, unlike Botticelli et al. [19],statistical significance was not achieved in our study, likely due to the limited sample size (n=23). The borderline p-value in the 13–25-year age group (p=0.058) further suggests that a larger sample may reveal significant differences.

Clinically, these findings indicate that while OPG remains an appropriate initial screening tool due to lower radiation exposure and accessibility, CBCT may be justified in cases where bucco-palatal position is unclear, root resorption is suspected, or surgical planning requires precise localization. Selective rather than routine CBCT use appears consistent with radiation protection principles.

Conclusion

CBCT provides a more accurate and comprehensive assessment of impacted maxillary canine position compared to OPG. While OPG remains valuable for initial evaluation, CBCT should be employed when detailed localization is required for diagnosis and treatment planning. Establishing clear guidelines for the judicious use of CBCT is essential to optimize patient care in orthodontics.

Conflict of Interest: None Declared

References :

1. Proffit WR, Frazier-Bowers SA. Mechanism and control of tooth eruption: overview and clinical implications. OrthodCraniofac May;12(2):59-66. https://doi.org/10.1111/j.1601-6343.2009.01438.x Res. 2009

2. Marks SC, Schroeder HE. Tooth eruption: theories and facts. Anat Rec. 1996 Jun;245(2):374-93.https://doi.org/10.1002/(sici)1097 0185(199606)245:2%3C374::aid-ar18%3E3.0.co;2-m

3. Gupta, Kushdeep & Sawhney, Hemant & Faisal, Mohd & Sasikumar, Athira & Kashwani, Ritik. (2024). Evaluation of Unilateral Transmigration of Cuspid Tooth in Mandibular Arch using 3D Imaging. International Research Journal of Multidisciplinary Scope. 05. 661-667. https://doi.org/10.47857/irjms.2024.v05i04.01206

4. Dachi SF, Howell FV: A survey of 3874 routine fullmouth radiographs. II. A study of impacted teeth. Oral Surg Oral Med Oral Pathol 1961, 14,1165–1169. https://doi.org/10.1016/0030-4220(61)90204-3

5. Grover PS, Lorton L: The incidence of unerupted permanent teeth and related clinical cases. Oral Surg Oral Med Oral Pathol 1985,59,420–425. https://doi.org/10.1016/0030-4220(85)90070-2

6. Aydin U, Yilmaz HH, Yildirim D: Incidence of canine impaction and transmigration in a patient population. DentomaxillofacRadiol 2004,33,164 169. https://doi.org/10.1259/dmfr/15470658

7. Sinha A, Vashisht A, Mahajan M, Sharma S, Bajaj N, Khandelwal H. Cone Beam Computed Tomography - Assisted Surgical Management of Root Canal Perforation. Oral Sphere J. Dent. Health Sci. 2025;1(4):224-232. doi: 10.63150/osjdhs.2025.23

8. Ngan P, Hornbrook R, Weaver B. Early timely management of ectopically erupting maxillary canines. Semin Orthod2005;11:152-63. http://dx.doi.org/10.1053/j.sodo.2005.04.009

9. Naoumova J, Kjellberg H. The use of panoramic radiographs to decide when interceptive extraction is beneficial in children with palatally displaced canines based on a randomized clinical trial. European journal of orthodontics. 2018 Nov 30;40(6):565-74. https://doi.org/10.1093/ejo/cjy002

10. Moyers RE. Standards of human occlusal development. monograph 5, craniofacial growth series. Ann Arbor, Mich: Center for human growth and development, The University of Michigan: 1976. https://babel.hathitrust.org/cgi/pt?id=mdp.39015007438222&seq=7

11. Broadbent BH. Ontogenic development of occlusion. Angle Orthod1941;11:223-41

12. Chaushu S, Zilberman Y, Becker A. Maxillary incisor impaction and its relationship to canine displacement. Am J Orthod Dentofacial Orthop 2003; 124:144-50. https://doi.org/10.1016/s0889-5406(03)00344-5

13. Peck S, Peck L, Kataja M. Concomitant occurrence of canine malposition and tooth agenesis: evidence of orofacial genetic fields. Am J Orthod Dentofacial Orthop 2002; 122: 657-60. https://doi.org/10.1067/mod.2002.129915

14. Ericson S, Kurol J. Resorption of incisors after ectopic eruption of maxillary canines: a CT study. Angle Orthod 2000; 70(6): 415−423

15.Nagpal A, Pai KM, Setty S, Sharma G. Localization of impacted maxillary canines using panoramic radiography. Journal of oral science. 2009;51(1):37 45. https://doi.org/10.2334/josnusd.51.37

16.Alqerban A, Jacobs R, Lambrechts P, Loozen G, Willems G. Root resorption of the maxillary lateral incisor caused by impacted canine: a literature review. Clinical oral investigations. 2009 Sep;13:247-55. https://doi.org/10.1007/s00784-009-0262-8

17. Haney E, Gansky SA, Lee JS, Johnson E, Maki K, Miller AJ et al. Comparative analysis of traditional radiographs and cone-beam computed tomography volumetric images in the diagnosis and treatment planning of maxillary impacted canines. American Journal of Orthodontics and Dentofacial Orthopedics. 2010 May 1;137(5):590-7. https://doi.org/10.1016/j.ajodo.2008.06.035

18.Walker L, Enciso R, Mah J. 3D Localization Of Maxillary Canines With CBCT. Am J Orthod Dentofacial Orthop. 2005 Oct 1;128(4):418-23. https://doi.org/10.1016/j.ajodo.2004.04.033

19. Botticelli S, Verna C, Cattaneo PM, Heidmann J, Melsen B. Two-versus three-dimensional imaging in subjects with unerupted maxillary canines. The European Journal of Orthodontics. 2011 Aug 1;33(4):344-9. .https://doi.org/10.1093/ejo/cjq102