Evaluation of the position of the permanent maxillary canine and its relationship to dental anomaly patterns in the paediatric patient



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Abstract

Aim To evaluate the prevalence of ectopic eruption of the permanent maxillary canine in patients 6 to 10 years of age and its relationship to other dental anomalies, age and sex of the patient.

Study design Descriptive, cross-sectional, observational, and retrospective study.

Methods A total of 260 panoramic radiographs were collected from patients who had their first visit at the Paediatric Dentistry Department of the Hospital HM Nens, HM Hospitals in Barcelona from January to May 2021. The prevalence of ectopic eruption was evaluated based on the following variables: age, sex, inclination angle and mesiodistal position of the crown of the permanent maxillary canine. Additionally, the presence of other dental anomalies was recorded. The statistical analysis to evaluate the relationship between two categorical variables was carried out using the Chi-square (or Fisher) test with unrelated samples and the Mann-Whitney test with related samples. A p-value of 0.05 and a 95% reliability level were considered statistically significant.

Results In total 25 canines were found in ectopic eruption; 21 (8.07%) were located on the left hemiarch and 4 (1.53%) on the right hemiarch, showing statistically significant differences (p=0.001) between both hemiarches. Regarding age, it was found that the age group from 8 years 6 months to 10 years showed a higher percentage of ectopic eruption than the younger age group, with a statistically significant value on the left hemiarch (p=0.002). Of the 43 dental anomalies, 23 were on the left hemiarch (53.49%) and 20 anomalies were on the right hemiarch (46.49%).

Conclusions The prevalence of ectopic eruption of the permanent maxillary canine was 9.23%. In this sample, no relationship was found between patients with maxillary canine with abnormal position and inclination and the presence of other dental anomalies.

KEYWORDS Ectopic eruption, Maxillary permanent canine, Dental Anomaly Pattern.

Introduction

In the normal eruption pathway, the maxillary permanent canine moves distal to the permanent lateral incisor and mesial to the first premolar in the direction of the apex of the primary canine [Alessandri Bonetti et al., 2011]. It has been observed that the permanent maxillary canine reaches its maximum angle of inclination towards midline at approximately 9 years of age [Ericson and Kurol, 1988; Alessandri Bonetti et al., 2011], at which point it rectifies again with a vertical movement of the cusp to reach a more distal position [Fernández et al., 1998].

Considering both clinical and radiographic criteria, when the permanent maxillary canine demonstrates an exaggerated mesial inclination towards the midline or overlaps with the root of the permanent lateral incisor, the permanent maxillary canine is considered to have an incorrect or altered eruption pathway [Fernández et al., 1998; Tsai, 2001; Alessandri Bonetti et al., 2009]. A late eruption or prolonged retention of the maxillary permanent canine should be suspected when the patient is 14–15 years old and shows one or more of the following clinical features: absence of vestibular prominence or such prominence is found palatally, late or altered eruption and/or migration of the lateral incisor distally [Bishara, 1992]. The prevalence of ectopic eruption of the permanent maxillary canine varies around 1–3% worldwide [Thilander and Jakobsson, 1968; Ericson and Kurol, 1986; Ericson and Kurol, 1987a; Ericson and Kurol, 1987b; Rimes et al., 1997; Kalavritinos et al., 2020], presenting ethnic variations [Falahat et al., 2008]; furthermore, it is the tooth with the highest frequency of impaction, followed by the third molar [Bjerklin and Guitirokh, 2011]. In the Caucasian population, the prevalence of ectopic eruption of the permanent maxillary canine ranges from 2–3% [Laganà et al., 2017]. There is much controversy in the literature [Ericson and Kurol, 2000; Bjerklin and Guitirokh, 2011; Laganà et al., 2017] in reference to the prevalence of ectopic eruption of this tooth with regard to gender. Laganà et al. [2017] obtained a 1:1 gender prevalence in a sample of non-orthodontic patients. Some studies [Bazargani et al., 2014; Laganà et al., 2017] found no statistically significant differences in relation to sex, while other authors [Bedoya and Park, 2009; Kalavritinos et al., 2020] found that this condition is twice as common in females as in males.

It has been shown that impacted maxillary permanent canines are usually associated with other dental anomalies [Garib et al., 2005; Peck, 2009; Celikoglu et al., 2011]. These interrelated conditions are known as Dental Anomaly Pattern [DAP]. Some of the conditions that are included as biological

components of DAP are: absence of teeth, microdontia, delayed tooth formation/eruption, infraocclusion, palatal displacement of the canine and transposition of the canine [Garib et al., 2005; Peck, 2009; Uslu et al., 2009; Celikoglu et al., 2011; Laganà et al., 2017] with dental agenesis as the most frequent dental anomaly, with a prevalence of around 25% in the world population [Bredy et al., 1991]. Garib et al. [2005] found a correlation between agenesis of second premolars and other permanent teeth, as well as an association between microdontia and palatally displaced canines.

Early diagnosis of ectopic eruption of the permanent canine by a dentist is crucial, since preventive measures can reduce the impaction and favour normal eruption of the canine, avoiding long-term detrimental effects [Alessandri Bonetti et al., 2011]. To avoid traumatic and/or prolonged orthodontic treatment, it is important to know the prevalence of this phenomenon. Therefore, this study was proposed with the aim of evaluating the prevalence of ectopic eruption of the permanent maxillary canine in patients between 6 to 10 years of age and its relationship with Dental Anomaly Patterns (DAP), age, and sex of the patient.

Materials and methods

Ethical considerations

This study was evaluated and approved by the Ethics Committee for Clinical Research (CEIC) of the Universitat Internacional de Catalunya (UIC) (ODP-ECL-2020-07), Sant Cugat del Vallès, Spain in November 2019 and the Ethics Committee for Research with Medicines (CEIm) of the Hospital HM Nens, HM Hospitals in Barcelona, Spain (20.07.1655-GHM) in July 2020. The study was conducted in accordance with the Helsinki Declaration (last updated: October 2013) and with the International Conference on the Guide to the Harmonization of Good Clinical Practice.

Study design and population

This was a descriptive, cross-sectional, observational, and retrospective study. The databases of the first visits made at the Paediatric Dentistry Department of the Hospital HM Nens, HM Hospitales in Barcelona during the period between January 2021 and May 2021 were consulted. Confidentiality and anonymity were always guaranteed, both in the sample collection and in the publication of the results. For the estimation of the prevalence of ectopic eruption of the permanent maxillary canine, assuming a value of around 3%, with a desired precision of 3% with a confidence level of 95%, a sample of at least 125 individuals was necessary, taking into account the prevalence in the available scientific literature [Falahat et al., 2008; Bjerklin and Guitirokh, 2011; Laganà et al., 2017; Kalavritinos et al., 2020].

The inclusion criteria were: those patients between 6 and 10 years of age who had made a first dental visit, had a correctly completed medical and dental record and had a digital panoramic radiograph with good image quality, always performed by the same X-ray machine. Those patients with previous orthodontic treatment, patients with some type of disease or syndrome, patients with congenital pathology, patients who had undergone exodontia and/or patients who had suffered previous dental trauma were excluded from the study.

The age range established for this study was up to 10 years since, as previously described, the permanent maxillary canine reaches its maximum angle of inclination towards the midline at approximately 9 years of age [Ericson and Kurol, 1988; Alessandri Bonetti et al., 2011] and from that point on, it descends towards the occlusal plane in a vertical direction until the age of 11–12 years, the age at which the permanent upper canine erupts into the oral cavity [Schour and Massler, 1940].

Study variables

The variables studied were linear and angular measurements traced on the patient's digital panoramic radiograph included in the study as follows:

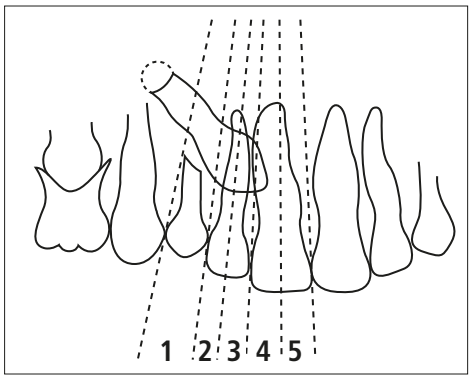


FIG. 1 Mesiodistal position of the maxillary permanent canine crown according to the designation of sectors 1-5. From Ericson and Kurol [1988].

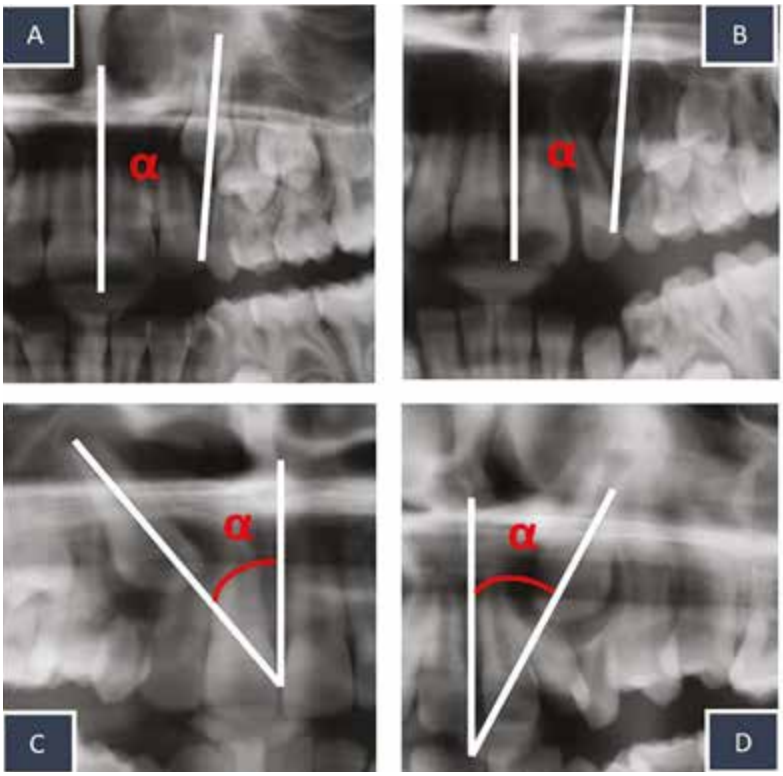


FIG. 2 Inclination of the maxillary permanent canine (angle α) with respect to the midline.
2A, 2B: canines with normal eruption pathway.
2C, 2D: canines with abnormal eruption pathway (angle α with an inclination greater than 25º).

1. The mesiodistal position of the crown of the maxillary permanent canine. The germ of the maxillary permanent canine was considered to be in pathological position when it was located between zones 2 and 5, according to the designation of sectors described by Ericson and Kurol [1988] (Fig. 1).
2. The angle of inclination of the maxillary permanent canine with respect to the midline. This was measured in degrees; considering the axis of the canine with respect to the midline, also described by Ericson and Kurol [1988] (Fig. 2). In this study an inclination greater than 25° was considered an anomaly.

The maxillary permanent canine was considered to be ectopic when it was located between sectors 2 to 5 and with an inclination angle greater than 25°, according to the parameters described by Ericson and Kurol [1988].

Procedure

The digital panoramic radiographs of each of the patients included in the study were printed on A4 paper at 1:1 scale (195x255mm) and traced with acetate paper. Once the tracings of the variables described above (mesiodistal position of the crown and inclination angle) had been made, the dental anomalies found in the panoramic radiographs were also noted, such as: ankylosis, microdontia, macrodontia, agenesis, ectopic eruption and/or presence of supernumerary teeth, verifying these findings with the data recorded in the dental and clinical record after the oral examination was carried out on the first visit. All the measurements taken on the digital radiographs were recorded by a single operator, previously calibrated.

Statistical analysis

The data obtained were processed and analysed using Microsoft Office Excel 2007 and the statistical program R version 4.1.2 (R: A Language and Environment for Statistical Computing, R Foundation for Statistical Computing, Vienna, Austria). Categorical variables were described with absolute frequencies and percentages. Numerical variables were determined with mean and standard deviation or median and quartiles (according to the distribution of the variables). To assess whether there was a relationship between two categorical variables, the Chi-square (or Fisher) test with unrelated samples and McNemar's test for related samples were used. A p-value of 0.05 and a 95% reliability level were considered statistically significant.

Results

Reproducibility of the measurement

Reproducibility was checked by double measurement with Cohen's Kappa index. Considering the degree of concordance described by Landis and Koch (1977), almost perfect concordance was obtained for the variables inclination angle (K=0.90 left hemiarch, K=0.89 right hemiarch) and mesiodistal position of the crown (K=0.81 left hemiarch, K=0.84 right hemiarch) of the maxillary permanent canine and, considerable concordances, in the variable of dental anomalies (K=0.66 left hemiarch, K=0.8 right hemiarch). This result showed a high reliability for all the measurements performed.

A total of 260 panoramic radiographs from the Hospital HM Nens, HM Hospitales in Barcelona, Spain, were included in the study. Regarding the characterisation of the sample, 140 (53.85%) of the radiographs were from female patients and 120 (46.15%) from male patients. According to age group, 108 panoramic radiographs (41.5%) corresponded to patients aged between 6 years and 8 years 6 months and 152 panoramic radiographs (58.5%) to patients aged 8 years 7 months and 10 years 11 months. The mean age of the sample was 8.3 years (±1.2); the female group presented a mean age of 8.2 years (±1.1) and the male group 8.4 years (±1.2).

Overall, of the 260 radiographs studied, 24 patients (9.23%), 12 boys and 12 girls, were found to have the upper permanent canine located between sectors 2–5 and with angles greater than 25° (pathological position and inclination). Of which, 21 canines (8.07%) were located on the left hemiarch and 4 canines (1.53%) on the right hemiarch, showing statistically significant differences (p=0.001) between both hemiarches; only 1 patient presented ectopic eruption of the maxillary canine on both hemiarches. Regarding sex, it was found that 12 of the canines that presented ectopic eruption were female (8.57%) and 13 were male (10.83%) (Table 1).

No statistically significant differences were found with respect to ectopic eruption of the permanent maxillary canine and sex, neither on the left hemiarch (p=0.55), nor on the right hemiarch (p=1). In relation to age, it was observed that the age group from 8 years-6 months to 10 years showed a higher percentage of ectopic eruption than the younger age group, this being a statistically significant value on the left hemiarch (p=0.002), also finding statistically significant differences in the older age group between the hemiarches (p=0.002). Likewise, no statistically significant differences were found between patients who presented the maxillary canine in ectopic position and inclination and the presence of any other dental anomaly on both hemiarches (p>0.05). Of the 24 patients who presented pathological position and inclination of the maxillary permanent canine, only 3 patients had some associated dental anomaly, 2 on the left side and 1 on the right side. In addition, on the right hemiarch, it was found that patients with ectopic eruption of the maxillary permanent canines presented almost a fourfold (PR=4.76) probability of having some other dental anomaly (Table 1).

Mesiodistal position of the maxillary permanent canine crown

In relation to this variable, 109 patients (41.9%) on the left hemiarch and 75 patients (28.8%) on the right hemiarch showed pathological position of the maxillary permanent canine because it was between zones 2 and 5, observing statistically significant differences (p<0.001) between both hemiarches (Table 2). In addition, 20% of the total sample (n=52) presented bilateral pathological position of the crown of the maxillary permanent canine. When the position of the canines was broken down according to the classification by sectors of Ericson and Kurol [1988], 95 canines were found on the left hemiarch in zone 2, 11 canines in zone 3, 2 canines in zone 4 and only 1 canine located in zone 5. On the right hemiarch, 54 canines were observed in zone 2, 19 in zone 3 and 2 in zone 4.

No statistically significant differences were found regarding the pathological mesiodistal position of the maxillary permanent canine crown and sex, neither on the left hemiarch (p=0.237) nor on the right hemiarch (p=0.080). There were also no statistically significant differences (p>0.05) between the different age groups in any of the hemiarches studied, although the number of canines found in sectors 2—5 was higher in the age group between 8 years 6 months to 10 years of age in both hemiarches.

Regarding the association between the pathological mesiodistal position of the maxillary permanent canine crown and the existence of another dental anomaly, no statistically significant differences were found in both hemiarches (p>0.05)

	Left				Right				Left vs right
	n(%)	EE(Yes)	PR(C.I)	p-value[1]	n(%)	EE(Yes)	PR(C.I)	p-value[1]	p-value[2]
Global	260(100%)	21(8.1%)			260(100%)	4(1.5%)			0.001*
Age									
6-8.5 years	108(41.5%)	2(1.9%)	Ref		108(41.5%)	0(0%)	Ref		0.480
8.6-10 years	152(58.5%)	19(12.5%)	6.75(1.60, 28.38)	0.002*	152(58.5%)	4(2.6%)	6.41(0.35, 117.86)	0.144	0.002*
Sex									
Girls	140(53.8%)	10(7.1%)	Ref		140(53.8%)	2(1.4%)	Ref		0.043*
Boys	120 (46,2%)	11(9.2%)	1.28(0.56, 2.92)	0.550	120 (46,2%)	2(1.7%)	1.17(0.17, 8.16)	1	0.016*
Anomalies									
No	238 (91.5%)	19 (8.0%)	Ref		243 (93.5%)	3 (1.2%)	Ref		0.001*
Yes	22 (8.5%)	2 (9.1%)	1.14 (0.28, 4.57)	0.694	17 (6.5%)	1 (5.9%)	4.76 (0.52, 43.40)	0.238	1

**Statistically significant value (p<0.05). NS = Not significant (p≥0.05)*
1= Chi-square test (or Fisher when required). 2= McNemar test
EE= Ectopic eruption; PR=prevalence ratio; CI=confidence interval

TABLE 1 Data regarding the prevalence of ectopic eruption of the permanent maxillary canine in the sample of the present study.

	Left				Right				Left vs right
	n (%)	Zones 2-5	PR (C.I)	p-value1	n(%)	Zones 2-5	PR (C.I)	p-value1	p-value2
Global	260(100%)	109(41.9%)			260(100%)	75(28.8%)			<0.001*
Age									
6-8.5 years	108(41.5%)	42(38.9%)	Ref		108(42%)	30(27.8%)	Ref		0.031*
8.6-10 years	152(58.5%)	67(44.1%)	1.13(0.84, 1.52)	0.403	152(58%)	45(29.6%)	1.07(0.72, 1.58)	0.749	0.004*
Sex									
Girls	140(53.8%)	54(38.6%)	Ref		120(46%)	34(24.3%)	Ref		0.002*
Boys	120 (46,2%)	55(45.8%)	1.19(0.89, 1.58)	0.237	140(54%)	41(34.2%)	1.41(0.96, 2.06)	0.080	0.050*
Anomalies									
No	238 (91.5%)	101(42.4%)	Ref		243 (93.5%)	67(27.6%)	Ref		0.001*
Yes	22 (8.5%)	8(36.4%)	0.86(0.48, 1.52)	0.581	17 (6.5%)	8(47.1%)	1.71(0.99, 2.94)	0.10	0.289

**Statistically significant value (p<0.05). NS = Not significant (p≥0.05)*
1= Chi-square test (or Fisher when required). 2= McNemar test
PR=prevalence ratio; CI=confidence interval

TABLE 2 Data regarding the angle of inclination of the permanent maxillary canine in relation with the superior dental midline in the sample of the present study.

(Table 2), but it was determined that of the 75 patients who presented the canine in a pathological position (zones 2–5) on the right hemiarch, these were almost twice as likely (PR=1.71) to present some other dental anomaly (Table 2).

Angle of inclination of the maxillary permanent canine with respect to the midline

Regarding the angle of inclination of the maxillary permanent canine with respect to the midline, there were 39 patients (15%) with angles greater than 25° on the left hemiarch and 15 patients (5.8%) on the right hemiarch, showing statistically significant differences (p<0.001) between the hemiarches (Table 3). In addition, 9 individuals (3.46% of the total sample) presented an angle of inclination of the maxillary permanent canine with respect to the pathological midline in both hemiarches.

No statistically significant differences were found with respect to the angle of inclination of the maxillary permanent canine with respect to the midline and sex, neither on the left hemiarch (p=0.295) nor on the right hemiarch (p=0.101). Statistically significant differences (p>0.05) were not found between the different age groups in any of the hemiarches studied, although the number of canines found with an inclination angle greater than 25° was higher in the age group between 8 years 6 months to 10 years of age in both hemiarches.

Likewise, no statistically significant differences were found between the patients who presented the pathological inclination angle of the crown of the maxillary permanent canine and the existence of any other dental anomaly in both hemiarches (p>0.05). Of the 39 patients on the right side and

	Left				Right				Left vs right
	n(%)	Angle (>25°)	PR(C.I)	p-value1	n(%)	Angle (>25°)	PR(C.I)	p-value1	p-value2
Global	260(100%)	39(15.0%)			260(100%)	15(5.8%)			<0.001*
Age									
6-8.5 years	108(41.5%)	11(10.2%)	Ref		108(42%)	6(5.6%)	Ref		0.182
8.6-10 years	152(58.5%)	28(18.4%)	1.81(0.94, 3.47)	0.067	152(58%)	9(5.9%)	1.07(0.39, 2.91)	0.901	0.001*
Sex									
Girls	140(53.8%)	18(12.9%)	Ref		140(54%)	5(3.6%)	Ref		0.009*
Boys	120 (46,2%)	21(17.5%)	1.36(0.76, 2.43)	0.295	120(46%)	10(8.3%)	2.33(0.82, 6.64)	0.101	0.010*
Anomalies									
No	238 (91.5%)	36 (15.1%)	Ref		243 (93.5%)	13 (5.3%)	Ref		<0.001*
Yes	22 (8.5%)	3 (13.6%)	0.90 (0.30, 2.69)	1	17 (6.5%)	2 (11.8%)	2.20(0.54, 8.96)	0.256	1

**Statistically significant value (p<0.05). NS = Not significant (p≥0.05)*
1= Chi-square test (or Fisher when required). 2= McNemar test
PR=prevalence ratio; CI=confidence interval

TABLE 3 Data regarding the mesiodistal position of the crown of the permanent maxillary canine in the sample of the present study.

15 on the left side who showed the pathological inclination angle of the maxillary permanent canine, only 3 had some associated dental anomaly on the left side and 2 on the right side. In addition, in the right hemiarch it was found that patients with a pathological inclination angle of the maxillary permanent canines showed double probability (PR=2.20) of having some other dental anomaly (Table 3).

Dental anomalies

Regarding the presence of dental anomalies, 32 children presented some dental anomaly (12.3% of the total sample); of these, 4 children presented 2 dental anomalies, 2 children were diagnosed with 3 dental anomalies and 1 child presented 4 dental anomalies. In addition, in 7 of the children in the total sample, some dental anomaly was observed on both the right and left sides. Of the 43 anomalies observed, 23 were on the left hemiarch (53.49%) and 20 anomalies on the right hemiarch (46.51%). Regarding sex, they were found in 9.16% of males (n=11) and 15% of females (n=21). Dental anomalies were diagnosed in only 12.5% (n=3) of the patients who presented ectopic eruption of the permanent maxillary canine, 2 on the left hemiarch and 1 on the right hemiarch.

The most frequently found dental anomaly was microdontia of upper lateral incisors in 51.16% of the cases (n=22), followed by: agenesis of upper lateral incisors or second premolars (37.21%; n=16), ectopic eruption of first permanent molars (4.65%; n=2), supernumerary teeth (2.33%; n=1), ankylosis (2.33%; n=1), and macrodontia (2.33%; n=1).

Discussion

The present study was designed to evaluate the prevalence of ectopic eruption of maxillary canines in a sample of Spanish patients in the mixed dentition period, as well as to determine its possible association with other dental anomalies. To date, we have not found any study in the literature regarding the prevalence of ectopic canines in the Spanish population. The prevalence of patients with ectopic canines in this study sample was 9.23%; Celikoglu et al. [2010] obtained a lower frequency, 4.9% of patients with impacted maxillary canines, in a sample of Turkish orthodontic patients. Prevalence similar to that obtained by Baccetti et al. [2010] (4.2% of maxillary canines impacted palatally) in a sample of Italian patients; although it should be noted that these authors [Baccetti et al., 2010] do not specify how they diagnosed canine impaction, unlike the precise and detailed diagnosis used in the present study to determine the pathologic position of the permanent maxillary canine. Of the 24 children diagnosed with pathological position and inclination of the permanent maxillary canine, only 1 individual presented it bilaterally; these results coincide with those of Fabiani et al. [2017] who obtained a higher prevalence of malpositioned maxillary canines with unilateral presentation (67.5% of the patients), although these authors [Fabiani et al., 2017] do not specify whether one hemiarch was more predominant than the other. In our study, 96% of our patients presented pathological eruption of the canine unilaterally, with the left side having the highest prevalence, with statistically significant differences between the hemiarches.

We decided to include patients in the mixed dentition period in the sample of this study because, according to Fabiani et al. [2017] and Schindel and Duffy [2007], early mixed dentition implies the moment in which the permanent canine germ begins its intraosseous migration towards the dental arch, thus being the ideal period to evaluate a possible impaction of the permanent maxillary canines. Fernandez et al. [1998] suggested that the maxillary canine reaches its maximum mesial inclination at approximately 9 years of age and, from this inflection point, the tooth progressively begins to straighten until eruption.

Warford et al. [2003] evaluated the panoramic radiographs of 82 patients under 12 years of age. As in our study, they also used the variable mesiodistal position of the crown of the maxillary permanent canine of Ericson and Kurol [1988], but they measured the position of the canine using a different reference: the bicondylar line, this measurement being equally valid as the classic one used in the present study. When comparing their results with ours, these authors [Warford et

al., 2003] obtained 82% of canines located between sectors 2–4; high results similar to those of the present study where we obtained that 50.8% of the children in the sample had at least one permanent maxillary canine in position 2—5. Warford et al. [2003] concluded that the sector designation variable has a greater influence in the prediction of canine impaction compared to the angulation variable, which did not provide any additional statistically significant predictability.

Bazargani et al. [2014] performed the same measurements as in our study, but with a smaller sample of 48 patients between 10 and 14 years of age, obtaining a mean angle of 23.1° and 58% of canines located in pathological areas. When comparing the prevalence of canines in pathological areas of the present study with the results of Bazargani et al. [2014], the percentages obtained are very similar (50.8% vs. 58%); also, like the data of the present work, these authors [Bazargani et al., 2014] did not obtain statistically significant differences with regard to sex. On the contrary, Baccetti et al. [2010] observed that females presented a 2:1 ratio with respect to the prevalence of ectopic eruption of maxillary canines in comparison with males.

Zuccati et al. [2006], in a sample of 87 patients with 108 impacted canines, studied the relationship between the location of the impacted maxillary canine with the duration of orthodontic treatment. They obtained a mean maxillary canine inclination of 33.3° and found that most of the canines were located between zones 1 and 2, using the same reference points as in our study to measure the inclination and mesiodistal location of the maxillary canine, although, unlike the present study, Zuccati et al. [2006] only took into consideration one hemiarch. Our results can be equated to those of Zuccati et al. [2006], since the canines in the present study were also mainly located in zone 1 (58.1% on the left hemiarch and 71.2% on the right hemiarch). These authors [Zuccati et al., 2006] determined that if the cusp of the canine was located between zones 4–5, these patients required on average about 10 more orthodontic treatment visits compared to canines located in zones 1,2 or 3, which seems to indicate the importance of measuring the canine by zones as a key factor in the diagnosis of a possible ectopia.

We have not been able to determine whether there is a relationship between the presence of ectopic eruption of the maxillary permanent canine with other anomalies of the dentition. Celikoglu et al. [2011] studied the frequency of dental anomalies related to the presence/agenesis of third molars. In contrast to our results, they concluded that there is a significant relationship between lateral incisor microdontia and other dental anomalies with third molar agenesis. Uslu et al. [2009] observed that a significant number of patients undergoing orthodontic treatment presented at least one dental anomaly [40.3%], although no statistically significant differences were obtained in relation to dental anomalies and malocclusion. Furthermore, these authors [Uslu et al., 2009] observed that the dental anomalies presented were independent of sex, although microdontia of the maxillary permanent first molar and ectopic eruption of maxillary canines were observed in greater numbers in the female group. While some authors [Uslu et al., 2009; Celikoglu et al., 2011] indicate that there are no statistically significant differences between sex and dental anomalies, others, such as Basdra et al. [2000], affirm the existence of statistically significant differences between sex and certain dental anomalies. In our study, 12.3% of the patients (n=32) presented some associated dental anomaly: 11 males (9.16%) and 21 females (15%); although the presence was greater in females, no statistically significant differences were obtained according to sex. Uslu et al. [2009] did not find statistically significant differences with respect to age; however, these authors [Uslu et al., 2009] point out that the presence of dental anomalies can increase with age, since they are more recognizable. This fact could explain the higher prevalence of ectopic eruption of the permanent maxillary canine observed in the older group of children in the present study. Cardoso Silva et al. [2014] obtained a prevalence of 21.8% of mandibular primary molars in infraocclusion in a sample of Spanish patients; a very different result from the present study in which a low prevalence of primary molar infraocclusions was observed (0.38% of the total sample). This difference between our results and those obtained by Cardoso Silva et al. [2014] could be mainly due to the fact that a different tracing was used to measure primary molar infraocclusions, as well as the fact that Cardoso Silva et al. [2014] analyzed a larger sample of patients (n=472) and included a much wider age range than ours (patients from 3 to 13 years of age), giving rise, perhaps, to a more heterogeneous sample. Hence, the importance of following a single, standardised protocol for the diagnosis of dental anomalies.

The main limitation of the present study is that the measurements were performed in 2D images (panoramic radiographs), which could present a slightly more limited diagnosis; performing a study with 3D radiographs could be more precise regarding the exact position of the permanent maxillary canine in relation to the arch, although such 3D images are not justified in the patient's routine examination. Early detection of ectopic eruption of the permanent maxillary canine, preferably before 11 years of age, has been found to be critical for the successful management of potentially impacted canines in order to avoid future long-term complications [Ericson and Kurol, 1988]. Alessandri Bonetti et al. [2011] concluded that early detection of a possible impacted maxillary canine is essential to avoid a more complicated orthodontic treatment, involving more time, higher biological cost and requiring fenestration surgery and orthodontic traction of the canine. In light of the results of the present study, the early detection of ectopic eruption of the canine must occur no later than at 8 years of age, but better before, in order to reduce the risk of impaction, applying the proper interceptive approach, also important for the management of any other anomalies present. It is of great importance to establish a follow-up protocol for patients who have presented altered values, to be able to evaluate the need for preventive extraction of the temporary canine or the need to initiate orthopaedic or interceptive orthodontic treatment at the appropriate time. It would be very useful to establish a consensus on an accurate and reliable system, perhaps through the routine tracing of the patient's panoramic radiographs, to standardise and help colleagues in the early diagnosis of these eruption anomalies.

Conclusions

1. The prevalence of ectopic eruption of the permanent maxillary canine in the sample of the present study was 9.23%.
2. The data obtained show a greater predisposition to ectopic eruption of the permanent maxillary canine on the left hemiarch and in the oldest group of patients (8 years 6 months to 10 years).
3. In this sample, no relationship was found between patients with maxillary canine with abnormal position and inclination

and the presence of other dental anomalies.

Conflict of interests

The authors declare no conflict of interest.

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