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The Prevalence and Patterns of Impacted Canines in Orthodontic Patients: A CBCT Study.

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Abstract

Introduction: Although prevalence of impacted canines has been analyzed in prior studies, there is a lack of evidence about the prevalence of impacted canines in the Malaysian population to support such practices. Understanding the prevalence of impacted canines will enhance awareness, knowledge, and understanding of the importance of obtaining preventive and interventional treatment. The research aims to establish the impacted canine prevalence in orthodontic patients using cone beam computed tomography (CBCT). **Materials and Methods**: An examination of clinical records of 175 patients with canine impaction from January 1st, 2010, to November 30th, 2020 who had CBCT scans and visited dental clinics for orthodontic treatment was done to determine their prevalence. Descriptive statistics and Chi-square test analysis were carried out to evaluate the results. **Results:** The results suggested that the impacted canine prevalence was 17.5 %, with a female preponderance. Impacted canines occurred most frequently in Class I malocclusion subjects. In addition, canine impaction is more frequent on the left side than on the right. Unilateral impaction dominated bilateral impaction. Palatal impaction was more prevalent than buccal impaction, while maxillary canine impaction was more common than mandibular impaction. **Conclusions:** This study's prevalence was higher than previously reported among other populations. The demography and gender have an effect on the incidence of impacted canines. These three-dimensional (3D) findings may provide clinical reference data for delivering information and education on impacted canines assessment and treatment.

Keywords: Canines, Impaction, Orthodontics, CBCT, Prevalence.

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Introduction

Impaction teeth are those teeth that do not erupt in the occlusal line at the normal functional level and do not have a normal arch relationship with other teeth in the mouth.[1,2] The permanent maxillary canine is the most commonly impacted tooth after the third molar.[3,4] Permanent canines are considered aesthetically and functionally important in the dental arch. As a result, impacted canines provide multiple aspects for practitioners since they compromise tooth exposure as well as movement for aesthetic and functional consequences.[4,5] An impacted canine can pose a risk of ectopic eruption, displacement, or odontogenic tumors.[2] Complications from tooth impaction and displacement often include cosmetic and phonetic compromises, reduction of arch length, and accompanying discomfort.[6,7] The optimum facial harmony is thought to be the outcome of well-defined underlying dentofacial features.[8] It is crucial to understand the changes in adult craniofacial structures with the advancement of knowledge and the increase in the number of patients.[4] Impacted canines are one of the concerns that demand thorough diagnosis and planning.[5,6]

The prevalence of impacted canine values varies in different ethnicities attributed to the sample selection and inclusion criteria, which suggest genetic and ethnic variations.[9-11] It has been proposed that impacted canine prevalence prevails in other populations. However, there are no published or accessible articles/studies available discussing the prevalence in detail in Malaysia in different ethnic groups, genders, or types of malocclusion.[7,11,12,13,14]

As the impacted canines are located near vital anatomical structures such as the nasal cavity and sinuses in the maxilla, and the mental nerve in the mandible, a comprehensive radiographic evaluation to determine the position of the impacted canines is essential prior to any treatment planning. A clinician can clearly identify its position by using CBCT scan.[4] CBCT has recently been used by orthodontists and dental professionals to diagnose impacted teeth because it overcomes the superimpositions inherent in two-dimensional (2D) imaging and provides several advantages over computed tomography (CT); rapid scanning time, image accuracy, user-friendly software, lower radiation dose, and lower cost.[2-4] Accurate diagnosis is necessary for the effective treatment of impacted canines as well as the acquisition of more scientific data. Thus, this study aimed to establish the prevalence of impacted canines in orthodontic patients using CBCT.

Materials and Methods

Study Sample

From January 1st, 2010, to November 30th, 2020, 175 patients with canine impaction from 1000 patients aged 15 to 50 years with full permanent dentition attended dental clinics for orthodontic treatment at Hospital Universiti Sains Malaysia (HUSM), Malaysia, were recruited based on inclusion and exclusion criteria.

Inclusion Criteria

Subjects aged 15 to 50 years with a full permanent dentition who had CBCT scans obtained to diagnose the impacted canines were included in the study, selected from 1000 image scans.

Exclusion Criteria

Patients with syndromic disorders or other craniofacial anomalies including cleft lip, those with incomplete dental records, history of previous tooth extractions of adjacent teeth or orthodontic treatment of adjacent teeth, previous history of jawbone trauma and patients who had a low-quality CBCT scan grade 2 with any distortion or loss of clarity were excluded. A CBCT grade of 2 represents “unacceptable,” whereas a grade of 1 indicates “acceptable”.[15]

Consent for Using Patient Data

All patients receiving orthodontic treatment at the orthodontic unit completed a consent form acknowledging that their data could be utilized for future research purposes.

Data Extraction

Using Microsoft Excel spreadsheets (Microsoft® Excel® MSO, Redmond, WA, USA), data such as age, ethnicity, gender, type of impacted canine, and type of malocclusion were extracted from the patient files who had CBCT.

Patient Recruitment and Allocation

Each CBCT image was accessed separately under a

code number unique to each subject to acquire the samples from the records. The author Dr. (Y.H.Y.A.), with more than five years of experience in CBCT using three -dimensional (3D) software analysis (Planmeca Romexis® 3D Classic, Finland) (Figure 1), examined the CBCT image on a 15.6-inch FHD flat screen HP monitor (HP Envy 10TX, HP Inc., Round Rock, Texas, USA) running Microsoft Windows® 11 (Microsoft Corp., Redmond, WA, USA).[14]

Sample Size Calculation

The sample size was calculated to determine the prevalence of impacted canines in orthodontic patients based on ethnicity, gender, and different types of malocclusion. The following single proportion formula[16] was used:

$$n = \left(\frac{z}{\Delta}\right)^2 \left(p(1-p)\right)$$

Where n = required sample size, D = the study's precision was 5 % as indicated by The World Health Organization (WHO) recommendations for oral health surveys, z = standard normal deviation corresponding to 95 % confidence interval (CI) = 1.96, P = predicted prevalence or proportion; the author estimated P as 4.19 %.[16] When substituted, n = $(1.96/0.05)^2$ 0.0419 (1-0.0419) = 61. Thus, the total sample was n = 61 participants. There was a possibility of a 10 % dropout rate from the record. Dropout 10 % = 61/(1-10 %) = 67.

Based on the inclusion and exclusion criteria, all identified cases of impacted canines from CBCT scans were included.[17,18]

Operational Definitions and Procedures

An impacted canine is described as an intraosseously positioned canine that fails to erupt at its appropriate place in the dental arch based on the radiographic evaluation.[7,19]

The prevalence of impacted canines considering ethnicity and gender was determined based on their identification card (NRIC).[20] The prevalence of the various forms of malocclusions was determined using Angle classification of occlusion for the molar relationship as Class I if the mesiobuccal cusp tip of the maxillary first molar aligns with the buccal groove of the mandibular first molar, with a few millimeters deviation in either a mesial or distal direction, with some other malocclusion of the remaining teeth. The maxillary first molar is Class II if the mesiobuccal cusp tip aligns with the embrasure space between the mandibular first molar and second bicuspid (distal) on either the right or left side. It is categorized as Class III on either the right or left side if it corresponds with the embrasure space between the mandibular first and second molars (mesial) (Figure 2, a to c).[21]

Figure 2: The classification of malocclusion is shown in the three-dimensional reconstructed image acquired from raw CBCT data; (a) Frontal view, (b) Right side Class I molar relationship, and (c) Left side Class I molar relationship.

Statistical Analysis

The data were analyzed using SPSS statistics version 27 (IBM SPSS Statistics, Armonk, NY, USA). To evaluate the results, descriptive statistics and the Chi-square

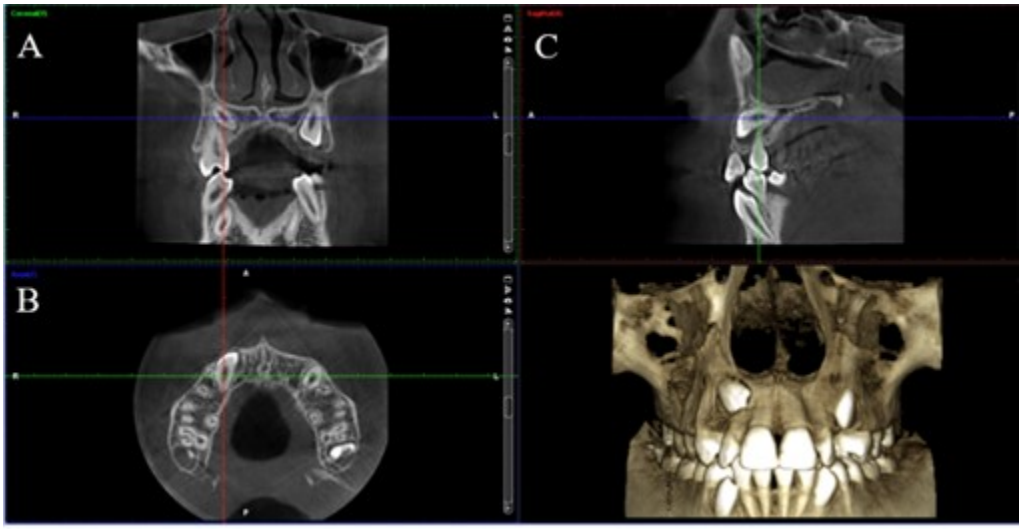

Figure 1: The three-dimensional reconstructed image obtained from raw CBCT data; (A) Coronal view, (B) Axial view, and (C) Sagittal view.

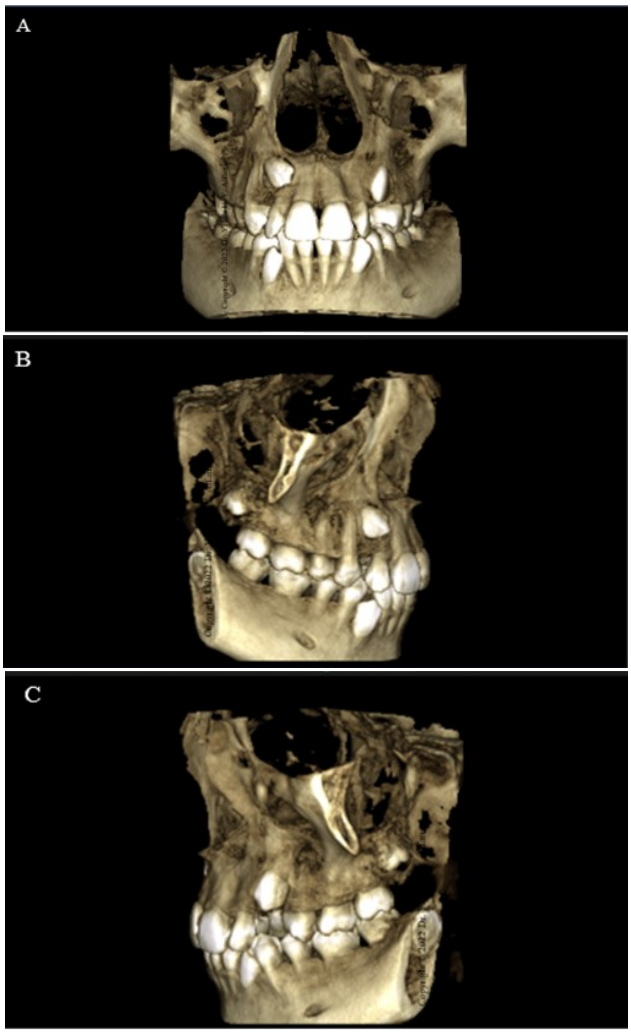

Figure 2: The classification of malocclusion is shown in the three-dimensional reconstructed image acquired from raw CBCT data; (A) Frontal view, (B) Right side Class I molar relationship, and (C) Left side Class I molar relationship.

test were used, with the significance level set at $P < 0.05$. The reliability of the CBCT measurements was assessed by repeating the measures two weeks after the initial examination to eliminate memory bias for re-evaluation on randomly selected subjects. The level of agreement for the variables was measured using Kappa statistics. The inter-and intrarater reliability of the parameters was good, with values ranging from 0.85 to 0.95.[20]

Results

Table I shows the demographic characteristics of the 175 participants with confirmed canine impaction, of which 72 were males and 103 were females. Mean age of the group was . Majority were of Malay ethnicity (84%) with the remaining 16% consisting of Chinese ethnicity. The prevalence of impacted canines in orthodontic patients attending HUSM was 17.5%.

The classification of malocclusions consisted of 77.7% Class I, 14.3% Class II and 8% were Class III (Table I). Majority of canine impaction were left sided (56%), unilateral (82.3%), palatal (80.6%) and maxillary (85.2%). Females had a higher prevalence of canine impaction, accounting for 103 (58.9%) of the samples, while the male was 72 (41.1 %) in the study population (Table I: *p=0.003*).

Discussion

The present study found a prevalence of impacted canine of 17.5 %, with a female preponderance. Impacted canines occurred most frequently in Class I malocclusion subjects and was more frequent on the left side than on the right. Unilateral impaction dominated bilateral impaction. Palatal impaction was more prevalent than buccal impaction, while maxillary canine impaction was more common than mandibular impaction.

Canine impaction hypotheses can be categorized into genetics and guidance. The adjacent lateral

Table I: General distribution of the sample size.

Variables	n (%)
Gender	
Male	72 (41.1)
Female	103 (58.9)
Ethnicity	
Malay	147 (84.0)
Chinese	28 (16.0)
Types of Maloccusion	
Class I	136 (77.7)
Class II	25 (14.3)
Class III	14 (8.0)
Side of Impaction	
Left	98 (56.0)
Right	77 (44.0)
Unilateral or Bilateral	
Unilateral	144 (82.3)
Bilateral	31 (17.7)
Palatal or Buccal	
Palatal	141 (80.6)
Buccal	34 (19.4)
Maxillary or Mandibular	
Maxillary	149 (85.2)
Mandibular	26 (14.8)

incisor's root guides the canine to erupt normally into the arch. However, there seems to be no guidance for the canine to follow if the next lateral incisor is congenitally missing or peg-shaped. Consequently, the canine will fail to erupt. This is known as the guidance theory.[4] The genetic theory considered the genetic factors such as race, gender, agenesis of adjacent teeth, aplasia, and supernumerary teeth to be a consequence of genetic and environmental multifactorial inheritance.[3,4]

The present study showed that the distribution of the impacted canines attending HUSM was 17.5 %, comparable to other studies such as Altaee et al., who found the impacted canines prevalence was 4.61 % in the Iraqi population.[11] More female subjects (58.9 %) in the current study than male subjects (41.1 %), resulting in a ratio of almost 1.37:1. These outcomes are consistent with Ngo et al., who found that females (58 %) dominate males (42 %) in the American population.[21,22] This result disagrees with Hsu et al. finding, who stated that the female to male ratio was 1:1.8.[23] A possible explanation for these variation findings is the sample's ethnic background variation may result in lower or higher rates of certain abnormalities. In other words, traits that may occur more commonly in certain ethnic groups may be considered specific to that population.[13,24]

Class I malocclusion was the most common. This was consistent with findings reported by Altaee et al.[11] but was contradictory with Abu-Hussein et al., who noted that impacted canine was most frequent in Class II malocclusions.[25] Unilateral canine impactions (82.3%) were more common than bilateral impactions (17.7%), consistent with other studies.[11,12] Moreover, similar to a report by Piya et al., the left-sided impacted canine (56 %) was slightly more frequent than the right -sided impaction (44 %).[13] However, dissimilar to a study done by Nagpal et al., right side impaction was more (54.4).[26]

Furthermore, the present study found that impacted maxillary canines occurred 85.2 % more than impacted mandibular canines (14.8 %). This finding is consistent with other studies.[7,12] Palatal canine impactions (80.6 %) were more common than buccal impactions (19.4 %), compatible with Pop et al., who reported that impacted canine was most commonly found in the palatal position.[27] The findings of this research were similar to the data reported in other studies, while the dissimilarities could be attributed to study variables such methodology and the inclusion criteria or study sample variables such as racial and genetic variations.

Repeated evaluations in this study revealed no significant difference between the two registrations for both raters and did not affect measurement repeatability. These findings are consistent with those of Ngo et al.[22] Experience and calibration are the main factors in improving landmark identification. Consequently, the author used a distinct set of CBCT images to do periodic calibrations with the expert operators.[14] Furthermore, all of the images were acquired by a single expert operator to eliminate variations in findings arising from discrepancies in the operator's skills.[22]

This study featured a few distinctive characteristics. All identified cases of impacted canines from CBCT scans were included in this study to represent various forms of impacted canines, as a larger sample size presented more precision and accuracy.[18] In comparison to prior research with smaller sample sizes, Fattahi et al. (106 subjects)[28], and Refaat and El-Desouky (90 participants).[29] Furthermore, based on CBCT, the current study generated a new clinical reference database for diagnosis and assessment. Consequently, a 3D investigation can improve diagnosis and treatment planning for impacted canine cases. [24,30] The present study provides the evidence base for future research that will include multicenter and study of the etiology of canine impactions, which could benefit practitioners in understanding this phenomenon.

The study had few limitations. This study was conducted on patients who attended dental clinics for orthodontic treatment at HUSM and hence may not be applicable to other centres. In terms of ethnicity, the use of Malay and Chinese patients made it challenging to find a sufficient number of CBCT patients who met the outlined criteria in this study. Some dental records were incomplete.

Conclusion

Sound knowledge of the canine morphology is essential for documenting and simplicity of interdisciplinary communication among clinicians. The prevalence of impacted canines among a sample of Malaysian orthodontic patients was 17.5 % with females more affected

common type. Incorporating this research into a clinical setting would create a multidisciplinary resource for information on impacted canines. This will be a valuable resource for students, researchers, and clinicians in the dental field, with a particular focus on orthodontics.

Abbreviations

2D	Two dimensional
3D	Three dimensional
CI	Confidence interval
CT	Computerised tomography
CBCT	Cone beam computerised tomography
HUSM	Hospital Universiti Sains Malaysia
NRIC	National record identification card

Institional Review Board

This study received no external funding. All data are available in the article, and no additional data are required. The authors declare that there is no conflict of interest.

Authors' Contributions

Dr. Yahya H. Y. Alfarra (Y.H.Y.A.) conducted the study as part of the PhD program, established the concept and idea, managed the data collection process, performed methodology, carried out project administration activities, and wrote and submitted the manuscript. The authors reviewed the study report.

Conflict of Interest

There are no conflicts of interest.

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