

ORIGINAL RESEARCH

Prevalence and distribution of impacted canines: a retrospective cross-sectional study

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(Neamat Hassan Abubakr)**Abstract**

Background: This study aimed to determine the distribution and position of impacted canines among patients at the School of Dental Medicine, University of Nevada Las Vegas. **Methods:** A retrospective keyword search of clinical notes in AxiUm™ identified cases with impacted canines among patients aged ≥ 12 years seen between 2014 and 2022. Demographic data were analyzed using a Chi-square test against Clark County's population demographics. **Results:** A total of 104 patients had impacted canines, with 69.2% being female and 30.8% male. The most affected ethnic groups were mixed (44%), Hispanic (25.96%), Caucasian (18.27%), African American (9.62%) and Asian (1.92%). The most common impaction was tooth #6 (64.42%). **Conclusions:** Among maxillary canine impactions, Type II accounted for 48.6%. The findings suggest a higher prevalence of impacted canines among females, Hispanic and mixed-ethnicity patients, with maxillary canines most commonly affected.

Keywords

Impacted canine; Maxillary canine; Mandibular canine

1. Background

Canines are paramount to the function and aesthetics of a patient's dentition. Canines are essential for tearing food, guiding the mandible into its proper position, and contributing significantly to overall aesthetics and occlusal or masticatory function [1, 2]. In some instances, canines become impacted. Impacted teeth are defined as those that fail to erupt through the gingiva and remain embedded within the bone beyond the typical physiological eruption period [3]. Maxillary canine impaction is a prevalent dental issue, ranking among the most common dental impactions, following the maxillary and mandibular third molars [4]. Previous studies have found the prevalence of impacted maxillary canines to be 2% and have been most commonly observed in females [5, 6] and mandibular impaction have been found to be at 0.3% [7].

Several explanations have been proposed for the higher frequency of maxillary canine impaction compared to other teeth. These canines develop deeper within the jaw, have longer eruption paths, and are expected to erupt later than the adjacent teeth [8]. Impacted canines have the potential to negatively affect developing dentition and cause pathology. Some negative outcomes include root resorption, degenerative cysts, ankylosis and/or a short arch [2]. The impacted maxillary canine tends to be positioned more palatally than labially, at a ratio of 3:1 [9]. Two primary theories have been proposed to explain the association with palatally impacted maxillary canines. The first, known as the guidance theory, suggests that the eruption of the canine depends on the lateral incisor's

root, and any developmental deviation of the lateral incisor can obstruct the canine's eruption [10]. In contrast, the genetic theory posits a hereditary cause for palatally impacted canines and proposes a potential link to related anomalies, such as absent or irregular lateral incisors [11].

It is important to properly plan for the potential need of orthodontic treatment and determine impaction early [12] as many negative outcomes could be avoided with proper intervention. Patients' development varies and it can be difficult to tell if a canine is impacted or if eruption is merely delayed. Thus, the use of thorough treatment planning and evaluation of the tooth's position, location, angulation and orientation is critical [8].

Numerous studies have examined these factors to develop classification systems for maxillary impacted canines using panoramic radiography and cone beam computed tomography (CBCT). Classification systems such as the KPG index (Kau, Pan and Gallerano) [13] and the 7-type classification system [8] have been created to describe the impaction of maxillary canines accurately. The 7-type classification system, in particular, categorizes different orientations of maxillary canine impaction based on long-axis angulation and occlusal plane orientation, providing a valuable framework for describing the type of impaction [8].

Understanding the classification of canine impaction is not only crucial for predicting both the direction and clinical outcome of treatment, but also for identifying variations in impaction prevalence and type across different demographic groups. The practical implications of this study are significant,

as it provides a comprehensive analysis of the prevalence of canine impaction within the University of Nevada, Las Vegas (UNLV), School of Dental Medicine (SDM) patient population and its correlation with specific demographic factors such as age, gender and ethnicity.

2. Material and methods

2.1 Study design and population

This study is a cross-sectional study of patients who attended the University of Nevada, Las Vegas dental clinics.

2.2 Search strategy

A retrospective keyword search in AxiUm™ was performed using terms such as “impacted canine” and “impacted” “cuspids” to identify patients 12 years and older who visited the UNLV School of Dental Medicine clinics between 2014 and 2022. A total of 15,062 patients were screened for impacted canines using panoramic radiographs, and only those who met the age criteria at the time of the radiograph were included. While CBCT images could have provided more detailed evaluation and classification of impactions, these were rarely available for the majority of patients. Individuals presenting anomalies associated with genetic syndromes or lacking panoramic radiographs were excluded from the study (Fig. 1).

Subsequently, those that passed exclusion had all patient identifiers removed from the collected data. Data such as the patients age, ethnicity and gender were also gathered from those who passed the exclusion criteria in order to observe any trends or correlation regarding impaction in the patient pool of UNLV SDM.

Impaction data was then gathered, including the number of impactions per individual, the tooth number that was impacted,

as well as the area (maxilla or mandible). When collecting data from the panoramic radiographs, maxillary canines were classified using the Yamamoto *et al.* [14] (Fig. 2, Ref. [14]). As there was no pre-existing classification system such as the one established by Yamamoto *et al.* [14] for mandibular impactions, these impactions were simply counted but not categorized.

The maxillary canine’s classification according to Yamamoto *et al.* [14]:

Type I: Canine between lateral incisor and first premolar.

Type II: Crown mesially tipped overlapping and pressing lateral incisor, creating a distal tipping.

Type III: distally tipped canine with an overlapped canine crown and root of first premolar.

Type IV/V: canine long axis is in horizontal orientation.

Type VI: canine crown is directed up toward orbital fossae.

Type VII: canine long axis in horizontal direction, crown is displaced buccally or interchanging with adjacent teeth.

2.3 Statistical analysis

Descriptive statistics and Chi square test were performed to determine demographics and to analyze impaction among genders and ethnicities.

3. Results

After an initial pool of 593 entries fitting the initial search criteria laid out in our AxiUm search, 104 patients presented with impacted canines once all exclusion criteria were applied and duplicate patient files were removed. Among all impaction cases, females accounted for 69.2% and the remaining 30.8% are males. Statistical significance was found between males and females in the #11 impaction but not in #6 the impaction (Table 1).

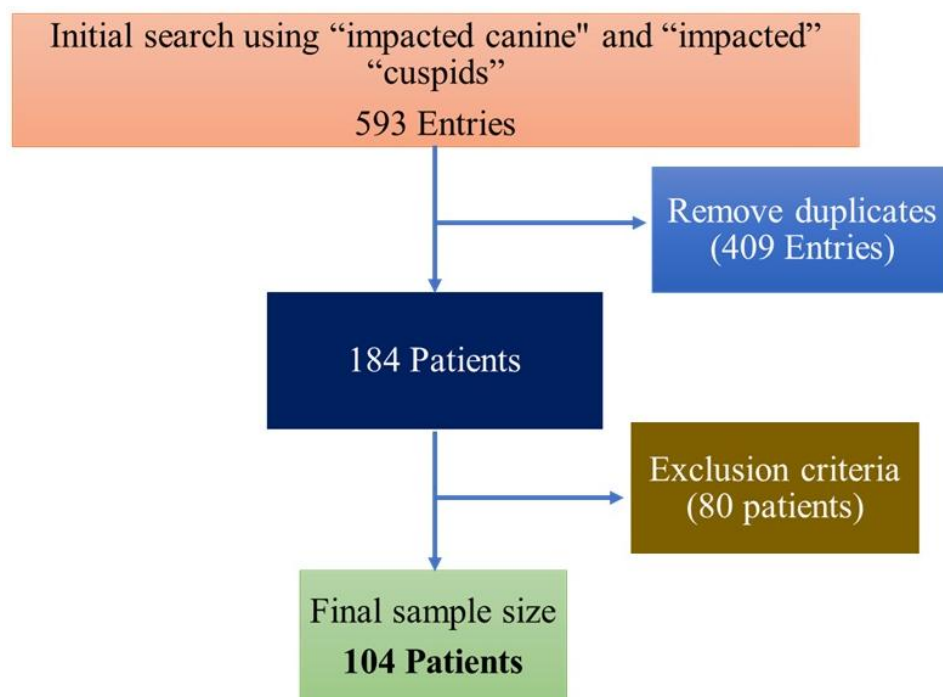


FIGURE 1. Flowchart of the impacted canine cases search.

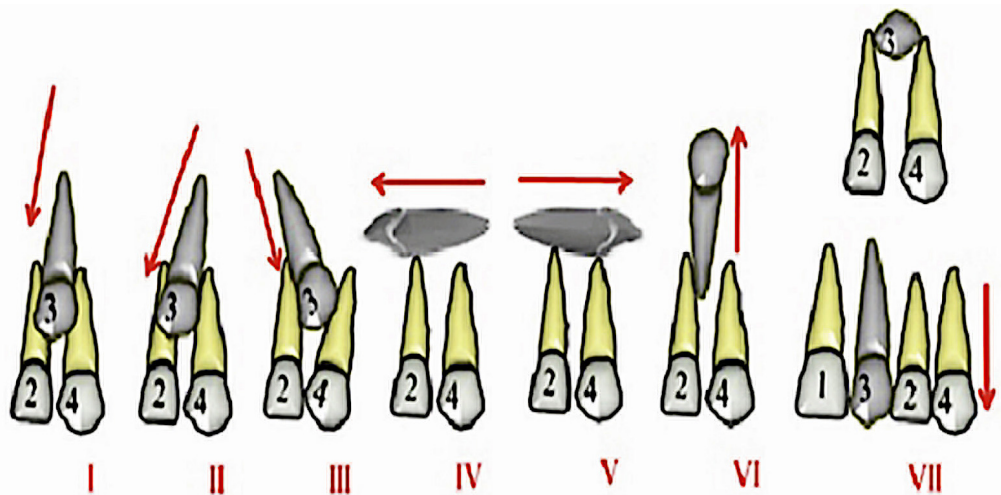


FIGURE 2. Classification of impacted maxillary canines [14].

TABLE 1. Association of type of impaction with gender according to Yamamoto’s classification.

Type	Tooth #6				Tooth #11			
	Female		Male		Female		Male	
	N	%	N	%	N	%	N	%
Type I	5	11.9	9	36.0	2	3.6	4	21.1
Type II	24	57.1	9	36.0	29	52.7	6	31.6
Type III	3	7.1	3	12.0	1	1.8	2	10.5
Type IV	-	-	1	4.0	19	34.5	6	31.6
Type V	9	21.4	3	12.0	-	-	1	5.3
Type VI	-	-	-	-	-	-	-	-
Type VII	1	2.4	-	-	4	7.3	-	-
Total	42	100.0	25	100.0	55	100.0	19	100.0
$\chi^2 = 9.243; p = 0.100$; Not significant					$\chi^2 = 13.573; p = 0.019$; Significant			

Results showed that Mixed and Hispanics (44.2% and 26%, respectively) represented the majority of the canine impactions at SDM followed by Caucasians and then African Americans (18.3% and 9.6%). The largest discrepancies between the data gathered vs. the general population demographics of Clark County were large under representations Caucasian and Asian populations (18.3% vs. 67.2% and 1.9% vs. 11.2% respectively), followed by a large over representation of Mixed ethnicity in our study (44.2% vs. 5.5%) (Table 2).

The age demographics showed 57.69% of the patients were aged from 12–17 years; followed by patients aged from 30–40 years (16.35%); 18–29 years (9.62%); 41–50 years (8.65%); 51–60 years (2.88%) while 4.81% were above 60 years old.

The majority of impacted canines were in the maxillary arch (89.4%), mandibular arch (5.8%) and impactions in both arches (4.8%) (Figs. 3,4).

According to Yamamoto’s classification, most impactions identified in the UNLV SDM patient cohort were Type II, followed by Type V and then Type I (Fig. 5, Ref. [14]).

4. Discussion

The present retrospective study aims to investigate the prevalence of impacted canines and highlights the importance of early detection for appropriate orthodontic treatment planning. Early intervention can prevent some of the negative consequences associated with maxillary canine impaction. The canine position plays a critical role both functionally and aesthetically, as impaction can affect smile symmetry and thereby influence orthodontic diagnosis. In 2023, Dindaroğlu *et al.* [15] reported that individuals with unilateral maxillary canine impaction exhibited greater social smile asymmetry. On the other hand, research indicated that the degree of facial asymmetry was not affect with the maxillary unilateral impacted canine [16].

While there were a number of limitations to this study regarding the number and categorization of the data related to how records have been collected in the past at UNLV SDM, there are potentially useful trends and correlations observed. In this study females made up the majority of impaction cases (69.2% female vs. 30.8% male). While it can be speculated that this correlation has much to do with the physiological size difference in growing individuals of each sex, it does trend in

TABLE 2. Association of type of impaction with ethnicity for both maxillary canines according to Yamamoto's classification.

Type	Ethnicity									
	African American		Asian		Caucasian		Hispanic		Mixed	
	N	%	N	%	N	%	N	%	N	%
Tooth #6										
Type I	2	40.0	-	-	1	8.3	7	36.8	4	13.3
Type II	3	60.0	-	-	5	41.7	9	47.4	16	53.3
Type III	-	-	-	-	3	25.0	1	5.3	2	6.7
Type IV	-	-	-	-	-	-	-	-	1	3.3
Type V	-	-	1	100.0	2	16.7	2	10.5	7	23.3
Type VI	-	-	-	-	-	-	-	-	-	-
Type VII	-	-	-	-	1	8.3	-	-	-	-
Total	5	100.0	1	100.0	12	100.0	19	100.0	30	100.0
$\chi^2 = 21.995; p = 0.341$; Not significant										
Tooth #11										
Type I	1	14.3	-	-	2	14.3	2	9.1	1	3.4
Type II	3	42.9	-	-	8	57.1	9	40.9	15	51.7
Type III	1	14.3	-	-	-	-	1	4.5	1	3.4
Type IV	2	28.6	-	-	4	28.6	10	45.5	9	31.0
Type V	-	-	-	-	-	-	-	-	1	3.4
Type VI	-	-	-	-	-	-	-	-	-	-
Type VII	-	-	2	100.0	-	-	-	-	2	6.9
Total	7	100.0	2	100.0	14	100.0	22	100.0	29	100.0
$\chi^2 = 44.921; p = 0.001$; Significant										

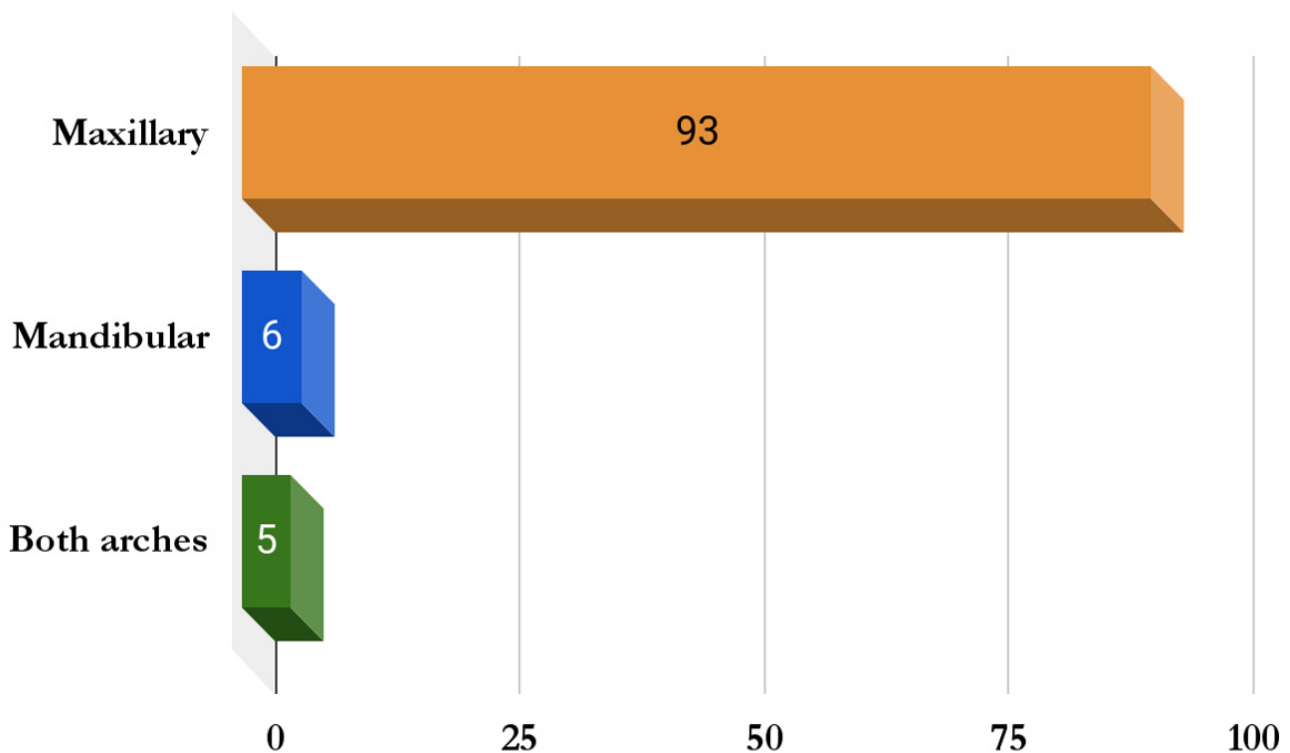


FIGURE 3. Distribution of canine impaction by arch.

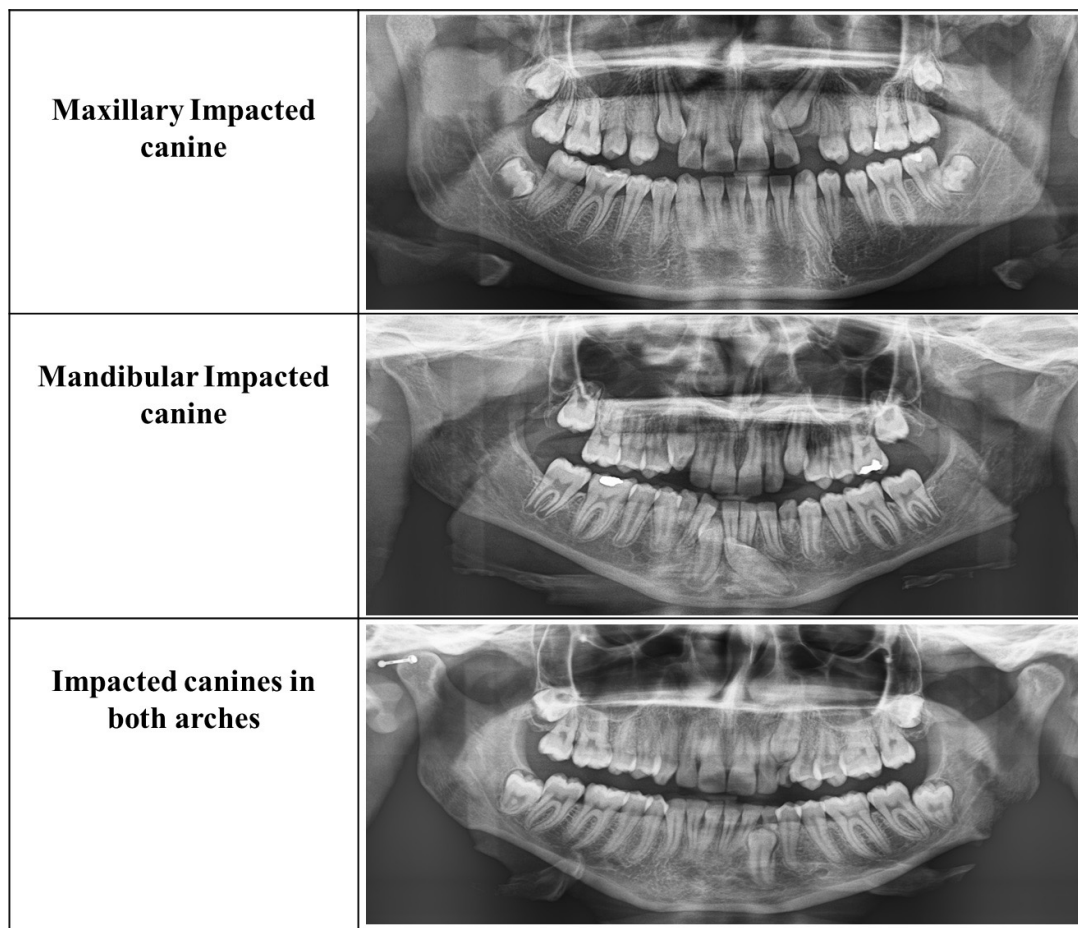


FIGURE 4. Clinical cases of impacted canines, in relation to their position in the arch.

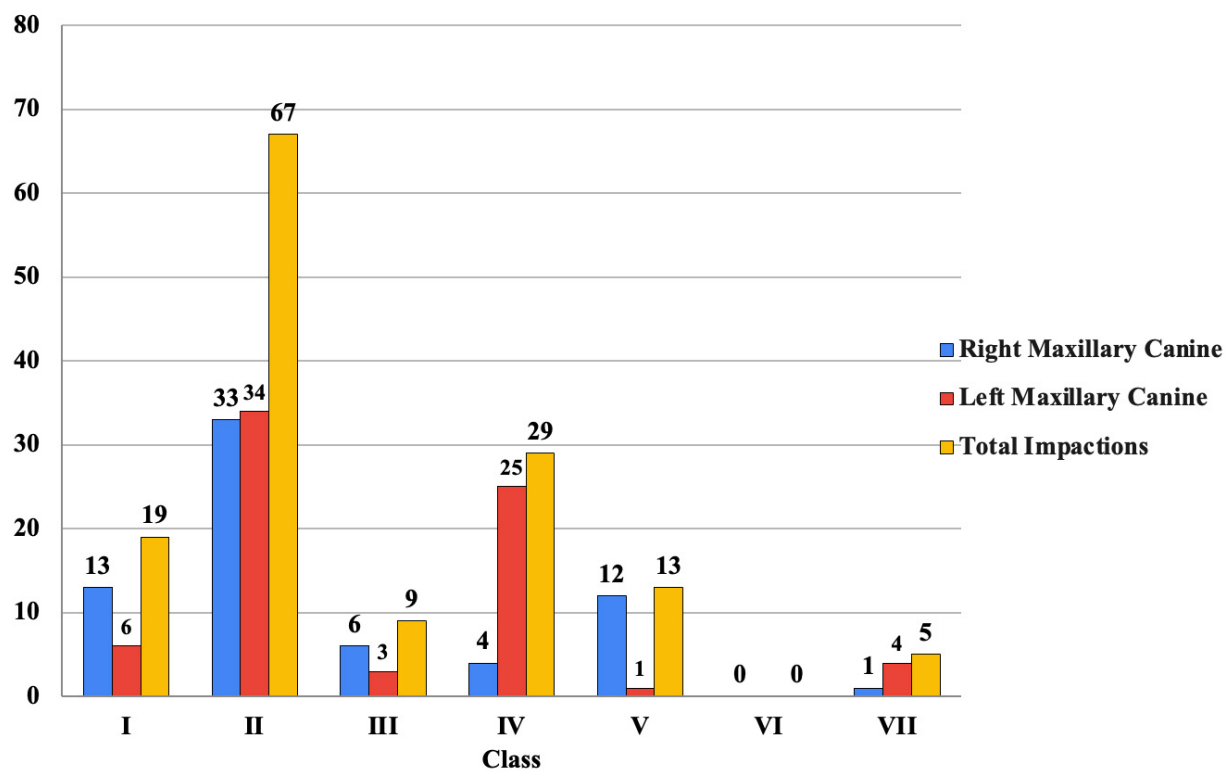


FIGURE 5. Impacted canine distribution according to Yamamoto *et al.* [14] classifications.

the same direction as data in previous studies looking at the predilection for impaction in individuals [5].

In 1986, Ericson and Kurol were the first to provide a classification for the position of the canine in both frontal and transverse sections, utilizing both Orthopantomograph (OPG) and axial vertex views to assess the severity of impaction [17]. It primarily assesses the position of the impacted canine based on the position of the canine cusp tip relative to the lateral incisor's root apex radiographically, along with the angle of inclination and horizontal overlap. This system helps estimate the complexity of impaction and the risk of root resorption. On the other hand, Yamamoto's classification uses a typological approach (Type I, II, III, *etc.*) that organizes impactions by orientation, alveolar position and potential eruption path [14]. Yamamoto's system may be useful for clinicians, especially when documenting the precise spatial relationships of impacted canines, as it provides a precise categorization of different impaction patterns.

The distribution of canine impactions seen in the maxilla and mandible was more prominently found in the maxilla. This aligns with previous research. Because of the rare occurrence of mandibular impactions, a classification system such as the one developed by Yamamoto *et al.* [14] has yet to be developed for mandibular impacted canines. The more limited bony space of the mandible also would probably manifest in fewer types of impactions of these canines as compared to the maxilla, but this is not something that can be definitively suggested by our data and is something that perhaps future studies could better elucidate. To predict the eventual eruption patterns of solitary mandibular canines undergoing transmigration, Mupparapu introduced a classification system for both unilateral and bilateral transmigrating mandibular canines [18].

Here, instances of impaction in both the maxilla and mandible would be greatly aided with the use of CBCT imaging. Early on in the classification of impaction for those in the patient pool who met all criteria, it was noticeable that CBCT imaging would greatly improve the accuracy of speed of classification using Yamamoto's class scheme. While CBCT imaging was available at UNLV SDM from 2014 onwards, the use of it for orthodontic patients at the school was not as uniform or common. With CBCT imaging becoming more commonly used by multiple dental specialists, its use in future studies looking at impaction prevalence would be a great aid in the speed and accuracy of classification.

In addition, this research was conducted and limited to panoramic imaging. Only Panoramic images could be evaluated due to limited access and lack of CBCT images. Although the class of impaction could usually be distinguished through a panoramic image, CBCT imaging would have added more value to the study. Schroder conducted research on maxillary canine impaction and thorough evaluation was done not on the class of impaction but rather the positioning of the canine, either palatal or buccal. They found that about 60% of the impacted canines were positioned palatally and under 30% were positioned buccally. They also examined how the positioning affected the root resorption of adjacent lateral incisors [19].

Research published in 2023 by Farha *et al.* [20] outlined how CBCT imaging can be effective in evaluating impacted maxillary canines. This research emphasizes the importance

of the imaging to implement the "correct biomechanical approach" and evaluation of the severity of impaction [20]. With this, there can be accurate diagnosis and planning to properly correct the impaction and minimize the root resorption and poor periodontal outcomes. Both of these things are critical in the treatment of maxillary canine impaction.

In accordance with these capabilities, recent systematic review and meta-analysis analyzed the skeletal structures specific to cases of palatal impaction [21]. The systematic review and meta-analysis confirmed that there is controversy in the co-relation of the maxillary vertical and transverse dimensions in palatally positioned impacted canines [21].

In the present study, the largest proportion of patients presenting with canine impactions identified as "Mixed", followed by those identifying as "Hispanic". Interestingly, a separate investigation found a higher incidence of impacted maxillary canines in a Jewish population, suggesting that genetic factors may contribute to susceptibility to canine impaction [22].

In this study, the highest proportion of canine impactions was observed among individuals identifying as Mixed ethnicity (44.2%) and Hispanic (26%), followed by Caucasians (18.3%) and African Americans (9.6%) ($\chi^2 = 55.135$; $p < 0.001$). When these data were compared with the demographic composition of Clark County, two statistically significant discrepancies emerged: Caucasians (18.3% vs. 67.2%; $\chi^2 = 49.125$; $p < 0.001$) and Asians (1.9% vs. 11.2%; $\chi^2 = 6.664$; $p = 0.010$) were underrepresented in our sample, and individuals identifying as Mixed ethnicity (44.2% vs. 5.5%; $\chi^2 = 38.949$; $p < 0.001$) were substantially overrepresented. These findings suggest that the patient population seeking treatment for canine impactions at the SDM does not fully reflect the broader demographics of Clark County.

Several factors may account for these disparities. Differences in access to dental care, particularly in referral patterns, appear to be central. The University of Nevada, Las Vegas (UNLV) dental clinics provides cost-effective services that are often more feasible for individuals of lower socioeconomic status, potentially leading to a greater proportion of patients from underserved communities—such as those identifying as Mixed or Hispanic—seeking care at the clinic. In addition, cultural perceptions regarding oral healthcare, awareness of existing services, and broader social determinants of health may influence patients' likelihood of pursuing dental treatment. Recognizing and understanding these multifaceted factors is essential for developing targeted interventions to improve access to orthodontic services and ensure that care is provided equitably across all demographic groups.

This investigation encompasses a diverse, multi-ethnic population, whereas most previous research on impacted canines has been limited to specific ethnic groups. Although the present sample size is smaller than that of many other studies, our findings stand out due to their focus on underrepresented populations—particularly Hispanic and mixed ethnicities, for which data remain scarce. By addressing this gap in the literature, our results provide clinicians with a valuable reference for the prevalence of canine impaction in their specific patient populations and offer new insights into the variability of impacted canine prevalence across different ethnic subgroups.

Ultimately, this study underscores the need for more inclusive diagnostic and treatment protocols for impacted canines.

Deep learning models to diagnose impacted canines utilizing panoramic radiographs might help in the proper diagnosis without the need for CBCT. A previous study indicated that a deep learning model to diagnose impacted canines has achieved a classification accuracy of 92.6% [23]. Future research on the association between skeletal classification and impacted canines would be beneficial. Dash *et al.* [24] examined impacted canines in relation to skeletal classification and concluded that the majority of impactions were Skeletal Class I (62.3%), followed by Class II (29%) and Class III (8.6%).

Due to the limitations in the research and interpretation based on panoramic imaging, future research could be done using CBCT imaging. Understanding the positioning of the canine and how it affects adjacent structures and future treatment planning could be positive for the future of orthodontic treatment planning and preserving patient's esthetics and surrounding teeth.

5. Conclusions

Within the limitations of this study, the findings demonstrate a strong correlation between the prevalence of impacted canines and female, mixed and Hispanic patients. Maxillary canine impactions were found to be more prevalent than mandibular canine impactions. Type II impactions were the most common among the classifications of maxillary impaction.

The findings highlight the importance of early diagnosis and intervention in patients at higher risk of canine impaction, particularly in orthodontic treatment planning and preventive strategies. Further longitudinal and genetic studies are recommended to explore the underlying etiological factors contributing to canine impaction prevalence across different populations.

AVAILABILITY OF DATA AND MATERIALS

All data are available upon request from the corresponding author.

AUTHOR CONTRIBUTIONS

AR, TA, NHA—contributes to the conception or design of the work; drafts the work; gives final approval of the version to be published; and agrees to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. DT, HZ—contributes to the conception or design of the work; revises the work; gives final approval of the version to be published; and agrees to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Since no supplementary radiographs or examinations were conducted specifically for this study, and all collected data were analyzed and presented anonymously, the Institutional Review Board (IRB) of the University of Nevada, Las Vegas, granted exempt status (UNLV-2024-361). The study adhered strictly to the principles of good clinical practice outlined by the World Medical Association (WMA) Declaration of Helsinki. Written informed consent was obtained from all patients attending the dental clinics at the School of Dental Medicine (SDM), UNLV. For participants under 18, written informed consent was secured from their parents or guardians.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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