

Dental Age and Skeletal Maturity Stages in Patients with Impacted versus Erupted Maxillary Canines

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Abstract

Aims: To compare skeletal maturity stages and mean dental ages in patients with impacted versus erupted maxillary canines through radiographs.

Materials and Methods: It was a case control study with a total number of 50 cases and 50 controls. The inclusion criteria were patients of chronologic age 13-16 years, cases with un erupted maxillary canines and controls with erupted maxillary canines. Dental age and skeletal maturity stages were recorded from pretreatment OPG and lateral cephalometric radiographs, respectively. To control the confounders, cases were matched with the controls on the basis of chronologic age, gender and vertical skeletal pattern.

Results: Independent sample t-test showed statistically significant difference ($p < 0.001$) between mean dental ages of cases (11.35 ± 0.47 years) and controls (13.17 ± 1.08 years). Chi-Square test also showed statistically significant difference ($p = 0.01$) of frequency distribution of skeletal maturity stages between cases and controls [CS1 (04%, 00%), CS2 (08%, 00%), CS3 (28%, 04%), CS4 (16%, 30%), CS5 (34%, 46%), CS6 (10%, 20%)], respectively.

Conclusions: Mean dental age was found to be significantly reduced in patients with impacted maxillary canines as compared to patients with erupted maxillary canines. Cervical vertebrae maturation was found to be significantly retarded in patients with impacted maxillary canines as compared to patients with erupted maxillary canines.

Key Words: Impacted maxillary canines, Cervical vertebrae maturation stages, Dental age

Introduction

A tooth is considered to be impacted when it fails to erupt in a particular time period [1]. Impaction of maxillary canine is a more prevalent developmental anomaly which ranges from 0.8 percent to 3.6 percent [2]. According to a local study conducted at the Aga Khan University Hospital Karachi, maxillary canine was found to be the most frequently impacted tooth [3]. From a developmental point of view, maxillary canine is more prone to be affected by environmental factors due to longest period of calcification and complicated sequence of movements during the course of eruption—from the place of origin at about the end of 1st year of life to the occlusal plane in 9th to 11th year of life [4,5]. Such kind of developmental manner may result in, one of the more prevalent development anomalies, maxillary canine impaction with a frequency of 0.8-3.6% [2,6]. The prevalence of maxillary canine impaction in Pakistani population has not yet been evaluated. However, a study reports the prevalence of maxillary canine impaction in a tertiary care hospital which is 4.2% [7]. The reported prevalence of impacted canines in north Indian population was 9.7% [8]. Similarly, prevalence of maxillary canine impaction in Iran was found to be 1.1% [9].

When Southern Chinese children and adolescents were studied, the reported prevalence was found to be 2.1% [10]. In a sample of Saudi population, maxillary canine impaction was 3.6% prevalent [11]. Failure of its eruption necessitates complex treatment involving surgical and orthodontic therapeutic approaches because of its important role in esthetics, function and preservation of arch form [2,12]. It may also be related to hostile sequel such as migration and mobility of neighboring teeth and loss of arch form, compromised function and esthetics, root resorption, dentigerous cyst

formation and infection [13]. To avoid such a detrimental sequel, diagnosis of canine impaction at correct time is very crucial.

From the diagnostic point of view, the status of eruption of a tooth is estimated with the help of Chronological Age (CA) which is a weak and indecisive indicator. Although CA is readily available, easy to use and familiar starting point for assessing the development but due to individual variability of eruption, it is very challenging to explain canine impaction only on the basis of subject's chronologic age. Available alternative biologic indicators are dental and skeletal maturation for more predictable validation of dentoskeletal events [14,15].

Newcomb [5] stated that patients with moderate to severe retardation of dental maturation have the potential for permanent teeth to be impacted with certain exceptions. Rozylo-Kalinowska et al. [16] reported that dental age was significantly reduced in patients with impacted maxillary canines than in healthy controls. Becker and Chauzu [17] described that delayed dental development was associated with only palatally displaced maxillary canines. Similarly, another study stated that dental age was delayed in subjects with palatally displaced maxillary canines [18]. After the appraisal of hand-wrist radiographs, Hägg and Taranger [19] supported the findings of Björk and Helm [15], that by the end of pubertal growth spurt, all canines and premolars are usually erupted. Recently, relationship of maxillary canine eruption and skeletal maturity has been evaluated by Cervical Vertebrae Maturation (CVM) method suggesting that post pubertal stages (CS5 or CS6) without an erupted maxillary canine pointed towards canine impaction [20].

If the dental age and skeletal maturity stages are lower

in patients with impacted maxillary canines as compared to unaffected controls, it will support the suspicion of tooth being impacted leading towards early diagnosis. Timely interceptive treatment would only be possible if it is diagnosed at an early stage which will be less invasive and cost effective.

Aims

The aim of the study was to compare skeletal maturity stages and mean dental ages in patients with impacted versus erupted maxillary canines.

Null Hypothesis

According to null hypothesis, maxillary canine eruption or impaction is not affected by change in skeletal maturity stages and mean dental age.

Materials and Methods

It was a case control study comprised of 100 subjects conducted at the Department of Orthodontics of the Aga Khan University Hospital with a total number of 50 cases and 50 controls.

Sample Size Calculation

The sample size was calculated using a statistical calculator "Sample Size Determination in Health Studies, WHO". Rozylo-Kalinowska et al. [17] has shown that the mean dental age of cases with impacted maxillary canine was 13.54 ± 1.28 and of controls with erupted maxillary canines was 14.32 ± 1.48 . Therefore, keeping level of significance at 5% with study's power at 80%, we need at least 50 patients in each group (Cases = 50, Controls = 50).

Inclusion Criteria

The inclusion criteria of study were patients of Pakistani origin having chronological age from 13 to 16 years, cases with at least one unerupted/impacted maxillary canine and controls with bilaterally erupted maxillary canines.

Exclusion Criteria

The exclusion criteria of the study were previous history of orthodontic treatment, multiple tooth agenesis, craniofacial anomalies, traumatic injuries or massive caries of the dentition, and patients having pathologic (e.g. odontomas, cysts and supernumeraries) or mechanical (e.g. soft tissue thickness or severe crowding) obstruction to the eruption pathways of maxillary canines.

Chronological Age

The chronological ages of the patients were recorded from orthodontic files based on the time from child's birth to day of orthodontic record acquisition.

Maxillary Canine Impaction

Status of maxillary canine eruption was taken into account with the help of intraoral photograph, dental casts and panoramic radiographs.

Dental Age

The dental age of cases and controls were determined using Demirjian's assessment method (Figure 1) [21]. In this method maturation of left quadrant of mandibular seven teeth was observed from panoramic radiographs including central and lateral incisors, canine, first and second premolars, first and second molars. These seven teeth were rated A-H scale individually depending upon their development stage. Dental

maturity score was given to each tooth developmental stage according to the standard tables (separate for males and females). The scores of these seven teeth were added together to get total maturity scores which were then converted into dental age of the person according to the standard tables formulated for this population group specifically [22].

Skeletal Maturity Stages

The CVM stage was assessed on each lateral cephalogram according to the method of Baccetti et al. (Figure 2) [23]. The elective areas of both radiographs were masked to minimize the potential biases.

Severity of Cases and Controls

Dental Health Component (DHC) of Index of Orthodontic Treatment Need (IOTN) was used to assess the severity of cases and controls. For the group of cases, all 50 subjects scored IOTN grade 5i. When the maxillary canine impaction was not taken into consideration, 80% of cases still scored IOTN grade 3 or 4 while 20% of cases scored IOTN grade 1 or 2. From the group of controls out of 50 subjects, 60% were graded IOTN score 3 or 4 while 40% were graded IOTN score 1 or 2.

Control of Confounders

The controls were matched with the cases on the basis of chronological ages, gender and vertical skeletal pattern (Tables 2 and 3).

Method Error

To rule out measurement error, 10 randomly selected OPG and lateral cephalometric radiographs were reassessed after 1 month by the principal investigator.

Statistical Analysis

All statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) for Windows (version 19.0 Chicago Inc. USA). Descriptive statistics such as mean and standard deviations of chronological and dental ages were

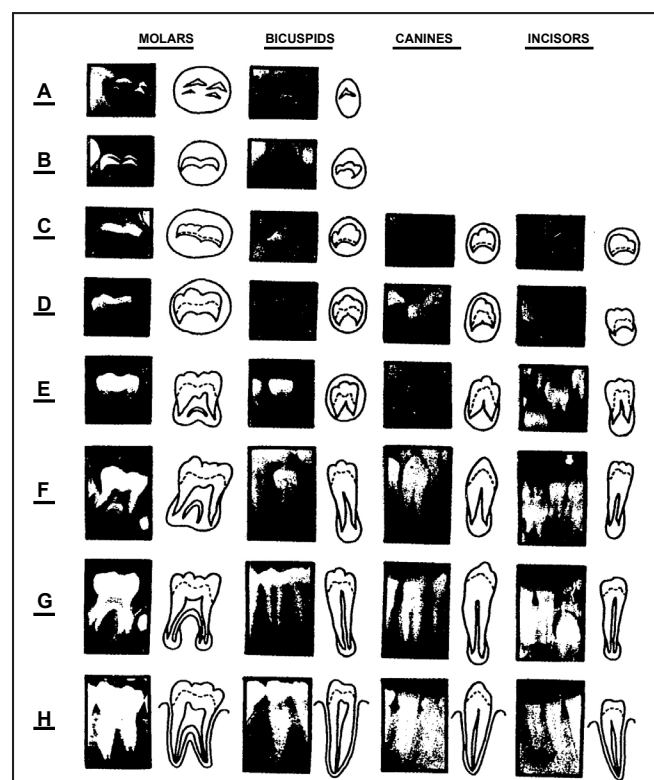


Figure 1. A-H developmental stages of mandibular left seven teeth according to Demirjian's method.

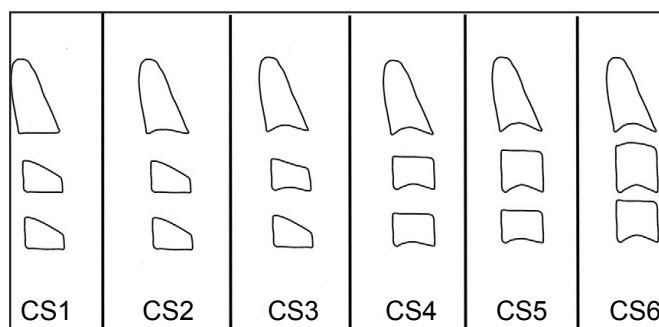


Figure 2. Diagrammatic illustration of cervical vertebrae maturation stages described by Baccettie et al.

determined. Frequency distribution of qualitative variables such as skeletal maturity stages, vertical skeletal pattern and gender were determined. Chi-Square test was applied to compare skeletal maturity stages of cases and controls. Independent sample t-test was applied to compare dental ages of cases and controls. Student t-test was applied to test the difference between chronological and dental ages of cases and controls.

Results

Mean and Standard Deviations (SD) of dental ages of both groups were determined. Mean dental age of cases was 11.35 ± 0.47 years whereas mean dental age of controls was 13.17 ± 1.08 years. When dental age of patients with impacted maxillary canines was compared with the controls, independent sample t-test showed statistically significant difference ($p=0.000$). The dental age was significantly reduced in cases as compared to controls.

Mean chronological ages of cases and controls were 13.46 ± 0.75 years and 13.44 ± 0.69 years, respectively. Analysis of difference between dental and chronological ages for patients with impacted versus erupted maxillary canines showed that dental age was significantly reduced in patients with canine impaction ($p=0.007$).

Table 1 shows frequency distribution of CVM stages in both groups and cervical stage 5 was most frequent stage found in cases as well as controls. Chi Square test showed statistically significant difference between CVM stages of cases and controls ($p=0.01$). Frequency distributions of gender and vertical skeletal pattern are explained in Table 2 and Table 3, on the basis of which cases were matched with the controls.

Discussion

Rozylo-Kalinowska et al. [16] reported that dental age was significantly reduced in patients with impacted maxillary canine than in healthy controls, also when palatal or buccal type of ectopia was taken into consideration. Becker and Chaushu [17] provided the evidence that dental development was significantly delayed in patients only with palatally displaced maxillary canines and buccal displacements were not associated with retarded dental age.

In the present study, we found that dental age was significantly reduced in patients with impacted versus erupted maxillary canines irrespective of palatal or buccal canine ectopia. We have taken into consideration Demirjian's dental age assessment method [21] because of its accuracy tolerance

of 0.1 years as compared to the method based on assessment of crown and root formation which has an accuracy of 0.5 years [24].

The panoramic radiographs were used in the study because they were originally used by Demirjian et al. [21]. They used panoramic radiographs because it is easy to obtain especially in young and apprehensive children with less exposure of radiations than full-mouth intra oral radiographs and minimum distortion in mandibular region. Furthermore, they are readily accessible and deliver a comprehensive understanding for the maturation of whole dentition [25].

The Demirjian's method was opted because in this method dental age estimation is based on rating the calcification stages and shape and proportion of root length (using the relative value crown height rather than absolute tooth length). This minimizes the influence of radiographic projection on the results of dental age estimation [26]. In addition, dental age table determined according to Demirjian's method has recently been presented for children of Pakistani origin [22]. Such evidence in the literature has provided the valuable support to eliminate the limitation of ethnic variation between different population groups.

To our knowledge, no literature is available on relationship of cervical vertebrae maturation and impacted permanent maxillary canines. However, Baccetti et al. [20] compared eruption of maxillary canine with skeletal maturity and concluded that eruption of permanent maxillary canine can occur at any stage in skeletal maturation before the end of pubertal growth spurt (CS1 - CS4). Moreover, they reported that a post-pubertal stage (CS5 or CS6) with unerupted maxillary canine indicates delayed canine eruption or impaction.

In our study, the most frequent stage among cases and controls was cervical stage 5 (CS5) which indicates that eruption status of permanent maxillary canine can be estimated at this stage. The absence of permanent maxillary canine in

Table 1. Frequency distribution of cervical vertebrae maturation stages among cases and controls.

Cervical Stages	Categories				p-value
	Cases = 50		Controls = 50		
1	02	04%	00	00%	0.01*
2	04	08%	00	00%	
3	14	28%	02	04%	
4	08	16%	15	30%	
5	17	34%	23	46%	
6	05	10%	10	20%	

N = 100

* P ≤ 0.05

Chi-Square Test

Table 2. Frequency distribution of gender among cases and controls.

Gender of Patients		Groups		Total	
		Cases	Controls		
Gender of Patients	Male	Count	25	25	50
		% of Total	25.0%	25.0%	50.0%
	Female	Count	25	25	50
		% of Total	25.0%	25.0%	50.0%
Total	Count	50	50	100	
	% of Total	50.0%	50.0%	100.0%	

Table 3. Frequency distribution of patients among cases and controls classified on the basis of their vertical skeletal pattern.

			Groups		Total
			Cases	Controls	
Vertical Skeletal Pattern of Patients	Normodivergent	Count	35	35	70
		% of Total	35.0%	35.0%	70.0%
	Hyperdivergent	Count	5	5	10
		% of Total	5.0%	5.0%	10.0%
	Hypodivergent	Count	10	10	20
		% of Total	10.0%	10.0%	20.0%
Total		Count	50	50	100

the oral cavity at CS5 suggests delayed canine eruption or impaction which is in concordance to the results of Baccetti et al. [20]. Secondly, if we compare frequency distribution of CVM stages, there was statistically significant difference ($p=0.01$) between cases and controls. Out of total number of cases, 12% were having CS1 and CS2 whereas these stages were not present even in a single control. Overall, CVM stages were retarded in patients with impacted maxillary canines as compared to unaffected controls.

The advantages of assessing skeletal maturity using CVM method include: around 95% coincidence between a growth interval in CVM and pubertal peak; straight forward appraisal of shape of cervical vertebrae; more than 98% inter-examiner reliability and elimination of a need for second radiation exposure [27,28].

The results of certain reported studies suggest [29-32] that CVM method can be used as an alternative reliable method for evaluation of skeletal maturation. However, certain limitations regarding skeletal maturation assessment by CVM method has also been reported. Nestman et al. [33] reported weakness of CVM method having difficulty in classifying the vertebral bodies of C3 and C4 as trapezoidal, rectangular horizontal, square, or rectangular vertical. Due to its poor reproducibility, they were unable to suggest the clinical use of this method for timing of orthodontic treatment. The question regarding reproducibility, reliability and validity of CVM method still remains unanswered [34].

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Certain confounding variables like chronological age, gender and vertical skeletal pattern were controlled between the cases and controls. Sacerdoti and Baccetti [35] stated that female gender and hypodivergence was significantly associated with palatally displaced maxillary canine. These variables influence the eruption timing of permanent maxillary canine due to which cases were matched with the controls. We acknowledge that there has not been observation regarding buccal or palatal displacement of maxillary canines in relation to dental age or skeletal maturation.

Our recommendation is to conduct a study on a larger sample to further evaluate the etiology of retarded skeletal maturation with regard to palatally or buccally displaced impacted maxillary canines. The clinical significance of the study suggests the reader that dental and skeletal ages will assist in evaluating the status of unerupted maxillary canine which is going to be impacted.

Conclusions

Mean dental age was found to be significantly reduced in patients with impacted maxillary canines as compared to the patients with erupted maxillary canines.

Cervical vertebrae maturation was found to be significantly retarded in patients with impacted maxillary canines as compared to the patients with erupted maxillary canines.

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