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Research Article

Prevalence and Classification of Impacted Maxillary Canine in People living in Duhok City by using Cone Beam Computed Tomography (CBCT)

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Abstract

Aims: The present study aimed to employ CBCT technology to investigate the prevalence, gender distribution, and classification (following Archer's 1975 method) of impacted maxillary canines in Duhok City in order to establish a standard for local clinical practice

Materials and Methods: In this retrospective cross-sectional study, 4,368 CBCT scans from various private clinics and dentistry centers in Duhok City between 2021 and 2026 were examined. The study sample comprised 2,111 males and 2,257 females, aged 12 to 60 years. Archer's categorization was used to identify and classify impacted maxillary canines. SPSS version 29 was used for statistical analysis. Associations were found using Chi-square and Fisher's exact tests, with a $P < 0.05$ threshold for statistical significance.

Results: Out of the entire sample, 162 individuals (3.6%) had at least one maxillary canine impacted. The frequency was much higher in women (2.6%) than in males (1.1%). The next most prevalent categories were Class II (buccal), Class I (palatal), and Class III (mixed labial–palatal). Archer Class IV (impaction inside the alveolar process) accounted for 1.8% of cases. There was a statistically significant correlation found between gender and both the kind of impaction and the impaction status.

Conclusion: The prevalence of impacted maxillary canines in Duhok City was relatively elevated compared to other previous studies on the same population (in Duhok City), more than or higher than other populations (in other cities)

Keywords: Duhok City, Archer's categorization, CBCT, Impacted maxillary canine, Prevalence.

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INTRODUCTION

According to (1), impacted teeth are those that obstruct the bone or eruption, slowing or completely stopping development. Maxillary and mandibular wisdom teeth, maxillary and mandibular canines, premolars, and maxillary lateral incisors are the most often afflicted teeth; however, impaction can affect any permanent tooth (2). However, the maxillary canines are the most often impacted teeth when wisdom teeth fall out (3).

The inability of a tooth to erupt into its correct position in the dental arch within the anticipated timeframe, usually due to a physical barrier or lack of space, is clinically known as tooth impaction. Canine impaction is thought to have a complex etiology that includes both systemic factors like genetic predispositions and developmental abnormalities of neighboring lateral incisors as well as a variety of local factors like the prolonged retention of primary teeth, dental arch crowding, and the presence of pathologies like odontomas (4).

The initial technique to evaluate the canines' locations is clinical testing. If an unerupted maxillary canine is not palpable by the age of 10 to 11 or if root resorption of neighboring teeth is suspected, conventional 2D radiographs, such as panoramic images and periapical intraoral radiographs in two projections, should be obtained to assess the relationship between the canine and neighboring teeth (5).

Dental diagnostics have been transformed by Cone Beam Computed Tomography (CBCT) since its inception. This technique produces high-resolution three-dimensional (3D) pictures at a far lower radiation exposure than traditional medical CT scans. Through precise axial, coronal, and sagittal plane identification of the impacted tooth, CBCT provides the precise anatomical information required for precise orthodontic and surgical treatment planning. According to (5), impacted maxillary canines are the most frequent reason for CBCT examinations in teens.

Although impacted maxillary canines are a clinically significant abnormality, quite little is known about their occurrence and characteristics in the Duhok community. This study employs CBCT technology to investigate the prevalence,

gender distribution, and classification (following Archer's 1975 method) of impacted maxillary canines in Duhok City in order to establish a standard for local clinical practice (6).

MATERIALS AND METHODS

Study Design and Environment

In Duhok City, Kurdistan Region, Iraq, a retrospective cross-sectional study was carried out using the archival database of private clinics and specialist dental radiology institutions. Population Under Study: CBCT scans from 4,368 diagnostic procedures comprised the research sample. There were 2,111 male respondents (48.32%) and 2,257 female subjects (51.68%).

Inclusion and Exclusion Criteria

- Inclusion: patients in Duhok City who had outlived the typical eruption age for maxillary canines were given high-quality CBCT scans of their maxilla.
- Exclusion: individuals with a history of maxillary malignancies or fractures, individuals with craniofacial problems (such as cleft lip and palate), scans with significant artifacts, and situations in which canines have already been excised are excluded.
- Data Collection and Classification: Using CBCT images, impacted maxillary canines were identified. Using Archer's Classification (1975), the discovered cases were grouped into five categories:

❖ Class I: The palette is home
❖ Class II: Found on the buccal/labial surface.
❖ Class III: In the center, with the root on one side and the crown on the other.
❖ Class IV: Situated between the incisor and first premolar, vertically inside the alveolar process.
❖ Class V: Found in an edentulous maxilla; not seen in this investigation.

Statistical Analysis

Utilizing the Statistical Software for the Social Sciences (SPSS), Version 29, the collected data were assembled and examined. We computed the prevalence rates using descriptive statistics. To ascertain the statistical association between gender and the kind or existence of canine impaction, the Chi-square (χ^2) test and Fisher's exact test were employed. A P-value (probability value) of less than 0.05 was found to be statistically significant.

RESULTS

There were 2111 males (48.32%) and 2257 females (51.68%) out of 4368 CBCT scans for residents of Duhok City (Table 1).

Table 1: Gender distribution of the sample size

Gender	Number	Rate
Male	2111	48.32
Female	2257	51.68
Total	4368	100

Prevalence: Out of 4,368 participants, 162 had at least one impacted maxillary canine, resulting in an overall prevalence of 3.6%.

Gender Distribution: Gender and impaction were shown to be statistically significantly correlated by the investigation.

- **Females:** 2.5% prevalence (greater incidence) in females.
- **Males:** 1.1% of men are affected. It was shown that the likelihood of an impacted maxillary canine in females was more than double that of males.

Impaction

In this study, 4206 of the 4368 participants—male and female—had normal maxillary canines and were unaffected. Of the 162 patients (100%) with at least one impacted maxillary canine, 49 (29.7%) were men and 113 (70.3%) were female. A total of 3.6% of both male and female canines had an impact. 1.1 percent were men and 2.5 percent were women. Gender and impaction were shown to be significantly correlated

($P < 0.05$) by the chi-square test, with females having a greater frequency of canine impaction than men [Table 2].

Table 2: Association between impaction and gender.

	Normal	Impaction	Total	
Gender	n (%)	n (%)	n (%)	P-value
Male	2062	49(1.1 %)	2111	
Female	2144	113(2.6%)	2257	p=0.006
Total	4206	162(3.7 %)	4368	

Classification Using Archer's System: The allocation of the 162 affected impacted cases according to Archer's classification was as follows:

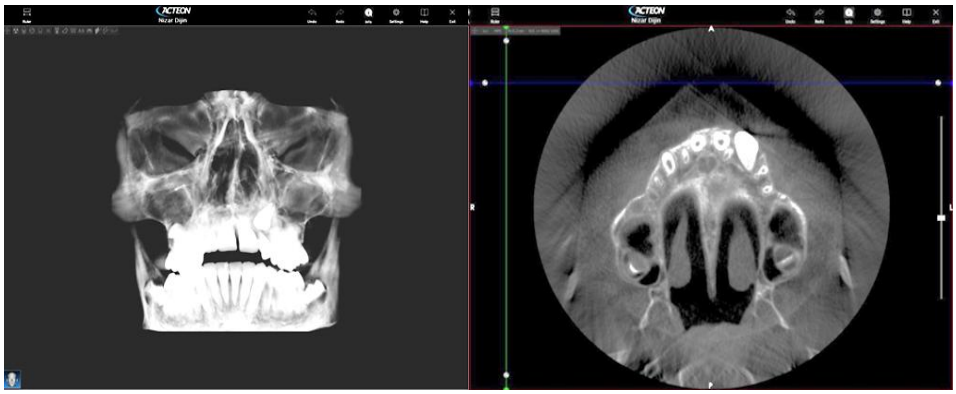
1. **Class IV (Alveolar Process):** This kind was the most common, accounting for 1.8% of the sample. It demonstrated a strong gender link and was more prevalent in females.
2. **Class II (Buccal):** This kind is the second most prevalent (1.1%). For this class, there was no discernible difference between males and females.
3. **Class I (Palatal):** Made up 0.7% of the sample, and there was a notable gender difference.
4. **Class III:** There is no discernible gender difference, and this kind is the least common (0.06%).

Class II (buccal) impactions were more common than Class IV in men. On the other hand, Class IV impactions were substantially more common than other classes in females.

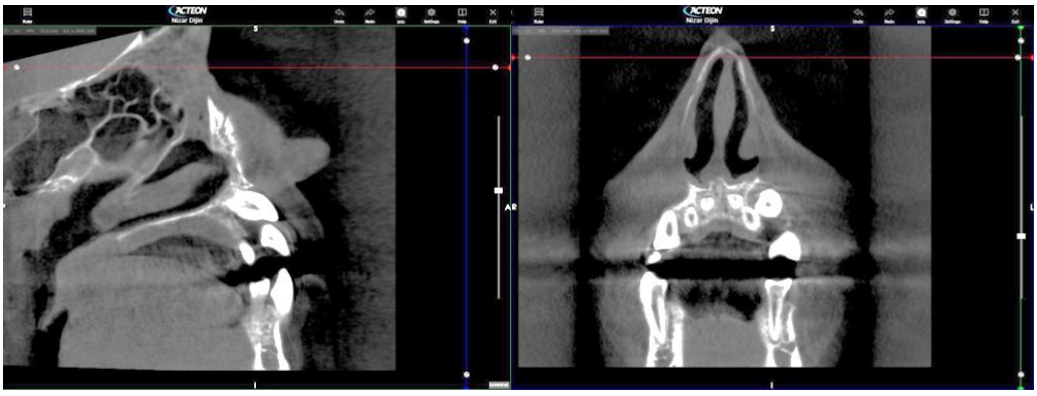
Axial

Sagittal Coronal

Figure 1: **Class I**: Impacted canines in the palate

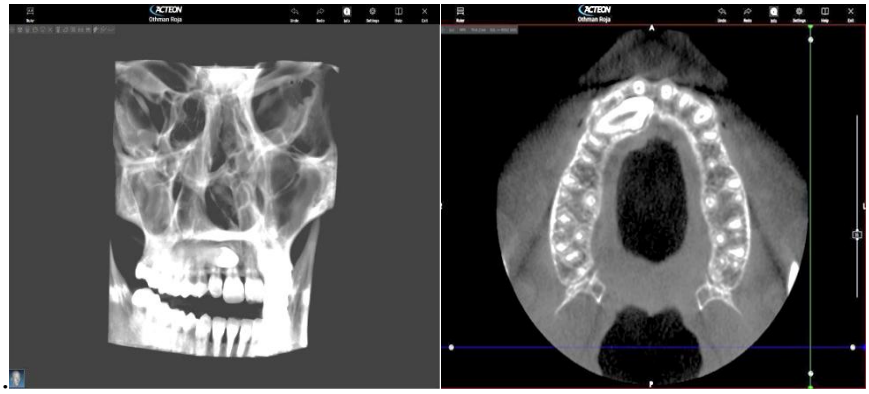


Axial

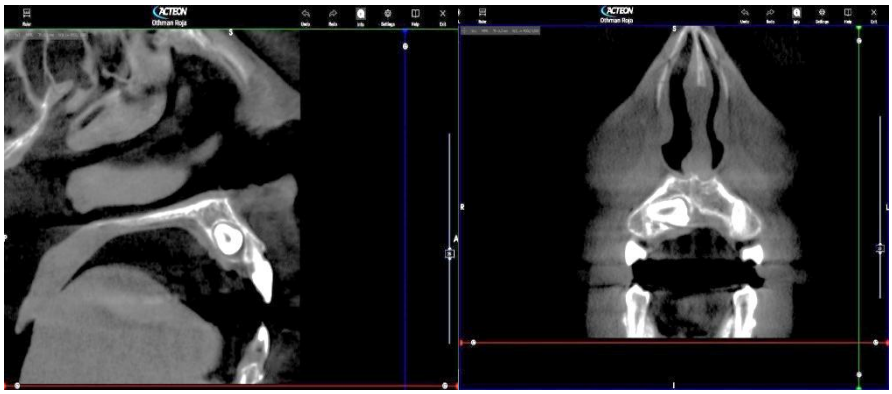


Sagittal Coronal

Figure 2: **Class II**: Impacted canines located on the labial surface



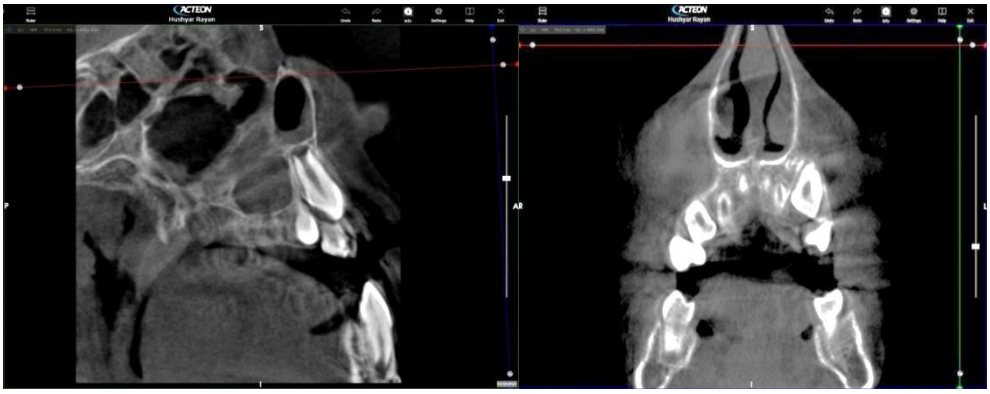
Panoramic reconstruction Axial



Sagittal Coronal

Figure (3): Class III: An impacted canine positioned both labially and palatally, with the crown located on one side of the dental arch and the root extending toward the opposite side

Panoramic reconstruction Axial



Sagittal Coronal

(Figure 4): **Class IV**: Impacted canine located within the alveolar process-usually vertically between the incisor and first premolar

Class V: Impacted canine in edentulous maxilla-Impacted canine can be in unusual positions like inverted position. According to Archer's classification, 49 (1.1%) out of 2368 (100%) examined teeth showed impaction. Class II (buccal) maxillary canine impaction was the most prevalent type, accounting for 23 (0.51%) teeth, followed by Class IV (within the alveolar process) with 18 (0.4%) teeth. Class I (palatal) impaction was less frequent than both Class II and Class IV, with 6 (0.13%) teeth. Class III (located both labially and palatally) was identified in 2 (0.04%) teeth, while Class V-representing impacted canines in an edentulous maxilla—was the least common (Table 3).

(Table 3): Prevalence and classification of impacted maxillary canines in males.

Archer Class	n	%	Mean (p)
Class I (Palatal)	6	0.13	0.0013
Class II (Buccal)	23	0.51	0.0051
Class III (Labial and Palatal)	2	0.04	0.0004
Class IV (Within alveolar process)	18	0.40	0.0040
Total (Males)	49	1.1	0.011

* P-value < 0.05 was considered statistically significant. Asymptotic Pr less than 0.0001; Exact Pr >= ChiSq (3.362E-05) = 0.000033. So the p-value) is much smaller than (p=0.05). This means there is strong, significant evidence of canine impaction.

Of the 2368 (100%) teeth in females, 113 (2.6%) had impacted maxillary canines. Class I (palatal) and Class II (buccal) impactions were nearly comparable and ranked second with 25 (0.59%) and 26 (0.57%), respectively, whereas Class IV (inside the alveolar process) maxillary canine impaction was the most prevalent kind of impaction, occurring in 61 (1.4%) of the teeth. Results from male patients also showed that 1 (0.02%) had type III canine impactions, which are positioned palatally and labially (Table 4).

(Table 4): prevalence and classification of impacted maxillary canines in females.

Archer Class	n	%	Mean (p)
Class I (Palatal)	25	0.59	0.0059
Class II (Buccal)	26	0.57	0.0057
Class III (Labial & Palatal)	1	0.02	0.0002
Class IV (Within alveolar process)	61	1.40	0.0140
Total (Females)	113	2.6	0.026

** P-value < 0.05 was considered statistically significant. Asymptotic Pr less than 0.0001; Exact Pr (0.0001)> ChiSq (5.259*10-13). So the p-value < 0.05; this means there is significance.*

Class IV (Within the Alveolar Process) 61 (1.4%) teeth were the most frequent form of impacted maxillary canines in females, whereas Class II (Buccal) 23 (0.51%) teeth were the most common type in males. Compared to males (1.1%), females had a considerably greater frequency of impacted maxillary canines (2.6%). Males had varying rates of Class I and Class II impacted maxillary canines, whereas females did not show any discernible variations. For the smaller form of impacted maxillary canines, type III (placed labially and palatally), the outcomes were the same for both boys and girls [Table 5].

(Table 5): prevalence and classification of impacted maxillary canines in males and females.

Archer Class	n	%	Mean (p)
Class I (Palatal)	31	0.7	0.0070
Class II (Buccal)	49	1.1	0.0110
Class III (Labial & Palatal)	3	0.06	0.0006
Class IV (Within alveolar process)	79	1.8	0.0180
Total	162	3.6	0.036

* P-value < 0.05 was considered statistically significant. Fisher's exact test showed a statistically significant association between gender and status (p<0.0001).

The current study found that people of Duhok City had a notably high frequency of impacted maxillary canines (3.6%) in both genders. The most common kind (1.8%) was kind IV (in the alveolar process), which was followed by Class II (baccal) (1.1%), Class I (palatal) (0.7%), and the smallest, III (found labially and palatally) (0.06%).

DISCUSSION

The present CBCT-based study evaluated the prevalence, gender distribution, and spatial position of impacted maxillary canines among individuals living in Duhok City, Iraq. The overall prevalence of impacted maxillary canines in this population was 3.6%, which is considered relatively high when compared with several studies reported after the year 2000 (7).

The management of impacted canines can pose a significant clinical challenge. As part of the treatment planning, accurate identification of the location, position, and

presence of associated pathology is paramount. CBCT images are considered the more contemporaneous diagnostic imaging technique, compared to conventional radiographs (8).

Various studies assessed the prevalence of impacted teeth among different study populations (9). The present study assessed the prevalence of impacted maxillary canines without considering impaction of other teeth (10).

Different prevalence was reported among different ethnic groups (11). Ethnic background of the sample may result in higher or lower rates of some anomalies (12). The prevalence found in the current study (3.6%) is higher than that reported in several populations worldwide. For instance, (13) reported a prevalence ranging from 1.0% to 2.5%, while (14) reported that the prevalence of impacted maxillary canines rarely exceeds 2% in most populations. However, studies conducted using CBCT imaging have reported higher detection rates.

In the present study, impacted maxillary canines were significantly more prevalent in females (2.5%) than in males (1.1%), with a statistically significant association between gender and canine impaction ($\chi^2 = 17.2$, $P < 0.05$). This finding is in agreement with numerous studies published after 2000.

Studies (15) and (16) both demonstrated a significantly higher prevalence of impacted maxillary canines in females, indicating that females are nearly twice as likely as males to exhibit canine impaction. This observed gender predilection may be explained by variations in craniofacial development, genetic factors, and delayed eruption patterns in females, as highlighted in (17).

As found in previous reports, canine impaction is more prevalent in the maxilla than the mandible. According to the literature, the prevalence of maxillary canine impaction ranges between 0.8 and 2.8% among different populations (18).

The present study assessed the prevalence of impacted maxillary canines without considering impaction of other teeth (19). In our current study the prevalence of impacted maxillary canines in population living in Duhok city were significantly high (3.6%) compering to a Kosovar population were (1.62%) (20), and Sweden

population were (1.1%) (21), Also when comparing with the prevalence of impacted maxillary canines in population living in Chinese were (2.1%) (22), and (0.92%) in the United States (23). In addition, (1.8%) of the Icelandic population (24). A prevalence of 2.7% was reported in the Saudi population (25). On the other hand, the result in our study was in agreement and very nearly the same as the result of the Chennai population, which was the prevalence of (3.77%) (26). study agreement was also in agreement with the result in the Turkish population, also (3.58%) (27). The prevalence of maxillary canine impaction was found to be 3.46% in Najran (28).

In Pakistan population, the prevalence of impacted maxillary canines was 5% (29), and in the Caucasian population were (4.8%, that are higher than the result of our study (30). Also, a prevalence of 5.1% was reported in some other parts of the Chennai population (31).

The general population in broader studies shows that the prevalence of impacted maxillary canines was reported to be between 0.9% and 3.3% (32) that is agree with the current study.

The result of current study show the prevalence of impacted maxillary canines in femals were (2.5%) more than the males were (1.1%) and that is agree with the result of Pakistan a study found that out of 187 patients with impacted maxillary canines, 117 were females and 70 were males, resulting in a female-to-male ratio of 1.67:1 (29), and also agree with study current in Sweden involving 601 patients with impacted maxillary canines reported that 65% were females and 35% were males (33), and also in India a study observed that the prevalence of impacted maxillary canines was 5.1% in females and 4% in males, though this difference was not statistically significant. (34). In these study in males the Class II of impacted maxillary canines were (0.51%) was significantly more than other types of impactions, followed by the type IV were (0.4%) which was significantly more than the Class I were (0.3%) and the less type of impacted maxillary canines was type III (0.04), These result is agree with other research indicates that buccally (Class II) impacted maxillary canines are more prevalent in Asian populations compared to Caucasian groups (35). And also agree with A study

conducted in Pakistan found that 50.3% of impacted canines were positioned buccally, 43.8% palatally (29), and these result is disagree with A study in Sweden analyzing 54,716 adolescents in the Västra Götaland region found that most impacted maxillary canines were palatally positioned (19), and also disagree with research involving 8,101 patients treated at the University Dentistry Clinical Center of Kosovo reported that out of 131 impacted maxillary canines, a significant number were palatally impacted. (20) But in the females the results were different from the males that were the type IV 61 (1.4%) was significantly more than the Class I and Class II were 25(0.57%) and 26(0.59%) respectively and the less types of impaction canine were Class III 1(0.02%) of all cases, these result is agree with research in India revealed that most impacted maxillary canines (Class IV) were present in the mid-alveolus region (36). These results disagreed with the study reported by Hassan AL-Zoubi et al that the Class I canines' impactions were more predominant, followed by Class IV, Class II, and Class III, respectively (37).

On the other hand, the findings of the present study revealed that Class III impaction (lateral incisor root contact) of impacted maxillary canines in the population of Duhok city, in both genders, was significantly less frequent than other types of impactions. This observation is consistent with study (38), which reported that impactions involving contact with adjacent incisor roots (Class IV) are relatively uncommon. A possible explanation for this low prevalence is that such impactions require a more complex deviation in the eruption path, often associated with severe spatial limitations or abnormal tooth angulation, conditions that may occur less frequently in the general population.

Furthermore, the current study demonstrated that Class IV impaction (middle or mid-alveolus) was the most prevalent type of impacted maxillary canine (1.8%) in the Duhok population. This finding is in agreement with the study (36), which also identified the mid-alveolar region as the most common site of impaction. The predominance of mid-alveolar impactions may be attributed to disturbances in the normal eruption pathway, where the canine fails to migrate properly either buccally

or palatally and instead remains within the alveolar bone. Additionally, genetic factors, discrepancies between tooth size and arch length, and variations in the timing of eruption may contribute to this pattern. These factors collectively suggest that mid-alveolar impaction represents a common developmental deviation, rather than a positional anomaly limited to buccal or palatal displacement, thereby explaining its higher frequency compared to other types.

Clinical Implications

The findings of this study emphasize the importance of early diagnosis of impacted maxillary canines, particularly in female patients who appear to be at higher risk. CBCT should be considered when conventional radiographs are insufficient, especially for treatment planning and for reducing the risk of root resorption of adjacent teeth, as emphasized by (39).

Limitations

The present study has some limitations. Its retrospective nature and lack of age stratification may limit the ability to assess eruption timing. Additionally, Class V impactions were not recorded due to the absence of edentulous cases in the sample.

CONCLUSIONS

Within the limitations of this CBCT-based study, impacted maxillary canines showed a relatively high prevalence in the population of Duhok City, with a significantly higher occurrence in females. Class IV impaction was the most frequent type, highlighting the diagnostic value of CBCT in accurate localization and classification of impacted maxillary canines.

1. The population of Duhok City has a very high frequency of impacted maxillary canines (3.6%).
2. A noticeable sexual dimorphism exists, with females being considerably more impacted than men.
3. The most prevalent appearance in this group is Class IV (vertical impaction within the alveolus), which is followed by Class II (buccal).
4. CBCT is essential for diagnosing and categorizing these instances because it provides vital information that 2D radiography could overlook.
5. For female patients and those with suspected eruption delays, early screening and 3D imaging are advised in order to avoid issues such as root resorption.

Acknowledgment
Not applicable

Authors' Contribution
Mustafa BT: Conceptualized and designed the study; collected data from private dental clinics and specialist dental radiology centers in Duhok City; performed radiographic analysis of CBCT scans; classified impacted canines according to Archer's classification system; and drafted and prepared the manuscript. **Musalah MKh:** Supervised the research process and provided methodological guidance for the retrospective cross-sectional study design.

Ethical statement:
The protocol for this retrospective cross-sectional study was reviewed and approved by the **Institutional Review Board (IRB) / Ethical Committee of the College of Dentistry, University of Duhok**. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. As this was a **retrospective study** using existing radiographic records (de-identified archival data), the requirement for individual informed consent was waived by the ethics committee. All clinical procedures (original CBCT scans) were performed as part of the patients' routine diagnostic or treatment requirements and not specifically for this research.

Conflict of interest
The author declares that there are no conflicts of interest regarding the publication of this manuscript.

Availability of data and materials: All data generated or analyzed during this study are included in this published article and its supplementary information files.

Declaration of Generative AI and AI-assisted technologies
We acknowledge the use of ChatGPT (OpenAI) to assist in language polishing and grammar correction of this manuscript. The intellectual content, data interpretation, and conclusions were entirely prepared and verified by the authors.

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انتشـــار وتصـــنيف الأنياب العلوية المنطمرة لدى ســـكان مدينة دهوك باســـتخدام التصـــوير المقطعي المحوسب ذي الحزمة المخروطية (CBCT)

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الملخص

الاهداف: هدفت هذه الدراسة إلى استخدام تقنية التصوير المقطعي المحوسب ذي الحزمة المخروطية (CBCT) لدراسة مدى انتشار الأنياب العلوية المنطمرة، وتوزيعها حسب الجنس، وتصنيفها (وفقًا لطريقة آرتشر لعام 1975) في مدينة دهوك، وذلك بهدف وضع معيار للممارسة السريرية المحلية. **المواد وطرائق العمل**: في هذه الدراسة المقطعية الاسترجاعية، تم فحص 4368 صورة CBCTمن عيادات خاصة ومراكز طب أسنان مختلفة في مدينة دهوك بين عامي 2021 و2026. وشملت العينة 2111 رجلاً و 2257 امرأة، أعمارهم 12 عامًا فأكثر. استُخدم تصنيف آرتشر لتحديد وتصنيف الأنياب العلوية المنطمرة. استُخدم برنامج SPSS الإصدار 29 للتحليل الإحصائي. تم تحديد الارتباطات باستخدام اختبارات مربع كاي واختبار فيشر الدقيق، مع اعتبار قيمة P < 0.05دلالة إحصائية .**النتائج**: من بين العينة الكلية، كان لدى 162 فردًا (3.6 %(ناب علوي واحد على الأقل منطمر. مقارنةً بالرجال (1.1 %(، كان التكرار أعلى بكثير لدى النساء (2.6 %(. كانت الأنواع من الفئة الثانية)الخدية(، والفئة الأولى)الحنكية(، والفئة الثالثة)المختلطة الشفوية-الحنكية(هي الأكثر شيوعًا بعد ذلك، بينما شكلت الفئة الرابعة من تصنيف آرتشر)الانطمار داخل النتوء السنخي(1.8 % من الحالات. وُجد ارتباط ذو دلالة إحصائية بين الجنس ونوع الانطمار وحالته . **الاستنتاجات**: كان انتشار الأنياب العلوية المنطمرة في مدينة دهوك مرتفعًا نسبيًا مقارنةً بالتقارير الواردة من عدة مجتمعات أخرى .أظهرت المريضات قابلية أكبر لانحشار الأسنان. التصوير المقطعي المحوسب ذو الحزمة المخروطية.(CBCT)

الكلمات المفتاحية: مدينة دهوك، تصنيف آرتشر، التصوير المقطعي المحوسب ذو الحزمة المخروطية (CBCT) ، انحشار الناب العلوي، الانتشار