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Original Article

Dentistry Section

Exploring Canine Anomalies: Patterns, Prevalence, and their Relationship to Skeletal Malocclusion among Orthodontic Patients at Bhimavaram, Andhra Pradesh, India

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ABSTRACT

Introduction: Canines are crucial for biting and tearing food, as well as guiding the jaw into proper orientation. Anomalies of the canines can result in a loss of these functions, leading to low self-esteem and overall poor health and quality of life. Understanding these dental anomalies and their varying occurrence among different racial populations can assist dental practitioners in providing vigilant treatment for specific communities.

Aim: To assess the prevalence and patterns of impacted canines and other canine anomalies, and to investigate potential relationships between impacted teeth and malocclusions in an orthodontic patient population.

Materials and Methods: A cross-sectional study was conducted in Department of Oral Medicine and Radiology, Vishu Dental College, Bhimavaram, Andhra Pradesh, India using 530 orthopantomographic and cephalometric records obtained from orthodontic patients as part of their diagnostic and therapeutic modalities. Radiographs with identified canine impactions during the screening process were assessed for skeletal relationships on lateral cephalograms using tracing techniques. Skeletal malocclusions were categorised based on the Point A, Nasion, Point B angle and Wits appraisal, and the data underwent analysis using the one-way Analysis of Variance (ANOVA) test and Fisher's-exact test.

Results: The study found a prevalence of 3.2% for impacted canines in the orthodontic population. Unilateral impactions were more prevalent than bilateral impactions, and the majority of impactions were associated with class- skeletal malocclusion. The grouping of skeletal relationships using ANB and WITS appraisal showed that ANB was significant in categorisation ($p<0.001$).

Conclusion: These findings provide insights into the prevalence and distribution of impacted canines, which were more prevalent in females and predominantly Unilateral impacted were unilateral. Majority of impacted canines were associated with Class-I skeletal malocclusion, followed by Class-II and III, among the study population.

Keywords: Canine anomalies, Impactions, Nasion, Orthodontic population, Point A, Point B angle, Skeletal patterns, Wits appraisal

INTRODUCTION

Permanent canines are cornerstones of dental arch formation and play a major role in aesthetic smiles and functional occlusion [1]. Canine anomalies may result in a loss of function, leading to poor health and related quality of life [2]. Different types of canine anomalies include impaction, ectopic eruption, transmigration, transposition, and agenesis. These dental anomalies are caused by complex interactions among genetic, epigenetic, and environmental factors during dental development. The aetiology of these anomalies is multifactorial, involving multiple levels and dimensions [3,4]. Impaction is one of the most common canine anomalies. Maxillary canines are the second most commonly impacted teeth, following third molars, with an incidence rate of 2%. Hypodontia in canines is very rare, with a total incidence rate of 0.08%. Among various canine anomalies, the ratio of impacted canines is considered high compared to other types [1].

Most canine impactions are found palatally, followed by impactions in the line of the arch and buccally, with incidence rates of 61% (palatally), 34% (in the line of the arch), and 4.5% (buccally), respectively. Females are more prone to canine impactions, with a prevalence rate of 2:1. Among canine impactions, a higher incidence is found in skeletal Class-I pattern, and the distribution is primarily unilateral [5].

In Caucasian populations, the prevalence of impacted maxillary canines ranges from approximately 1% to 3%, with 70-80% of impactions occurring palatally. In Asian subjects, impacted canines are usually found in the mid-alveolus or labial position, and the prevalence ratio of palatal impactions between Europeans and Asians has been reported as 5:1 [1,2]. There is some evidence suggesting that patients with certain skeletal features may be at a higher risk for developing impacted canines, while other studies have found no association [6,7].

The prevalence rates of certain dental anomalies, such as tooth impaction, may be influenced by a person's ethnic background [1]. Understanding these dental anomalies and their varying occurrences among different racial populations can help dental practitioners be more vigilant when treating specific communities. This awareness allows for timely clinical intervention, preventing complications such as root resorption of adjacent teeth, canine transposition, reduced arch length, and the development of cystic masses leading to infection and pain. Due to the varying prevalence of canine impaction across populations, early detection and management are crucial. This approach ensures that affected individuals receive optimal treatment, guiding the impacted canine tooth to its proper position and avoiding subsequent aesthetic, pathological, and functional complications [7].

There are very few reports of studies conducted in India, with studies by Jain S and Debbarma S and Jha AK et al., focusing on the Central Indian population. There is a lack of literature specific to our geographical area of Andhra Pradesh [3,8]. Therefore, the present study was aimed to determine the prevalence and pattern of canine impactions in orthodontic patients and to correlate if there is any significant associations with skeletal malocclusion.

MATERIALS AND METHODS

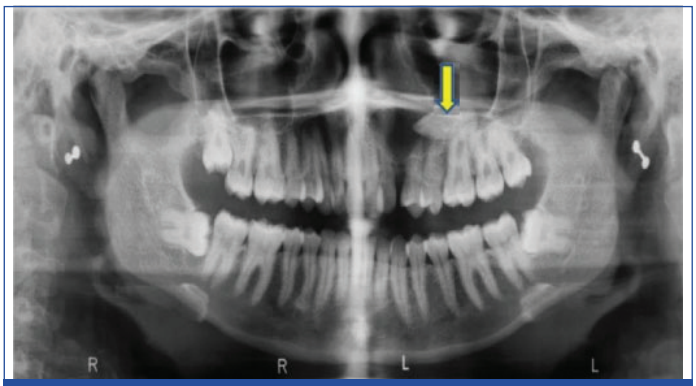
A cross-sectional study was conducted among the orthodontic population attending Vishnu Dental College, Bhimavaram, Andhra Pradesh, India, for routine dental and therapeutic purposes from January 2020 to October 2022, and the study was planned in the month of November 2022. The study protocol obtained approval from the Institutional Ethical Review Board and has been assigned the reference number (IECVDC/22/UG01/OMR/IVT/60).

Inclusion and Exclusion criteria: Orthodontic patients who were advised to have panoramic and cephalometric radiographs as part of their diagnostic and therapeutic procedures were included in the study. Subjects under 13 years old (where unerupted canines could be considered normal), patients with tooth loss due to caries or other causes, patients with craniofacial syndromes, and those with poor-quality radiographs were excluded from the study.

Sample size calculation: The sample size was calculated based on the prevalence of canine impaction as the primary outcome. The calculation considered a prevalence of 1.38% [3], a 5% confidence interval, and a 1% margin of error. The estimated sample size was 530.

Study Procedure

Patient demographic data, medical history, and clinical information were obtained from patient record files. Panoramic and lateral cephalometric radiographs were taken using the X mind Pano ceph machine with an extraoral imaging plate cassette and Photostimulable Phosphor (PSP) sensors. The imaging process followed the manufacturer's recommendations for standard exposure conditions. The PSP sensor was processed using a Digora Panoramic cephalometric tomography (PCT) scan. The final images were obtained in DICOM format using SCANORA software. Each image was enlarged to 110% of its original size, and adjustments were made to optimise contrast and brightness for standardised viewing conditions [Table/Fig-1,2].



[Table/Fig-1]: Panoramic image showing maxillary left canine impaction.

[Table/Fig-2]: Panoramic image showing mandibular left canine impaction.

The panoramic radiograph was assessed to determine the presence or absence of canine anomalies, including impaction, transmigration, transposition, agenesis, and ectopic eruption, as described by Lagana G et al., and Yavuz MS et al., respectively [4,9]. According to the classification scheme proposed by Yamamoto G et al., impacted canines are categorised into various types based on their orientation and position within the jaw [10]:

Type-I: Vertically impacted canines, with their tooth axis nearly perpendicular to the occlusal plane.

Type-II: Mesially inclined impacted canines, leaning against the occlusal plane.

Type-III: Distally inclined impacted canines, leaning against the occlusal plane.

Type-IV: Horizontally impacted canines with their crowns directed mesially.

Type-V: Horizontally impacted canines with their crowns directed distally.

Type-VI: Inversely impacted canines.

Type-VII: Labio-lingual (palatal) impaction and ectopic impaction.

The classification of transmigrated canines was based on the criteria given by Mupparapu M [11]:

Type-I: Canine positioned mesio-angularly against the midline, either labial or lingual to the anterior teeth, with the crown crossing the midline.

Type-II: Horizontally impacted canines located below the apices of the incisors.

Type-III: Canine positioned mesial or distal to the contralateral canine.

Type-IV: Horizontally impacted canines located below the apices of either premolars or molars.

Type-V: Vertically positioned canines in the midline.

Transposition: Tooth transposition refers to the positional interchange of two neighboring teeth or the emergence of a tooth in a location typically occupied by another tooth. In the literature, canine transposition has been observed between the lateral and central incisors and between the first and second premolars [4].

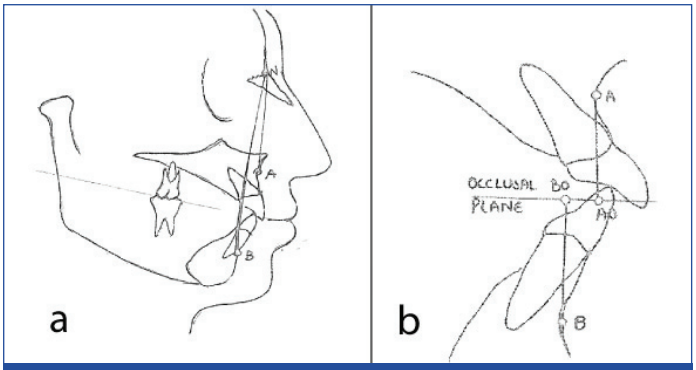
Tooth agenesis or hypodontia: This refers to the absence of tooth crown calcification on the radiograph and no evidence of tooth loss due to factors such as caries, periodontal disease, or trauma. To confirm the absence of missing teeth, the authors reviewed the patients' records to ensure there was no history of extractions, syndromes, or craniofacial malformations [4].

Ectopic eruption: This condition occurs when permanent teeth, due to inadequate growth in the jaw or a specific segment of the jaw, follow a path of eruption that intersepts with a primary tooth, leading to its premature loss and subsequent misalignment of the permanent tooth [9].

Subjects in the study were classified into skeletal class 1, 2, or 3 groups based on the ANB and WITS values obtained from lateral cephalometric radiographs. Tracings of the radiographs were made on transparent acetate sheets using a 0.3 mm lead pencil. The assessment of all cephalometric radiographs was conducted in a room with reduced lighting, using a shielded, illuminated viewing box, and measurements were taken manually. The skeletal classification was determined by evaluating the ANB angle and WITS appraisal. The normal values and range of cephalometric features for skeletal relationships are described in [Table/Fig-3a,b,4] [7,12].

STATISTICAL ANALYSIS

Information regarding the presence or absence of canine anomalies, cephalometric measurements, chronological age, and gender was collected and recorded in an electronic spreadsheet. Statistical analysis was conducted using Statistical Package for Social Sciences (SPSS) software version 20.0. The prevalence and distribution of canine anomalies were evaluated, and significant



[Table/Fig-3]: a) Showing ANB angle and; b): showing WITS appraisal respectively.

Skeletal relationship	ANB angle	WITS appraisal
Class-1	0 to 4°	-3 mm to +1 mm
Class-2	>4°	-2.1 mm to 4.5 mm
Class-3	<0°	Less than -3 mm

[Table/Fig-4]: Range of values for ANB angle and WITS appraisal for the skeletal relationships [7,12].

associations were analysed using an independent samples t-test. The independent samples t-test was used to compare the means of two independent groups and determine if there were statistically significant differences in the population means. A p-value p≤0.05 was considered statistically significant.

RESULTS

Out of the 530 records screened that met the inclusion criteria, 17 subjects with impacted canines were identified. Among them, three subjects had bilateral impactions, resulting in a total of 20 impacted canines. The prevalence rate of canine impaction was found to be 3.2%, and these cases were selected for further analysis. Among the selected subjects, five were males and 12 were females, indicating a higher frequency of canine impaction in females compared to males. The maxilla showed a higher frequency of canine impaction compared to the mandible. Unilateral impactions were more common than bilateral impactions, with a higher frequency observed on the right-side [Table/Fig-5]. One subject was found to have transmigration, belonging to Class-V, with a prevalence of 0.18%. No other canine anomalies such as agenesis, ectopic eruption, or transposition were observed in the population under investigation.

Variables		Frequency	Percentage
Gender	Females	12	70.6%
	Males	5	29.4%
Jaw	Maxilla	15	88.2%
	Mandible	2	11.8%
Side of jaws	Right	8	47.1%
	Left	6	35.3%
	Bilateral	3	17.6%
Type of skeletal relationship	Class-I	10	58.8%
	Class-II	4	23.5%
	Class-III	3	17.6%

[Table/Fig-5]: Descriptive table of patients showing distribution of canine impactions in different variable.

Out of the 20 impacted canines, 11 belonged to Type-II, which are canines inclined mesially against the occlusal plane. Five canines belonged to Type-I, which are vertically impacted canines, and four canines belonged to Type-IV, which are horizontally impacted canines with the crown directed mesially. The distribution of patients with impacted canines based on their skeletal relationships, determined by ANB and WITS values measured on lateral cephalograms, showed that out of the total 17 subjects, 10 had Class-I skeletal relationships, four had Class-II skeletal relationships, and three had Class-III skeletal relationships [Table/Fig-5].

The three skeletal groups exhibited a significant difference in terms of ANB values (p<0.001), as shown in [Table/Fig-6]. This confirms that the sample was appropriately categorised, and there was a substantial distinction in skeletal patterns among the groups. However, no significant difference was observed between the three skeletal groups in terms of WITS value.

Parameters	Class-I	Class-II	Class-III	p-value
ANB	2.6±1.4	7.2±1.2	2.0±1.0	<0.001*
WITS	2.3±0.9	4.2±2.2	-6±0.26	0.09

[Table/Fig-6]: Comparison between skeletal groups for cephalometric variables.

DISCUSSION

In the present study, the prevalence of impacted canines among the orthodontic population was estimated to be 3.2%, which is similar to the study conducted by Kamiloglu B and Kelahmet U in the Cypriote orthodontic population, where the prevalence was reported as 3.53% [13]. Several studies evaluated the prevalence of impacted canines in both orthodontic and non orthodontic populations. The study by Jain S and Debbarma S found a prevalence of 1.38% in the central Indian orthodontic population [3]. In Nepal, the prevalence of canine impaction among orthodontic patients was reported as 5.6% [14]. In the Saudi population, a prevalence of 5.9% was observed [15]. The variations in the prevalence of canine impaction are wide-ranging, and these differences can be attributed to factors such as sample selection, methodology used in the study, and the geographical location where patients were recruited. These factors indicate the potential influence of racial and genetic differences.

The prevalence of mandibular canine impaction in the present study was much lower, at 11.8%, compared to 88.2% for maxillary impaction. This finding is consistent with the results of studies conducted in Saudi Arabia and Nepal [2,14]. The impaction of mandibular canines is less common compared to maxillary canines, which may be attributed to the more favourable eruption sequence of mandibular canines occurring prior to premolars. Previous literature suggests that unilateral impaction of canines is more prevalent than bilateral impactions [2]. However, Fardi A et al., reported a contrasting finding, where bilateral canine impaction was more common in the Greek population [16]. In the present study, unilateral impactions accounted for 82.4% of cases, while bilateral impactions accounted for 17.6%. Among unilateral impactions, previous literature has reported a higher frequency for left-sided canines compared to right-sided canines [16]. The present study found a slightly higher prevalence of impacted maxillary canines on the right-side (47.1%) compared to the left-side (35%). This result is in agreement with Jain S and Debbarma S [3], who also reported more right-sided impacted canines. In a study conducted on the Chinese population, an equal distribution of unilaterally impacted maxillary canines was found between the left and right-sides [17].

The majority of studies [2,8,14,18] have found a higher prevalence of canine impactions among females. In the present study, authors also observed a higher prevalence of impacted canines in females (70.6%) compared to males (29.4%). However, some studies have reported an equal occurrence of impacted canines in both genders [3,7,13]. The results of the present study differ slightly from those of Yamamoto G et al., who found that Type-I impactions were the most common (28 teeth, 40.4%), followed by Type-II (24 teeth, 34.3%), and Type-IV (8 teeth, 11.5%) [10]. Alassiry A also found Type-I maxillary canine impaction to be the most common, followed by Type-II, VI, III, V, and VII [18]. The variation in the prevalence pattern of canine impaction could be attributed to differences in the ethnic origin of the population samples. The present study focused on a South Indian population, while the aforementioned studies were conducted in Japanese and Saudi population [13].

In the present study population, the prevalence of transmigration was found to be 0.18%. Specifically, the left mandibular canine transmigrated and belonged to Type-V. A slightly higher rate of transmigration was reported in a study conducted by Kamiloglu B and Kelahmet U in the Cypriote population.

Both the ANB angle and WITS appraisal were used to categorise the skeletal relationships in the study sample. The majority of canine impactions were found in Class-I relation (58.8%), followed by Class-II relation (23.5%) and Class-III relation (17.6%) [1]. A study by Fernandez CCA et al., found that dental anomalies were most prevalent in Class-III skeletal malocclusion, although this finding was not statistically significant [19]. They also suggested that specific clinical patterns may exist, indicating common etiological roots. However, a study by Di Carlo G et al., found no association between skeletal characteristics and maxillary canine impaction, suggesting that such skeletal features cannot be used as diagnostic or prognostic aids for determining the risk of impaction [7].

The present study aimed to investigate the association between canine anomalies and skeletal relationships, but no significant relation could be established. However, during the data collection process, it was observed that canine anomalies appeared to be associated with other dental anomalies, such as third molar impactions or retained deciduous canines. To gain a deeper understanding of the prevalence of dental anomalies in patients with diverse skeletal malocclusion patterns, a larger sample size would be beneficial. This could serve as a foundation for future genetic investigations, potentially contributing to a better understanding of the underlying causes of these conditions. It is possible that certain genes and pathways may play a role in both specific types of dental anomalies and skeletal malocclusions. However, to establish a definitive connection, a genetic study would need to be conducted.

Limitation(s)

The absence of data on additional canine anomalies such as transposition, agenesis, and ectopic eruption in the study sample further limits the comprehensive understanding of canine tooth abnormalities in the population. This highlights the need for future studies that encompass a larger and more diverse population in order to provide a more comprehensive analysis.

CONCLUSION(S)

In the present study, the orthodontic group showed that canine impactions were the most commonly encountered canine anomalies, with a prevalence rate of 3.2%. Canine impactions and transmigration were observed, with skeletal Class-I having the highest number of canine impactions. Overall, present study provides insights into the prevalence and characteristics of impacted canines within the orthodontic population, highlighting differences in skeletal relationships. Further research is warranted to explore potential correlations and implications for treatment planning.

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