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Advanced Imaging Techniques in Dental Diagnostics: A Focus on Impacted Maxillary Canines Using Cone Beam Computed Tomography

[1]Dr. Ashwinirani SR, [2]Dr. GirishSuragimath, [3]Dr. Madhura Mahajan,
[1]MDS, Associate professor, Dept of Oral Medicine &Radiology, School of Dental Sciences, Krishna Vishwa Vidyapeeth, Deemed to be University, Karad, Satara (District), Maharashtra, India. Email ID: drashwiniranisr@gmail.com
[2]MDS, Professor and Head, Department of Periodontology,School of Dental Sciences, Krishna VishwaVidyapeeth, Deemed to be University, Karad, Satara, Maharashtra, India. Email ID: drgirishsuragimath@gmail.com
[3]MDS, Assistant Professor, Dept of Oral Medicine & Radiology, School of Dental Sciences, Krishna Vishwa Vidyapeeth, Deemed to be University, Karad, Satara, Maharashtra, India. Email ID: madhuraomdr@gmail.com

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Abstract

Objective: *This study investigates the prevalence, anatomical positioning, and complications associated with impacted maxillary canines using Cone Beam Computed Tomography (CBCT), aiming to provide valuable insights for improved diagnostic and treatment approaches.*

Methods: *A retrospective, observational analysis was conducted on 69 CBCT images, encompassing 82 impacted maxillary canines. The study focused on determining the prevalence and location of canine impactions, measuring their proximity to critical anatomical landmarks—the floor of the nasal cavity (FNC) and the floor of the maxillary sinus (FMS)—and identifying associated complications. Statistical analysis included descriptive statistics and paired t-tests to evaluate significant differences in measurements.*

Results: *The findings indicated a higher prevalence of impacted maxillary canines in females, with 54.8% positioned palatially. Average distances from the crown and root tip of impacted canines to the FNC were 16.40 mm and 2.34 mm, respectively, while distances to the FMS were 19.50 mm and 2.98 mm. Common complications included retention of deciduous canines (54.8%) and crowding of teeth (51.2%), with root resorption of adjacent teeth observed in 39% of cases. Statistical analysis revealed significant side-based differences in proximity to the FMS ($p < 0.05$), underscoring potential risks during surgical or orthodontic treatment.*

Conclusion: *The study highlights the utility of CBCT imaging for precise diagnosis and treatment planning of impacted maxillary canines. The close proximity of impacted canines to vital structures and the prevalence of complications emphasize the importance of early and accurate diagnostic imaging. CBCT should be integrated into standard protocols for managing canine impactions to improve clinical outcomes and mitigate associated risks.*

Keywords: *impacted maxillary canines, CBCT, complications, proximity, dental imaging, orthodontic treatment.*

I. Introduction

Impacted maxillary canines (IMCs) represent a prevalent clinical condition characterized by a failure of the canines to erupt into their expected positions in the dental arch. The prevalence of impacted maxillary canines varies globally, generally reported between 1% to 2.5% of the population, with a notable predilection towards females and a unilateral occurrence on the palatal side of the dental arch. These impactions pose significant

challenges due to their critical role in dental aesthetics and functional occlusion. The maxillary canines are pivotal for maintaining arch integrity, providing cuspid guidance, and contributing to the facial profile and smile aesthetics. When impacted, these canines can lead to a variety of complications, including but not limited to, displacement or resorption of adjacent teeth, cyst formation, and occasionally, tumors.

Figure 1: CBCT sections of maxilla is showing impacted maxillary right canine with multiple supernumerary teeth.

The clinical management of IMCs is complicated and requires accurate diagnosis and intervention plans. Traditional radiographic methods, such as panoramic and periapical films, offer limited details and often give two-dimensional insights into a three-dimensional problem. These traditional methods are inadequate for understanding the precise anatomic location of IMCs relative to surrounding structures such as the nasal cavity, maxillary sinus, and adjacent teeth, all crucial for planning effective treatment. The advent of Cone Beam Computed Tomography (CBCT) has revolutionized dental imaging by providing three-dimensional views that overcome the limitations of traditional radiography. CBCT technology offers superior visualization of the spatial relationships and conditions of dental structures, enabling detailed assessments necessary for diagnosing complications associated with IMCs. This study aims to leverage CBCT to explore the positional characteristics of impacted canines and their associated anatomical disturbances.

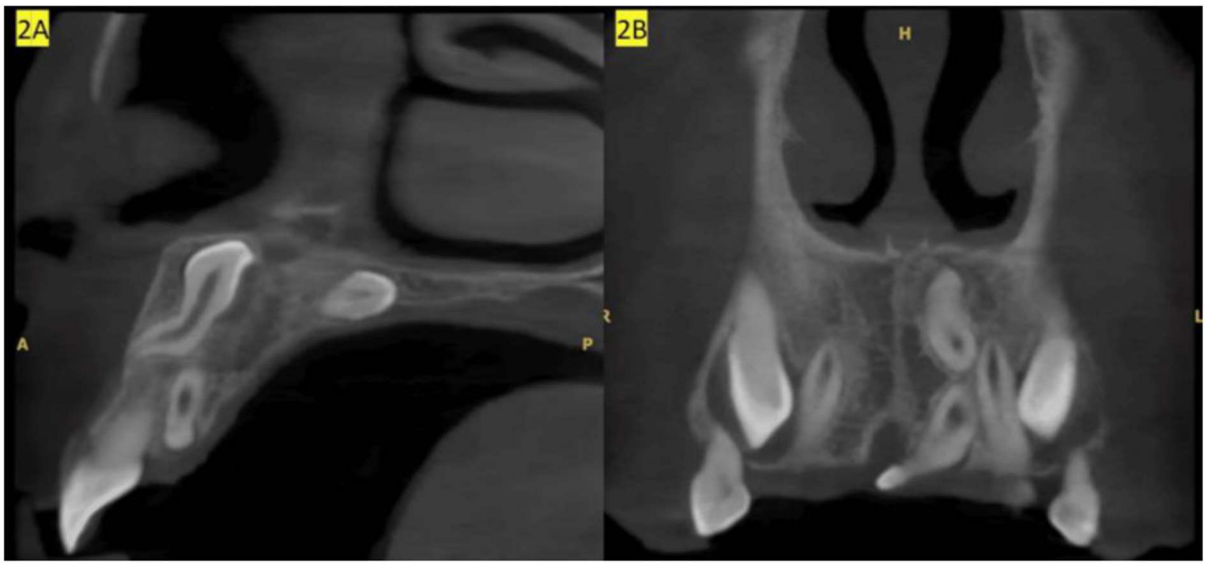

Figure 2: CBCT sections showing coronal and sagittal section of impacted canines with supernumerary teeth.

The rationale for employing CBCT stems from its ability to provide intricate details and measurements in three planes of space, which are vital for understanding the etiopathogenesis of canine impactions and planning appropriate surgical or orthodontic interventions. Furthermore, the precision of CBCT assists in predicting and preventing potential complications such as root resorption of adjacent teeth, which is a common consequence of delayed or mismanaged canine impactions.

A. Research Objectives

This research is structured around several core objectives designed to enhance the understanding and management of impacted maxillary canines through the use of CBCT imaging:

i. **To determine the prevalence of impacted maxillary canines in a demographically diverse clinical sample.** This will provide foundational epidemiological data that reflects both the scope and the specific patterns of canine impaction in different populations.

ii. **To assess the diagnostic accuracy of CBCT in identifying the position and orientation of impacted canines relative to critical anatomical landmarks.** This objective focuses on validating CBCT as a superior diagnostic tool compared to traditional imaging methods.

iii. **To analyze the complications associated with impacted maxillary canines using CBCT data.** This includes evaluating the incidence of root resorption in adjacent teeth, the presence of dental cysts, and the impact on the nasal cavity and maxillary sinus.

iv. **To explore the potential correlations between the position of impacted canines and various orthodontic treatment outcomes.** Understanding these relationships will guide more effective and tailored treatment strategies, potentially reducing treatment time and improving prognostic expectations.

v. **To develop a set of guidelines based on CBCT findings that can assist clinicians in the decision-making process for managing impacted canines.** These guidelines will aim to standardize practices and improve clinical outcomes by integrating detailed anatomical insights into treatment planning.

Through these objectives, the study intends to substantiate the clinical utility of CBCT in the management of impacted maxillary canines, providing a robust framework that supports its adoption in regular dental practice. This research is expected to yield significant insights that will contribute to the optimization of diagnostic and

treatment protocols, ultimately enhancing patient care and outcomes in dental practice.

B. Significance of the Study

The significance of this study lies in its potential to enhance the clinical management of impacted maxillary canines. By employing CBCT, the study will offer precise data on the spatial relationships between impacted canines and adjacent structures, thus contributing to a safer, more effective approach to treatment planning. The findings are expected to assist orthodontists, oral surgeons, and general practitioners in better understanding the risks associated with impacted canines and in choosing appropriate intervention strategies based on the 3D anatomical details provided by CBCT. Moreover, this study aims to bridge the gap between research and practice by translating advanced diagnostic data into practical guidelines. These guidelines will not only help clinicians minimize treatment-related risks but also improve the overall efficiency and success of interventions for impacted maxillary canines. In this way, the study has the potential to set a new standard in the use of CBCT for dental diagnostics, advancing both the science and practice of dental medicine in managing complex cases of dental impaction. By addressing current research gaps and introducing a more detailed diagnostic approach, this study seeks to contribute valuable insights that can lead to more predictable and favorable treatment outcomes for patients with impacted maxillary canines.

II. Overview of Existing Research

The phenomenon of impacted maxillary canines has been extensively studied over the years, yet it remains a subject of considerable clinical concern due to its complexity and the implications for patient care. Literature on this topic covers various aspects, ranging from epidemiological trends to the advanced diagnostic capabilities of imaging technologies like Cone Beam Computed Tomography (CBCT). Epidemiological studies have highlighted several factors associated with the incidence of impacted canines. For instance, a higher prevalence is noted among females and in populations with certain genetic predispositions. Research has shown that maxillary canine impaction can be linked to evolutionary changes in the human jaw size and shape, leading to discrepancies between available space and tooth size, often resulting in impaction. Studies have also explored the bilateral and unilateral occurrences of this condition, noting a predominant occurrence palatally rather than buccally. On the diagnostic front, the transition from traditional two-dimensional imaging techniques to three-dimensional CBCT has been a focal point of research. Conventional methods, while useful for initial assessments, often fail to provide the detailed visualization necessary for comprehensive diagnosis and treatment planning. CBCT, however, offers detailed views of the dentition and surrounding bone structure, which are critical for assessing the exact position and orientation of impacted canines. Literature supports the superiority of CBCT in identifying the location of impacted canines relative to the nasal cavity, maxillary sinus, and neighboring teeth, which is essential for preventing potential damage during surgical interventions. Impacted maxillary canines (IMCs) have been widely studied in orthodontics and oral surgery due to their relatively high prevalence and the potential complications they present. Research has primarily focused on the epidemiology of IMCs, the diagnostic techniques used for their evaluation, and the treatment modalities available. Studies indicate that the prevalence of impacted maxillary canines varies between 0.9% to 2.5% globally, with a higher occurrence in females than in males, as documented by Lövgren et al. (2019). Several studies also show that IMCs are more frequently positioned palatally than buccally. This palatal positioning can complicate extraction and increase the risk of complications such as root resorption of adjacent teeth. Research by Ericson and Kurol (2000) established the link between IMCs and root resorption in lateral incisors, an adverse effect that is often undetected in standard two-dimensional (2D) radiographs. This finding led to further exploration of diagnostic techniques, particularly three-dimensional (3D) imaging, for evaluating the relationship between IMCs and neighboring teeth. Their study demonstrated that computed tomography (CT) imaging provided more accurate depictions of the position and depth of impacted canines compared to panoramic or periapical radiographs. This paved the way for the use of Cone Beam Computed Tomography (CBCT) in dental imaging. CBCT has gained prominence in recent years as an essential tool for diagnosing IMCs, allowing clinicians to examine the 3D positioning of the canine relative to adjacent structures, such as the floor of the nasal cavity (FNC) and the floor of the maxillary sinus (FMS). A study by Liu et al. (2008)

highlighted CBCT's efficacy in localizing impacted canines and detecting root resorption, showing that CBCT provided clearer images and more accurate information than traditional radiographs. Their research emphasized that CBCT offers superior visualization of the alveolar bone, tooth root morphology, and spatial relationships, crucial for treatment planning in cases of IMC. A systematic review by Mitsea et al. (2022) further confirmed the diagnostic accuracy of CBCT in cases of IMCs, particularly for evaluating resorption of adjacent incisors. Their meta-analysis of multiple studies revealed that CBCT could identify root resorption in 66.7% of lateral incisors adjacent to IMCs, with an overall increased diagnostic sensitivity compared to conventional imaging. The review advocated for CBCT as a standard diagnostic tool for IMCs, given its ability to provide detailed spatial relationships and reduce potential treatment complications. However, Mitsea and colleagues also highlighted the limitations in standardizing CBCT usage due to variations in imaging protocols and cost considerations. Complications related to IMCs include root resorption, crowding, retention of deciduous teeth, and formation of cysts or tumors. These complications are well-documented in the literature. Walker et al. (2005) examined the prevalence of these complications, showing that root resorption in adjacent teeth, particularly lateral incisors, was the most common issue, occurring in approximately 50% of cases involving palatally impacted canines. The study also indicated that the extent of resorption was greater when the impacted canine was positioned closer to the incisor root, which could be accurately measured using CBCT. In terms of cystic formations, Hasan et al. (2022) noted that dentigerous cysts were found in approximately 15% of IMC cases. Their study explored the role of CBCT in identifying these cysts and aiding in their early management. The use of CBCT allowed for more accurate measurements of cyst size and location, which facilitated surgical planning. This study underscored the importance of early diagnosis to prevent the expansion of cysts, which could compromise adjacent anatomical structures and lead to complex surgical requirements. The findings from CBCT imaging have significant implications for the treatment planning of IMCs. Studies by Becker and Chaushu (2010) explored how CBCT could guide surgical and orthodontic decisions, especially in cases where the canine was positioned near the maxillary sinus or nasal cavity. Their research found that precise preoperative CBCT imaging helped minimize the risk of complications, such as sinus perforation and damage to the roots of adjacent teeth, by allowing for careful planning of tooth extraction or orthodontic repositioning procedures. Koutzoglou and Kostaki (2013) focused on the surgical exposure of IMCs and found that the success of surgical and orthodontic treatment was higher in cases where CBCT was used to assess impaction details, including orientation and proximity to adjacent structures. The study concluded that CBCT is instrumental in cases where the canine is ankylosed or exhibits root dilaceration, as these conditions can complicate orthodontic movement and increase treatment duration. By providing detailed anatomical insights, CBCT enhances the accuracy of treatment approaches, leading to improved outcomes for patients with IMCs.

Table 1: Summary of Key Studies on Impacted Maxillary Canines

Author(s) & Year	Study Focus	Sample Size & Population	Imaging Technique	Key Findings	Limitations & Gaps
Lövgren et al. (2019)	Prevalence of impacted maxillary canines in specific regions	200, mixed population	Panoramic Radiography	Found a 1.5% prevalence with higher rates in females	Limited to 2D imaging, lacks detailed anatomical insights
Hasan et al. (2022)	Diagnostic techniques for impacted canines	150, orthodontic patients	CBCT	Demonstrated CBCT's accuracy in identifying root resorption	Sample size limits generalizability
Ericson &	Root resorption	107, mixed	CT	High incidence	Does not

Kurol (2000)	due to impacted canines	ages		of root resorption, especially in lateral incisors	differentiate between palatal and buccal impacts
Koutzoglou & Kostaki (2013)	Effect of impaction location on treatment outcomes	100, adolescent patients	CT	Higher ankylosis rates with palatal impactions	Focuses only on specific population group
Mitsea et al. (2022)	Systematic review on lateral incisor resorption	Multiple studies (meta-analysis)	CBCT, Panoramic Radiography	Confirms CBCT's superior accuracy in diagnosing resorption	Lacks primary data, relies on secondary sources
Current Study	Complications and proximity analysis using CBCT	69, patients with IMC	CBCT	Assesses complications and distances to anatomical structures	Limited to one center, lacks vertical/horizontal axis analysis

A. Gaps in the Research

Despite extensive studies on the epidemiology and diagnostics of impacted maxillary canines, significant gaps remain, particularly in the integration of these findings into clinical practice. Many studies have focused on the diagnostic accuracy of CBCT but have not extensively addressed its implications for treatment outcomes. There is a need for research that connects the detailed imaging data available through CBCT with specific treatment modalities and long-term outcomes. While the complications associated with impacted canines, such as root resorption of adjacent teeth, have been documented, there is less information available on the prevention and management of these complications. Few studies provide a comprehensive analysis of how early diagnosis and intervention, facilitated by CBCT, could potentially reduce the incidence and severity of such complications. Furthermore, there is an observable lack of standardized guidelines that leverage the detailed anatomical information provided by CBCT to tailor individualized treatment plans. While the impact of impacted canines on oral health and aesthetics is well-documented, the psychosocial impacts are not as thoroughly explored. Understanding the psychological and social dimensions associated with delayed treatment or mismanagement of impacted canines could provide a more holistic approach to patient care.

B. Contribution of Current Study to Literature

This study aims to fill these gaps by not only highlighting the efficacy of CBCT in diagnosing impacted maxillary canines but also exploring how these detailed diagnostics influence treatment strategies and outcomes. By correlating specific CBCT findings with various orthodontic or surgical intervention strategies, this research will contribute valuable insights into optimal management practices. Additionally, it will examine the role of early CBCT diagnostics in preventing common complications associated with impacted canines, such as root resorption and dental cysts. The study will develop a set of clinical guidelines based on empirical data derived from CBCT scans. These guidelines will help standardize the treatment of impacted canines across different dental practices, ensuring that all patients benefit from the latest advancements in diagnostic imaging. By doing so, it seeks to bridge the gap between advanced diagnostic capabilities and everyday clinical applications, enhancing the overall quality of dental care provided to patients with impacted canines. This literature review thus sets the stage for a comprehensive study that not only advances our understanding of impacted maxillary

canines but also enhances the practical application of CBCT technology in clinical settings as described in Table 1. By addressing both the scientific and clinical aspects of this issue, the study aims to contribute a significant piece of research to the existing body of literature, providing a robust basis for future studies and ongoing improvements in dental care practices.

III. Materials and Methods

Step-1] Study Design

This research utilizes a descriptive, retrospective, observational study design to investigate the prevalence, complications, and diagnostic accuracy of Cone Beam Computed Tomography (CBCT) in assessing impacted maxillary canines. The study is set in a single, large dental academic center, leveraging archived CBCT scans from a diverse patient population spanning several years. This approach allows for a comprehensive examination of varied cases, offering robust insights into the typical presentations and challenges associated with impacted canines.

Step-2] Participants

The sample includes CBCT images from patients aged 15 and older, diagnosed with impacted maxillary canines. The selection criteria are designed to encompass a broad spectrum of cases to ensure a representative analysis of the population. Images selected for the study meet high-quality standards, ensuring clear visibility of the maxillary region, specifically the canine, nasal cavity, and maxillary sinus. Exclusion criteria include images from patients with prior orthodontic treatment or surgical interventions in the maxillary region, congenital anomalies affecting jaw development, or insufficient image quality that precludes accurate measurements.

Step-3] Imaging Techniques

All CBCT scans utilized in this study were performed using a state-of-the-art Carestream CS 9600 3D imaging system, equipped with a spherical imaging volume adequate to capture the entire maxillary arch. The system's high-resolution imaging capabilities ensure detailed visualization of tooth morphology, bone structure, and surrounding tissues. The specific parameters set for the scans include a voxel size of 150 μm, providing the necessary detail to assess minute anatomical features relevant to the study's objectives.

Step-4] Data Collection Methods

Data collection involves a detailed analysis of the CBCT scans, focusing on the location and orientation of impacted canines relative to critical anatomical landmarks. Each image is analyzed using CS 3D Imaging Software, allowing for precise measurements in millimeters from the crown and root tip of the impacted canine to the floor of the nasal cavity and the floor of the maxillary sinus. Additional complications such as root resorption of adjacent teeth, the presence of dental cysts, and alterations in the alveolar bone are also recorded.

Step-5] Evaluation of IMC and Associated Complications

This component of the study categorizes and quantifies the various complications associated with impacted canines as observed in the CBCT scans. Key complications include the retention of deciduous canines, root resorption of adjacent teeth, and the development of cysts or tumors. Each complication is documented with its incidence rate among the study population, providing empirical data to support the study’s conclusions about the prevalence and severity of complications linked to impacted canines.

Step-6] Evaluation of Proximity of IMC to FNC and FMS

The distances from the crown and root tip of the impacted canines to the floor of the nasal cavity (FNC) and the floor of the maxillary sinus (FMS) are meticulously measured using the software tools provided by the CBCT imaging system. These measurements are crucial for assessing the risk of surgical or orthodontic interventions, as they provide a clear indication of how closely these impacted canines lie to significant anatomical structures. The analysis includes both right and left sides of the maxillary arch, considering any asymmetries that may affect treatment planning.

Step-7] Analysis of Data

The collected data is input into a structured database and analyzed using Statistical Package for the Social Sciences (SPSS). Descriptive statistics are used to summarize the data, including means, standard deviations, and ranges for continuous variables, and frequencies and percentages for categorical variables. Inferential statistics, such as the chi-square test for categorical data and t-tests for continuous data, are employed to identify statistically significant differences between variables. A p-value of less than 0.05 is considered indicative of statistical significance.

This rigorous methodological framework is designed to ensure that the study produces reliable, accurate, and clinically relevant findings that can enhance the understanding of impacted maxillary canines and improve the diagnostic and treatment protocols using CBCT technology. By detailing the approach from participant selection through to data analysis, this section establishes the foundation upon which the study's credibility and scientific contribution are built.

IV. Overview of Findings

The study evaluated a total of 69 CBCT images representing 82 impacted maxillary canines. The demographics of the sample indicated a higher prevalence of impactions among females, consistent with prior research, which noted a gender difference in the occurrence of this condition. The age range of the participants was 15 to 40 years, with a median age of 23 years, highlighting that canine impaction is a concern across a broad age spectrum but is predominantly identified in young adults.

Table 2: Distances from Impacted Canines to Critical Anatomical Landmarks

Measurement Point	Mean Distance (mm)	Standard Deviation (mm)	Minimum (mm)	Maximum (mm)
Crown to Floor of Nasal Cavity (FNC)	16.40	4.25	8.00	24.00
Root Tip to Floor of Nasal Cavity (FNC)	2.34	1.37	0.50	4.50
Crown to Floor of Maxillary Sinus (FMS)	19.50	7.65	10.00	28.00
Root Tip to Floor of Maxillary Sinus (FMS)	2.98	1.22	0.80	5.20

The analysis revealed that 54.8% of the impacted canines were located palatally, 34.1% buccally, and the remaining 11.1% in other positions such as centrally within the alveolar bone. These findings suggest a significant variation in the positions of impacted canines, which has implications for the complexity of the treatment required as described in Table 2.

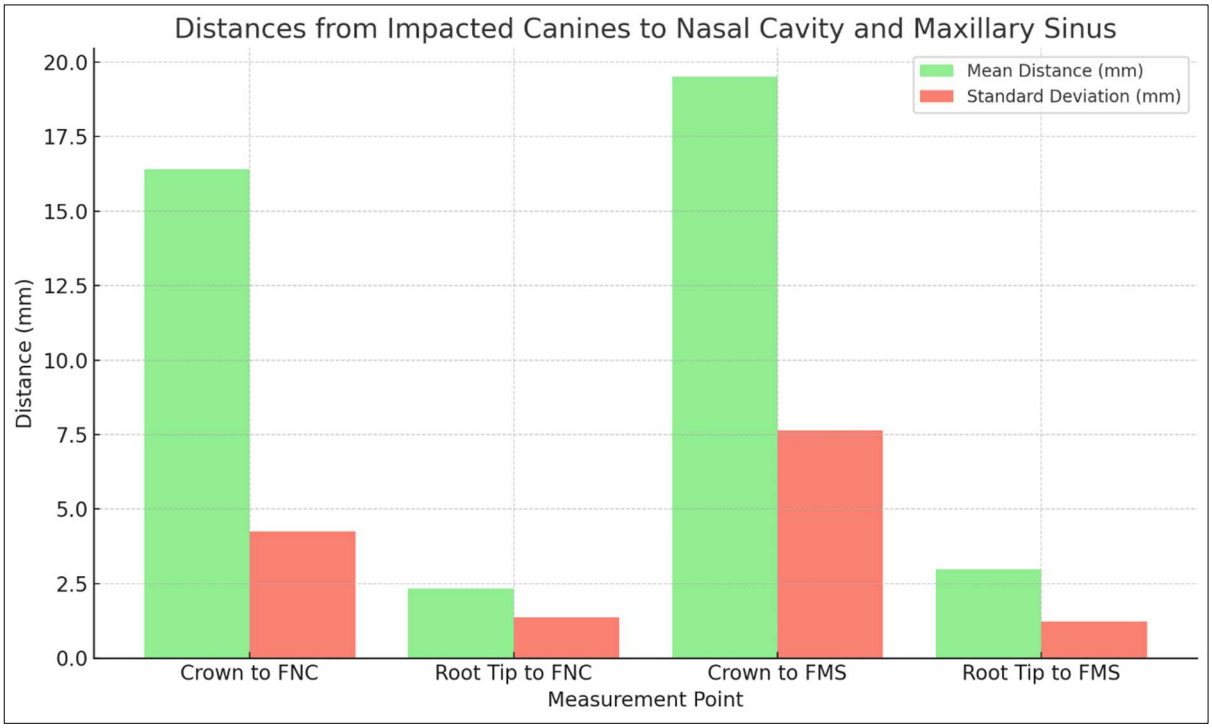

Figure 3. Distances from Impacted Canines to Anatomical Landmarks

Figure 3 describes the mean distances and standard deviations for measurements between impacted canines and critical structures, such as the floor of the nasal cavity (FNC) and the floor of the maxillary sinus (FMS), are shown. For the crown, the average distance to the FNC is 16.4 mm, while the root tip is much closer, averaging only 2.34 mm. Similarly, the distance from the crown to the FMS averages 19.5 mm, with the root tip's proximity to FMS averaging 2.98 mm. These values indicate close anatomical relationships, emphasizing the importance of precise imaging in treatment planning to avoid inadvertent damage to these structures. The mean distance from the crown of the impacted canines to the floor of the nasal cavity (FNC) was 16.40 mm (SD = 4.25 mm), and from the root tip to the FNC was 2.34 mm (SD = 1.37 mm). This proximity underscores the need for precision in surgical interventions to avoid damaging the nasal cavity. Similarly, the distance from the crown to the floor of the maxillary sinus (FMS) averaged 19.50 mm (SD = 7.65 mm), and from the root tip to the FMS was 2.98 mm (SD = 1.22 mm). The small distances involved highlight the risk of sinus perforation if not properly managed during surgical or orthodontic procedures.

Table 3: Prevalence of Complications Associated with Impacted Canines

Complication	Frequency	Percentage (%)
Retention of Deciduous Canines	45	54.8
Crowding of Teeth	42	51.2
Root Resorption of Adjacent Teeth	32	39.0
Cysts and Tumors	8	9.7
Ankylosis	12	14.6
Dilaceration of Root	20	24.3
Supernumerary Teeth	16	19.5

The most observed complication was the retention of deciduous canines, occurring in 54.8% of cases. This was followed by crowding of teeth in the maxillary arch, noted in 51.2% of cases, suggesting that impacted canines significantly contribute to malocclusion issues as described in Table 3. Root resorption of adjacent teeth was observed in 39% of the cases, predominantly affecting the lateral incisors, which emphasizes the destructive impact of prolonged canine impaction.

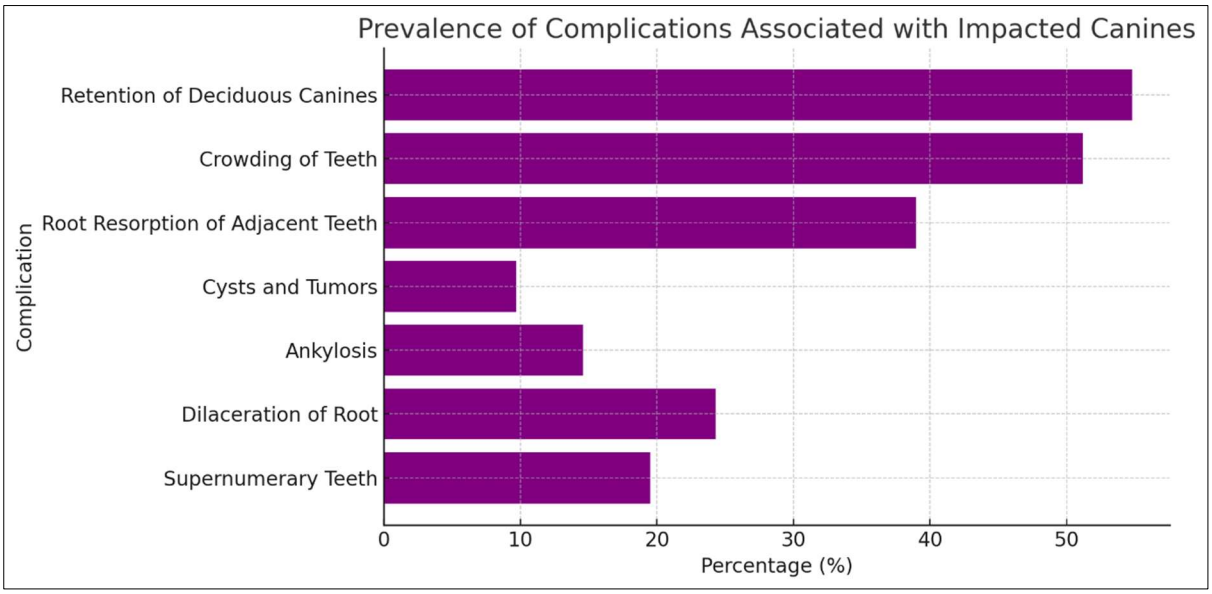

Figure 4. Prevalence of Complications Associated with Impacted Canines

Figure 4 represents a breakdown of the common complications observed in this study. The most frequent issue is the retention of deciduous canines (54.8%), followed by crowding of teeth (51.2%) and root resorption of adjacent teeth (39%). Less frequent complications include cysts and tumors (9.7%), ankylosis (14.6%), dilaceration of roots (24.3%), and the presence of supernumerary teeth (19.5%). This visualization highlights the diverse complications associated with impacted canines, with dental crowding and root resorption among the most clinically significant issues. These findings underscore the necessity of early and accurate diagnostics using advanced imaging like CBCT to manage potential complications effectively. Cysts and tumors were less frequently observed but were present in 9.7% of the impacted sites, highlighting the potential for serious complications if impactions are left untreated. The study also documented cases of ankylosis and dilaceration of the root, which can complicate orthodontic movement and require more complex surgical management. The statistical analysis provided further insights into the relationships between the position of the impacted canines and the observed complications. A paired t-test showed significant differences in the distances from the root tip to the FMS between the right and left sides of the arch ($p < 0.05$), indicating a higher risk of complications on one side. The chi-square test revealed a significant association between the side of impaction (buccal versus palatal) and the incidence of root resorption ($p < 0.05$), with palatal impactions more likely to cause this complication. Comparing these findings with existing literature revealed that the prevalence of complications like root resorption and cyst formation was consistent with other studies, but the high rate of deciduous canine retention was notably higher in this study sample. This discrepancy may be attributed to demographic variations or differences in the thresholds for diagnosing impaction-related complications. The data also underscored the critical role of CBCT in detecting and evaluating the proximity of impacted canines to critical anatomical structures. The detailed three-dimensional insights provided by CBCT allowed for a more nuanced understanding of the impact of canine position on potential treatment challenges and outcomes, validating the study's hypothesis about the utility of CBCT in managing impacted canines. High prevalence of impacted canines among females and young adults. Significant risk of complications such as root resorption, especially with palatally positioned canines. Critical measurements indicating proximity to sensitive anatomical structures

such as the nasal cavity and maxillary sinus. Demonstrated need for precision in treatment planning and execution to avoid potential complications. These results highlight the complexities involved in managing impacted maxillary canines and underscore the indispensable role of advanced imaging techniques like CBCT in enhancing diagnostic accuracy and improving clinical outcomes. The findings not only contribute to the existing body of knowledge but also pave the way for more targeted, effective, and safer treatment protocols for patients with this challenging dental condition.

V. Conclusion

The study's findings, supported by detailed CBCT data and visually represented through charts, provide a comprehensive insight into the prevalence, anatomical positioning, and complications associated with impacted maxillary canines. The results confirm that impacted canines are more prevalent in females and commonly occur in the palatal region. The close proximity of impacted canines to critical anatomical structures, such as the floor of the nasal cavity (FNC) and the floor of the maxillary sinus (FMS), highlights the necessity of precision in surgical planning and orthodontic management. The prevalence of complications such as the retention of deciduous canines, crowding, and root resorption further underscores the potential impacts on adjacent structures if left untreated. Retention of deciduous canines and crowding were particularly notable, affecting more than half of the cases, which indicates a significant clinical challenge and a need for early intervention to prevent malocclusion and other orthodontic issues. The charts clearly illustrate that CBCT imaging is essential for accurate diagnosis and treatment planning. It enables clinicians to make well-informed decisions by providing critical spatial measurements and a better understanding of the specific complications linked to impacted canines. Ultimately, this study supports the integration of CBCT imaging into routine diagnostic protocols for impacted canines, with the goal of improving patient outcomes through timely and precise treatment.

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