

Prevalence of Maxillary Permanent Canine Impaction in Relation to Anomalous Lateral Incisors

Ilknur Veli, DDS, PhD;^{1,*} Burcin Yuksel, DDS;² Tancan Uysal, DDS, PhD³

ABSTRACT

Objective: The aim of this study was to document the prevalence of maxillary permanent canine impaction in relation to anomalous adjacent lateral incisors in a Turkish population.

Materials and Methods: Pretreatment orthodontic records of 68 subjects (27 male, 41 female) with palatal or buccal impaction of one or both permanent maxillary canines were included in this study. Localization of the impacted permanent canines was determined by using cone-beam computed tomography images and classified as buccal or palatal impaction. Maxillary lateral incisors were recorded as normal, small, peg shaped, impacted, or missing using 3-dimensional digital models. The percentage of the total sample in each group was calculated, and the significance of the relationship between canine impaction and anomalous lateral incisors was examined with the Pearson χ^2 test at a significance level of 0.05.

Results: The overall prevalence of peg-shaped maxillary permanent lateral incisors was found to be 18.3%. Impaction of the maxillary canine was 5.18 times more common in females than males, and palatal canine impaction was almost 1.27 times more common than the buccal impaction.

Conclusion: Palatally impacted maxillary permanent canines were more common than buccally impacted canines and occurred more often in female subjects. Also, the prevalence of maxillary canine impaction in association with anomalous lateral incisors was different among Turkish males and females. (*Turkish J Orthod.* 2014;27:90–99)

KEY WORDS: Canine impaction, Cone-beam computed tomography, Lateral incisor

INTRODUCTION

Maxillary canines are important teeth in terms of aesthetics and function. Eruption of a maxillary canine occurs at an age ranging from 9.3 to 13.1 years,¹ and the likelihood of maxillary impaction ranges between 1% and 3%.² Clinicians should be aware of dental anomalies that occur with impacted maxillary canines so that early recognition and interventional treatment can spare the patient time, expense, more complex treatment, and injury to otherwise healthy teeth.³

The most common causes for canine impactions are usually localized and are the result of any one, or combination of the following factors: (1) tooth size/arch length discrepancies, (2) prolonged retention or early loss of the deciduous canine, (3) abnormal

position of the tooth bud, (4) presence of an alveolar cleft, (5) ankylosis, (6) cystic or neoplastic formation, (7) dilaceration of the root, (8) iatrogenic origin, and (9) idiopathic condition with no apparent cause.⁴ The abnormal morphology of the maxillary permanent lateral incisors is also responsible for displacement of the adjacent canines.^{5,6} Absence of the maxillary permanent lateral incisors or presence of small or peg-shaped lateral incisors have been implicated in the etiology of palatally displaced canines^{7,8} by not providing proper guidance to the canine during its eruption⁹ through the distal surface of the lateral incisor root.¹⁰

***Corresponding author:** Assistant Professor Dr İlknur Veli, İzmir Katip Celebi Üniversitesi, Ortodonti A.D. 35630, Cigli, İzmir, Turkey. Tel: +90 232 324 40 40/ 2500 E-mail: ilknurveli@hotmail.com

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¹Assistant Professor, İzmir Katip Celebi University, Faculty of Dentistry, Department of Orthodontics, İzmir, Turkey

²Research Assistant, İzmir Katip Celebi University, Faculty of Dentistry, Department of Orthodontics, İzmir, Turkey

³Professor and Head, İzmir Katip Celebi University, Faculty of Dentistry, Department of Orthodontics, İzmir, Turkey

A recent review of the literature suggested that the etiology of palatally impacted canines was genetic and the etiology of buccally impacted canines was inadequate arch space.⁹ Because the normal eruption path of the permanent canine is slightly buccal to the line of the arch, reduced space in the canine area, together with the close proximity of the adjacent teeth, will prevent the canine from taking up its normal position in the arch, and it will remain buccally displaced.¹⁰ Jena and Duggal¹¹ reported no positive association between lateral incisor anomalies and maxillary canine impaction. However, they found that there was a high probability of palatal canine impaction when adjacent lateral incisors were anomalous.

The diagnosis of canine impaction is based on both clinical and radiographic examinations. Although various conventional 2-dimensional (2D) radiographic techniques are used clinically as the primary diagnostic radiograph for the localization of impacted canines, including occlusal films, panoramic radiographs, and lateral cephalograms, in most cases periapical films are reported to be uniquely reliable for radiographic examinations.⁴ The importance of posteroanterior cephalograms in the diagnosis and prediction of canine eruption disturbances has also been emphasized in the literature.¹² Recently, cone-beam computed tomography (CBCT) has been used for the validation of the impacted canine as CBCT images provide applicable diagnostic information for canine localization in the sagittal, axial, and coronal planes without overlap.¹³

To date, numerous studies have focused on population differences in association with impacted canines.¹⁰ Most published cases of palatal impaction are European in origin, and studies of palatally impacted canines in the dentition of Africans or Asians are rare.⁹ Peck *et al.*¹⁴ reported that impacted canines in Asians are usually midalveolar or labial and calculated the prevalence rate ratio for maxillary canine impaction of all types as European:Asian = 2:1. Oliver *et al.*⁶ found that buccally impacted canines were more frequent in Asians, who also displayed more crowding, whereas palatal canine impaction was more frequent among whites. Thus, considering the generally accepted strong association between impacted maxillary permanent canines and anomalous lateral incisors, the epidemiologic features need to be investigated. To our knowledge, no published study has evaluated the association between maxillary impacted permanent

canines and morphologic disorders of maxillary lateral incisors in a Turkish population. Therefore, the aim of this study was to investigate the relationship between impacted permanent maxillary canines and anomalous maxillary lateral incisors in a western Turkish sample.

MATERIALS AND METHODS

Determination of optimal sample size indicated that a minimum of 50 teeth could achieve 80% power for 1 degree of freedom, 61 teeth achieved the same level of power for 2 degrees of freedom, and 69 teeth achieved 80% power for 3 degrees of freedom to detect an effect size (W) of 0.40 with a significance level (α) of 0.050 for χ^2 tests.

This retrospective study was carried out on the records of patients who reported for orthodontic treatment in the Department of Orthodontics at Izmir Katip Celebi University. A total of 68 patients (27 male and 41 female, aged between 13 and 18 years) with unilateral or bilateral impacted maxillary permanent canines were diagnosed based on radiographic examination by using panoramic radiographs. Localization of the impactions was then classified as buccal and palatal by using reconstructed images obtained with CBCT (Fig. 1). All patients self-identified as white and were from western Turkey. Patients with complete records of clear panoramic radiographs, CBCT images, and three-dimensional (3D) digital models and with no missing mandibular permanent lateral incisors were included in this study. Patients with a history of trauma, craniofacial deformity associated with tooth aplasia or displacement, or previous orthodontic treatment were excluded from the present study. Because informed consent forms were signed by all patients or their parents before treatment, no ethical approval was needed for the present study.

During evaluation, each affected maxillary side was considered separately, and this resulted in a total of 82 impacted maxillary permanent canines. The CBCT images were taken to determine the diagnostic accuracy of the localization of impacted canines and the detection of canine-induced root resorption of maxillary incisors. A Newtom 5G (QR, Verona, Italy) scanner was used for exposure according to the following parameters: a maximum output of 110 KV and 98.12 mAs, field of view; 12 × 8 high resolution, and a typical exposure time of 5.4 seconds. The canine was considered to be in a palatal position whenever it did not assume its

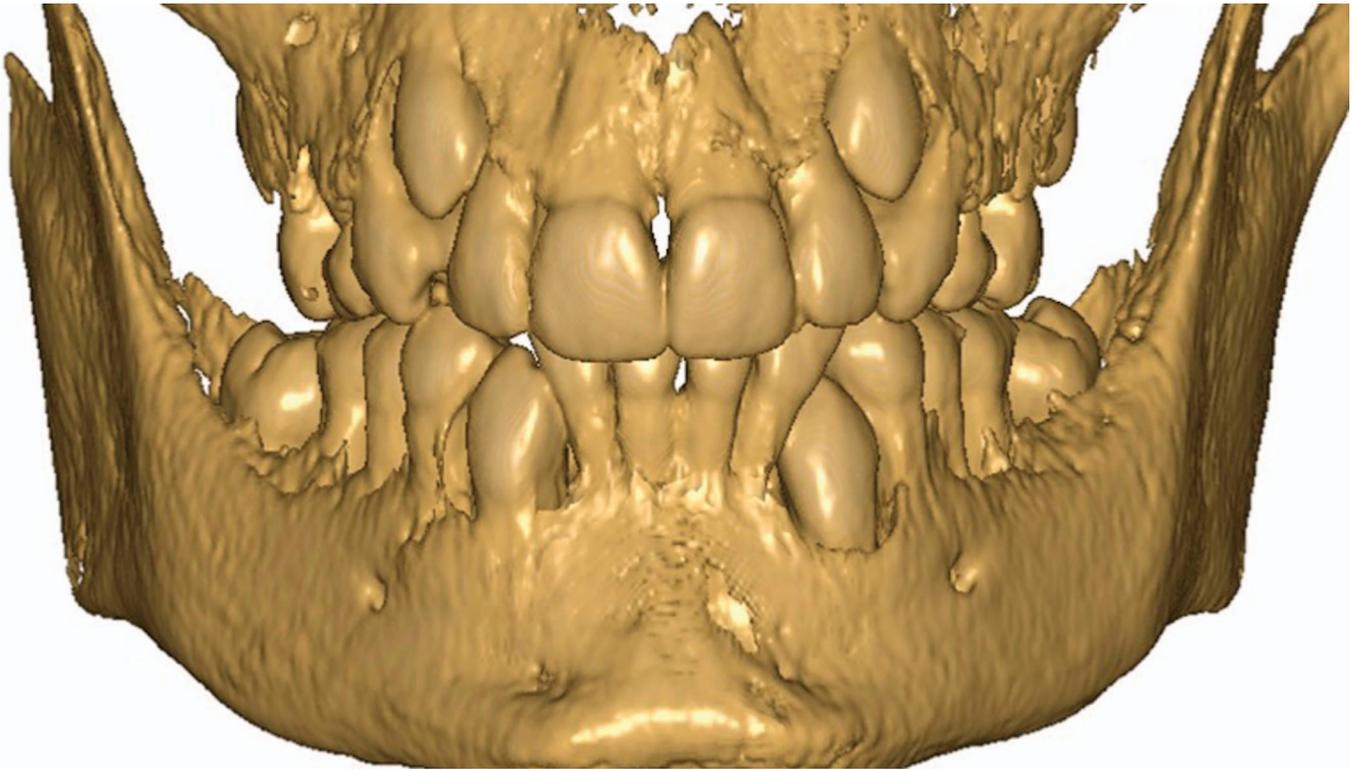


Figure 1. Reconstructed image showing buccally impacted canines, obtained with cone-beam computed tomography.

normal, slightly buccal localization in the dental arch or when its position was radiographically determined as such.⁵

Subsequently, maxillary permanent lateral incisors were classified as normal, small, peg shaped, impacted, or congenitally missing by using 3D digital study models (D250 3D Dental Scanner; 3Shape A/S, Copenhagen, Denmark) of the patients. All evaluations were performed by one investigator (B.Y.).

According to the findings of Brin *et al.*⁵ and Becker *et al.*,¹⁵ in this study, maxillary permanent lateral incisors were classified as normal lateral incisor (when the mesiodistal width was larger than that of its mandibular counterpart), peg-shaped lateral incisor (when the greatest mesiodistal width was found at the cervical margin), impacted lateral incisor, small lateral incisor (when the mesiodistal width was equal to or smaller than that of its mandibular counterpart), or missing lateral incisor (when clinically missing and not reported as extracted).

Statistical Analysis

The data were analyzed using the Statistical Package for Social Sciences software package (SPSS for Windows, version 16.0; SPSS Inc, Chicago, IL, USA). The percentage of the total sample in each group was calculated, and the

analysis for significant associations was performed using the Pearson χ^2 test; results were assumed to be significant when the *P* value was <0.05 .

RESULTS

The prevalence and frequency of maxillary permanent canine impaction by gender and localization are shown in Table 1 and the bar chart in Figure 2. The results revealed that impaction of the maxillary permanent canine was 5.18 times more common in females than males, and palatal canine impaction was almost 1.27 times more common than buccal canine impaction. No statistically significant relationship was found between gender and both palatal and buccal impaction.

The distribution and frequency of various categories of maxillary lateral incisor by gender are shown in Table 2 and the bar chart in Figure 3. None of the male patients had impacted maxillary lateral incisors. The distribution of peg-shaped lateral incisors was almost equal, and the distribution of small lateral incisors was 4.16 times more common among females. The occurrence of impacted lateral incisors was 3.7 times more common in females as well. On the other hand, the distribution of missing lateral incisors was 1.89 times more common in males.

Table 1. Prevalence and frequency of canine impaction according to gender and localization^a

Canine	Male		Female		Total	
	n	%	n	%	n	%
Buccal	12	42.9	24	44.4	36	43.9
Palatinal	16	57.1	30	55.6	46	56.1
Total	28	100	54	100	82	100

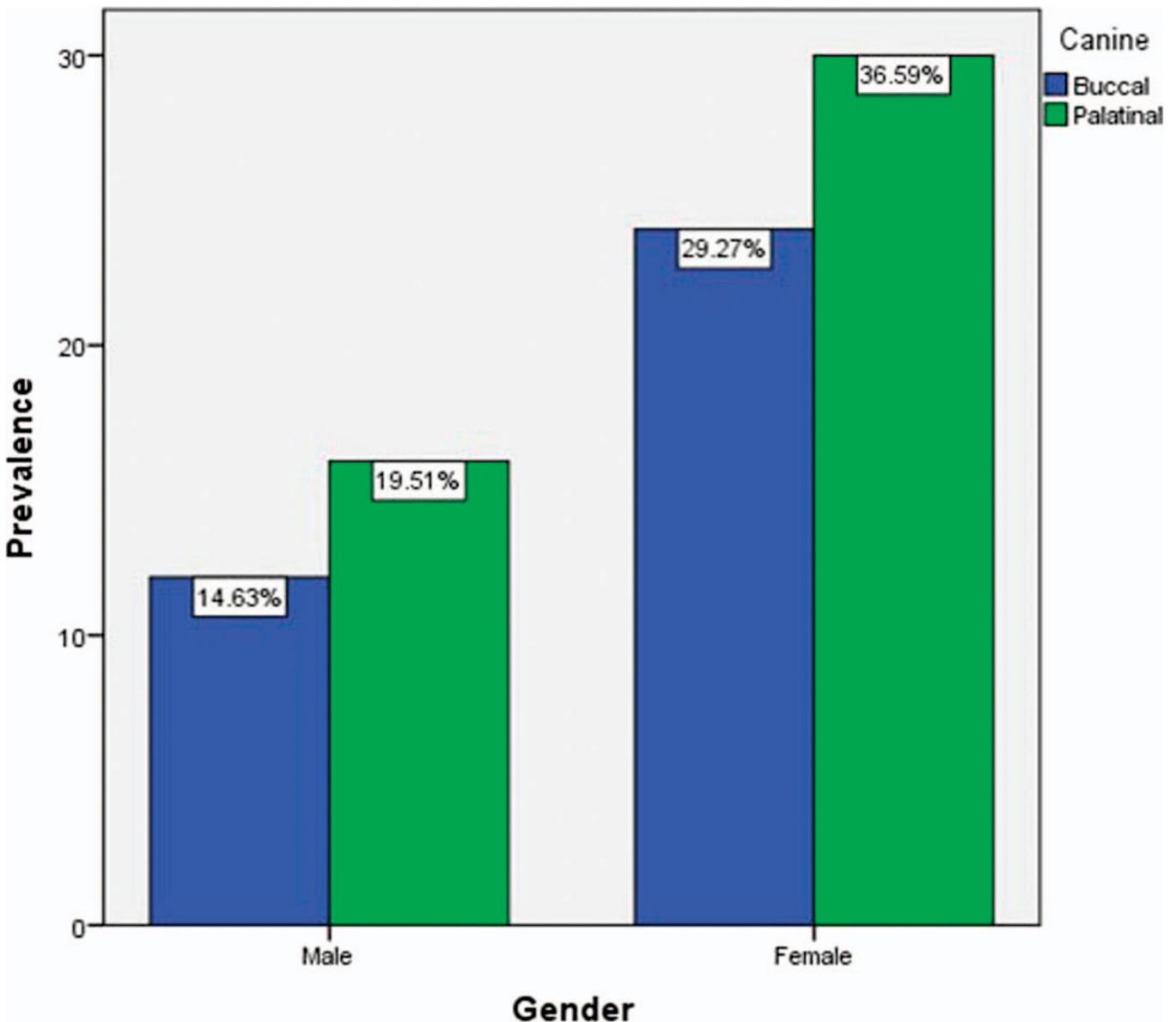
^a χ^2 test = 0.891; degrees of freedom = 1; $P > 0.05$, not significant.

Because the analysis did not meet the underlying assumption of the χ^2 test in terms of having enough expected counts for the cells, the categories that did not have enough frequency were excluded from the

Table 2. Distribution and frequency of various categories of maxillary lateral incisors according to gender^a

Lateral	Male		Female		Total	
	n	%	n	%	n	%
Normal	20	71.4	25	46.3	45	54.9
Small	2	7.1	16	29.6	18	22
Peg shaped	5	17.9	10	18.5	15	18.3
Impacted	0	0	2	3.7	2	2.4
Missing	1	3.6	1	1.9	2	2.4
Total	28	100	54	100	82	100

^a χ^2 test = 0.106; degrees of freedom = 4; $P > 0.05$, not significant.

**Figure 2.** Total prevalence of maxillary permanent canine impaction according to gender and localization.

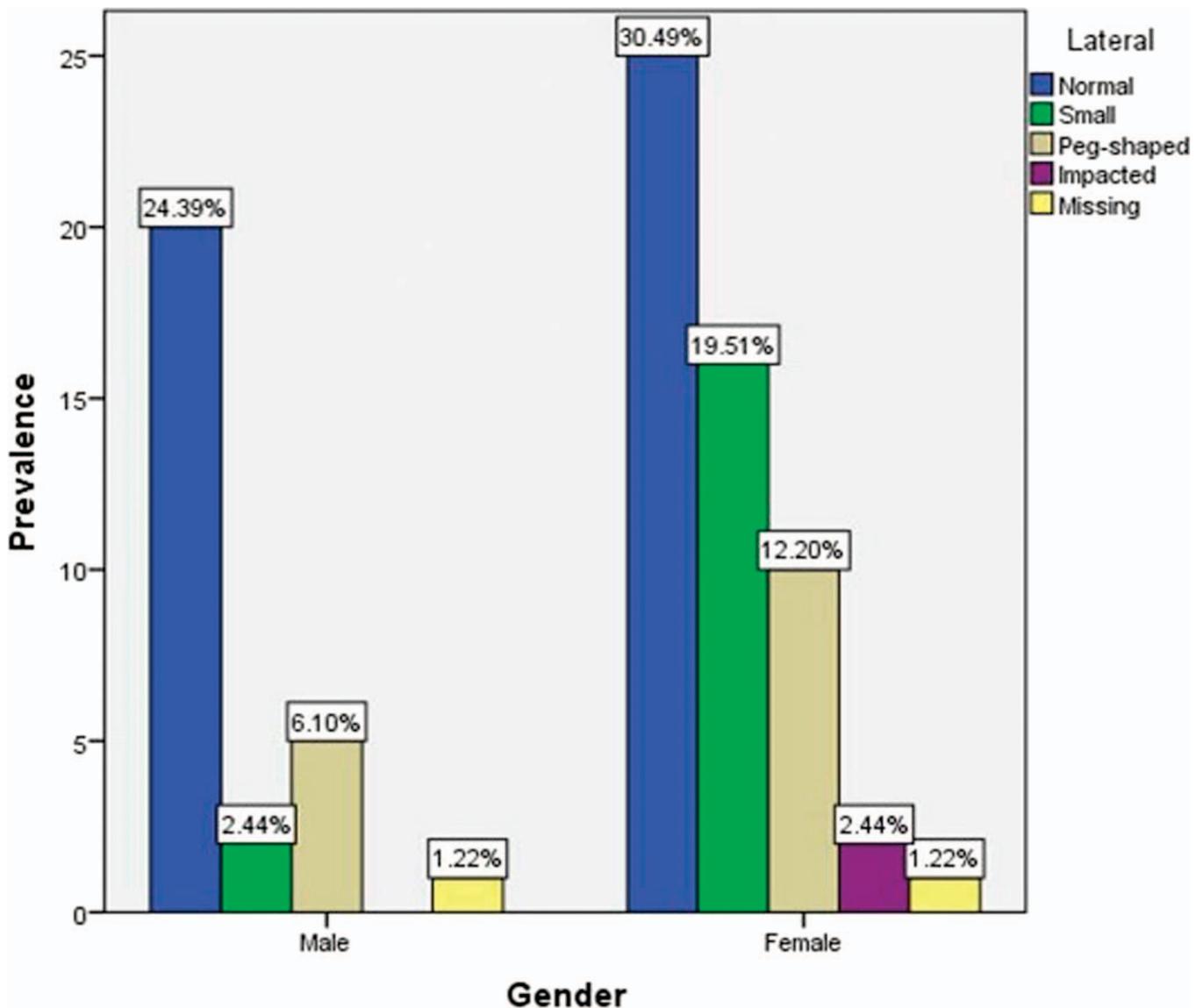


Figure 3. Total prevalence of various categories of maxillary lateral incisors according to gender.

analysis so that the assumption could hold; the second χ^2 analysis was implemented without the missing and impacted categories (Table 3; Fig. 4). The results showed that the distribution of peg-

Table 3. Distribution and frequency of various categories of maxillary lateral incisors according to gender ^a

Lateral	Male		Female		Total	
	n	%	n	%	n	%
Normal	20	74.1	25	49	45	57.7
Small	2	7.4	16	31.4	18	23.1
Peg shaped	5	18.5	10	19.6	15	19.2
Total	27	100	51	100	78	100

^a χ^2 test = 0.042; degrees of freedom = 2; $P > 0.05$, not significant.

shaped lateral incisors was again almost equal and the distribution of small lateral incisors was 4.24 times more common among females.

The prevalence and frequency of maxillary canine impaction in relation to various categories of lateral incisors are shown in Table 4 and the bar chart in Figure 5. It was found that 66.7% of the total buccally impacted canines and 45.7% of the total palatally impacted canines were associated with normal lateral incisors. The prevalence of buccal and palatal canine impaction with peg-shaped lateral incisors was 11.1% and 23.9%, respectively. None of the patients with palatally impacted maxillary canines had impacted lateral incisors.

The second χ^2 analysis implemented without missing and impacted categories revealed that

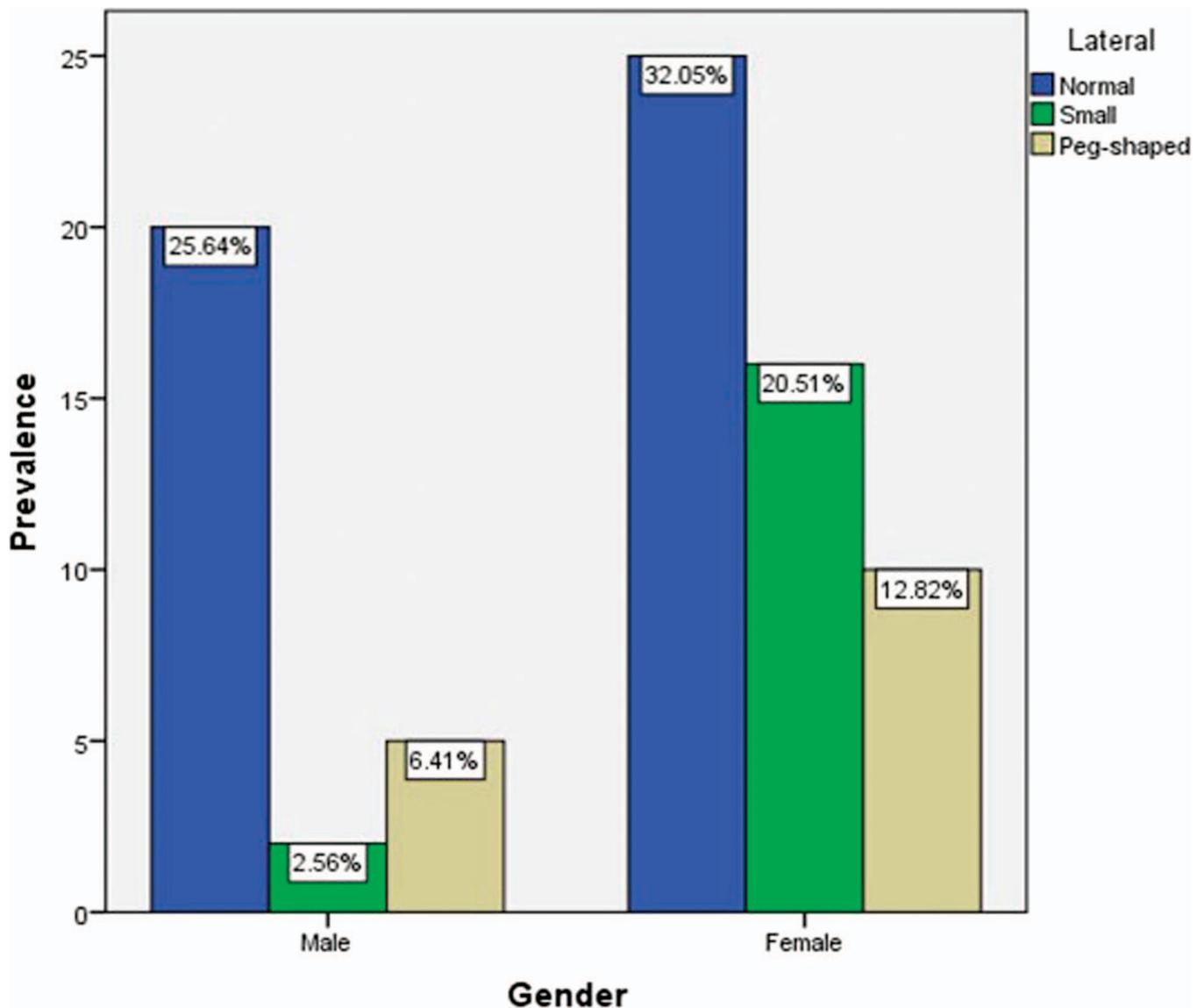


Figure 4. Total prevalence of normal, small, and peg-shaped maxillary lateral incisors according to gender.

70.6% of the total buccally impacted canines and 47.7% of the total palatally impacted canines were associated with normal lateral incisors (Table 5; Fig. 6). The prevalence of buccal and palatal canine impactions with small lateral incisors was 17.6% and 27.3%, respectively.

DISCUSSION

The maxillary canines have the longest development period and the longest route from the point of formation to their final location in full occlusion. During their development, the crowns of the perma-

Table 4. Prevalence and frequency of various categories of maxillary lateral incisors according to localization of the canine^a

Canines	Lateral Incisor			Impacted n (%)	Missing n (%)	Total n (%)
	Normal n (%)	Small n (%)	Peg Shaped n (%)			
Buccal	24 (66.7)	6 (16.7)	4 (11.1)	2 (5.6)	0	36 (100)
Palatal	21 (45.7)	12 (26.1)	11 (23.9)	0	2 (4.3)	46 (100)
Total	45 (54.9)	18 (22)	15 (18.3)	2 (2.4)	2 (2.4)	82 (100)

^a χ^2 test = 0.079; degrees of freedom = 4; $P > 0.05$, not significant.

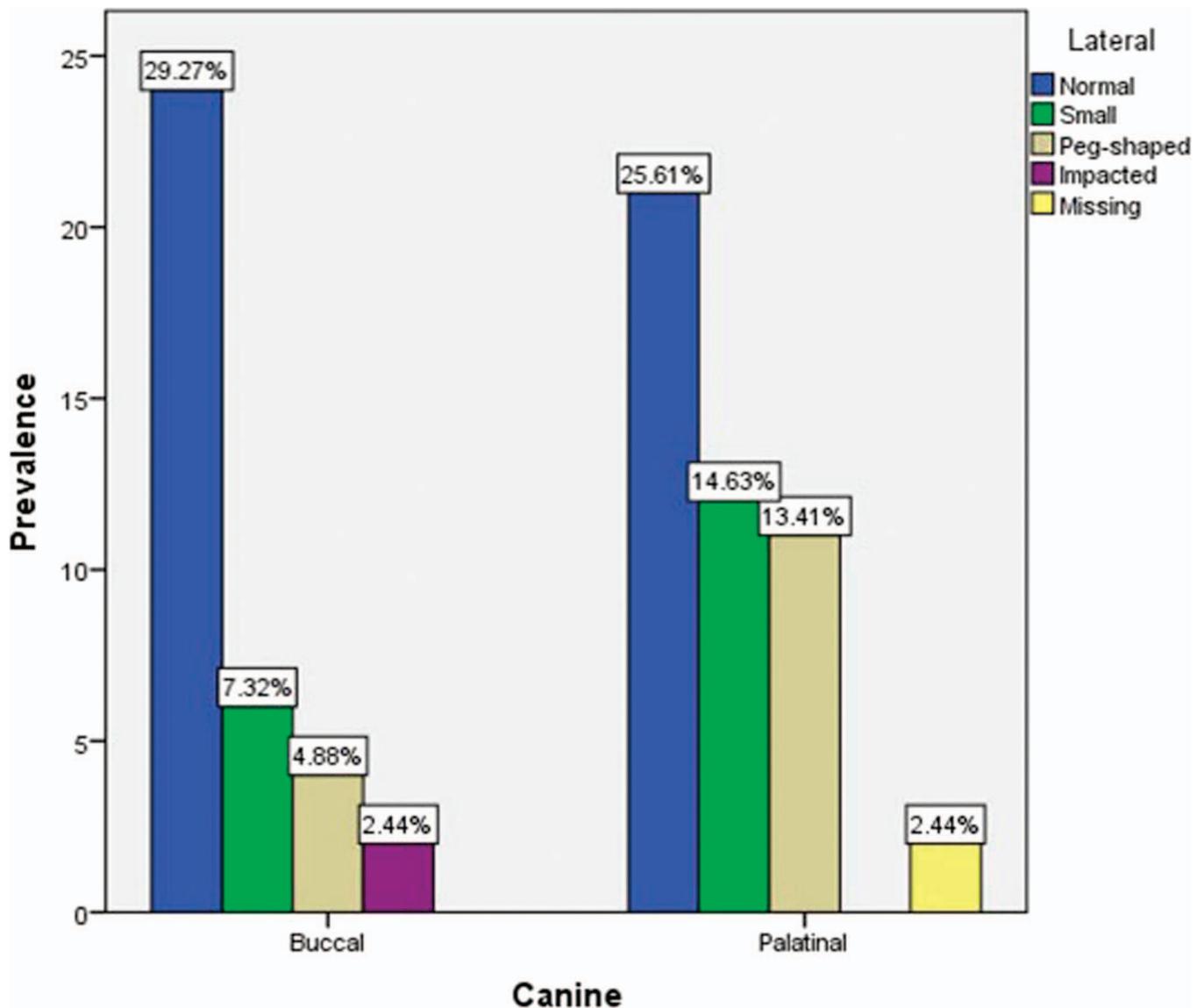


Figure 5. Total prevalence of various categories of maxillary lateral incisors according to localization of maxillary impacted canines.

dent canines are in close proximity to the roots of the lateral incisors.¹⁶ Absence of the maxillary lateral incisor and variations in the root size of the tooth have been implicated as important etiologic factors

Table 5. Prevalence and frequency of anomalous maxillary lateral incisors according to localization of the canine^a

Canines	Lateral incisor			Total n (%)
	Normal n (%)	Small n (%)	Peg Shaped n (%)	
Buccal	24 (70.6)	6 (17.6)	4 (11.8)	34 (100)
Palatal	21 (47.7)	12 (27.3)	11 (25)	44 (100)
Total	45 (57.7)	18 (23.1)	15 (23.1)	78 (100)

^a χ^2 test = 0.119; degrees of freedom = 2; $P > 0.05$, not significant.

of canine impaction.⁴ This retrospective epidemiologic study analyzed the prevalence and frequency of maxillary permanent canine impaction in relation to anomalous adjacent lateral incisors.

The diagnosis of canine impaction was made on the basis of standardized panoramic radiographs.^{10,17,18} Reconstructed images obtained from CBCT were then used to determine the localization of the impacted canines. Although periapical or panoramic radiographs are important tools for detecting or determining the position and inclination of impacted canines,¹⁹ the diagnostic accuracy and validity for localizing impacted canines and adjacent structures can be underestimated because of deficiencies such as distortion projection errors,

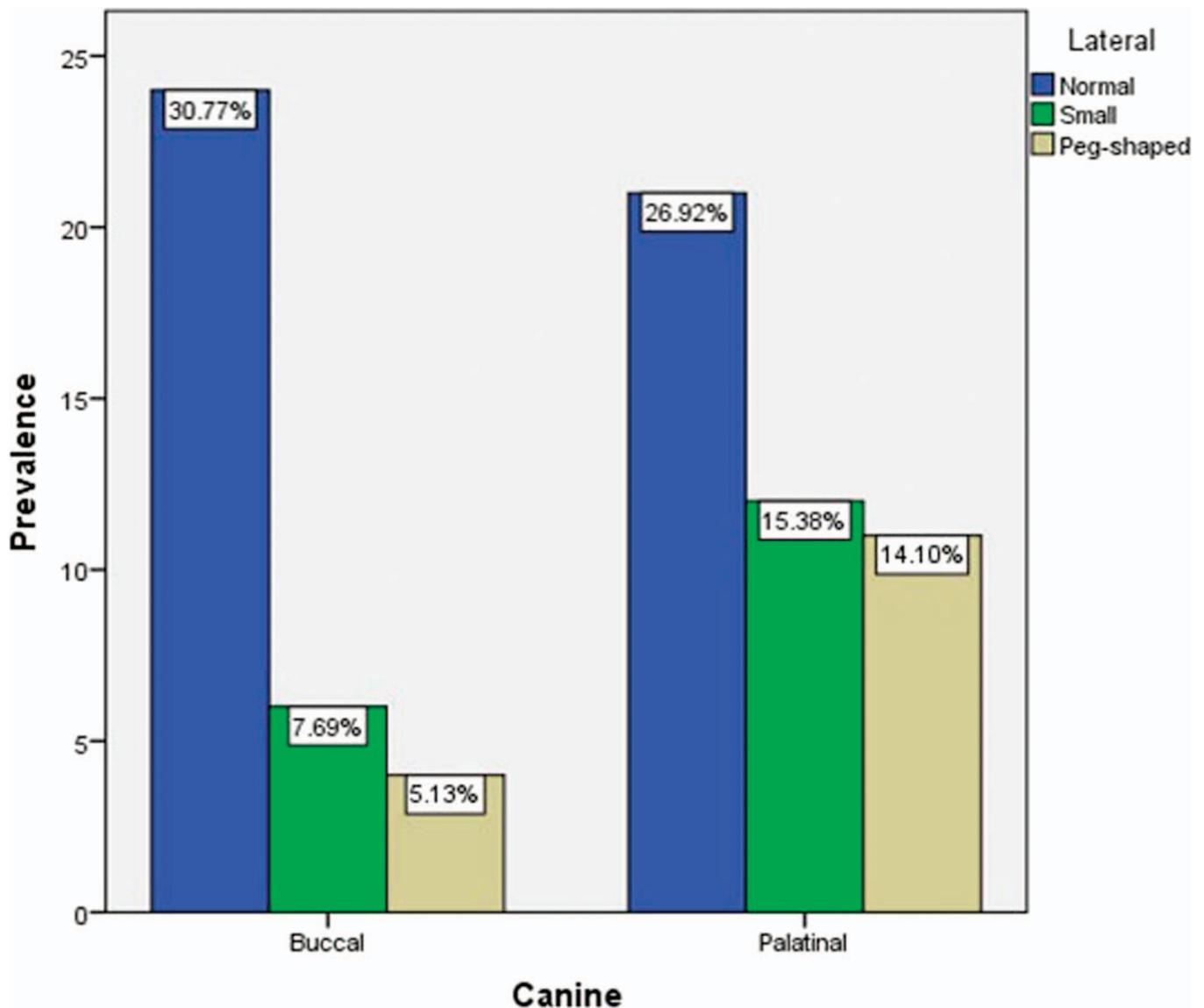


Figure 6. Total prevalence of normal, small, and peg-shaped maxillary lateral incisors according to localization of maxillary impacted canines.

blurred images, and complex maxillofacial structures that are projected onto a 2D plane, thus increasing the risk of misinterpretation.^{20–24} Alqerban *et al.*¹³ compared the diagnostic accuracy for the localization of impacted canines between conventional radiographic procedures using one 2D panoramic radiograph and CBCT scans and concluded that the CBCT is more sensitive than conventional radiography for both palatal and buccal canine localization.

The results revealed that impaction of the maxillary canine was 5.18 times more common in females than males, and palatal canine impaction was almost 1.27 times more common than buccal canine impaction. It is already known from earlier studies that palatally displaced maxillary canines are more

prevalent among females than males.^{15,25,26} Mercuri *et al.*²⁷ also reported that palatally impacted canines and buccally impacted canines occurred more often in female subjects. Jena and Duggal¹¹ reported that maxillary canine impaction in association with anomalous lateral incisors was equal among males and females. However, no statistically significant gender association was found with either palatal impaction or buccal impaction, similar to findings in other studies.^{28,29}

The epidemiologic data reported in this study suggested that maxillary canines may become impacted buccally or palatally when the lateral incisors are normal. Brin *et al.*⁵ observed a significant relationship between anomalous lateral

incisors and palatal canine impaction. However, Mossey *et al.*²⁹ found a weak association between palatal canine impaction and lateral incisor anomalies. The different frequency of palatal impaction in different populations, coincident with racial grouping, is supportive evidence of genetic involvement in the etiology of palatal impaction. It was reported that palatal impaction was not a dependent variable of anatomical variations of the maxillary lateral incisor.

Langberg and Peck³⁰ evaluated the mesiodistal crown size of the maxillary and mandibular incisors of patients with palatally impacted canines and reported statistically significant tooth-size reductions associated with palatal impaction. In the present study, 29.6% of the lateral incisors in females and 7.1% of the lateral incisors in males were small. Uysal *et al.*³¹ reported statistically significant gender differences in tooth sizes in a Turkish sample and showed that males had significantly larger teeth than females.

Prevalence rates of peg laterals have been reported to range from 0.6%³² to 9.9%³³ in the literature. Hua *et al.*³⁴ performed a meta-analysis and concluded that the prevalence of peg-shaped maxillary permanent lateral incisors varies by race, population type, and sex. They reported that the occurrence rates of peg-shaped maxillary permanent lateral incisors were higher in Mongoloid (3.1%) than in black (1.5%) and white (1.3%) patients; they were also higher in orthodontic patients (2.7%) than in the general population (1.6%) and in dental patients (1.9%). Stecker *et al.*³⁵ reported that the prevalence rates of peg laterals in the Minneapolis and St Paul metropolitan area of Minnesota were 7.5% and 1.6% for Asians and for other races, respectively. However, in another multiethnic study conducted in Hawaii, the prevalence rate of peg laterals was significantly higher in the descendants of Filipinos (3.1%), whereas the prevalence rates in descendants of whites (1.7%), Chinese (1.6%), and Japanese (1.9%) were similar.³⁶ The overall prevalence of peg-shaped maxillary permanent lateral incisors was 18.3%, which was higher than the reported results in the literature. High prevalence of peg-shaped lateral incisors in maxillary palatal impaction can be attributed to the guidance theory, that is, inadequate guidance from peg-shaped lateral incisors causes palatal displacement of the adjacent canine.^{10,37}

In the present study; when the possible relationship between anomalous lateral incisors and various

impactions of maxillary canines was investigated, no significant association was found. Becker¹⁰ reported a high prevalence of palatal displacement of the maxillary canines in the presence of anomalous lateral incisors in an Israeli population.

In our study, only 12% of the total buccally impacted canines were associated with anomalous lateral incisors. This resulted in a weak association between maxillary buccal canine impaction and lateral incisor anomaly. However, there was a relatively higher association (25%) between palatal canine impaction and anomalous lateral incisors than between buccal canine impaction and anomalous lateral incisors.

None of the patients with palatally impacted maxillary canine had impacted lateral incisors. On the other hand, Jena and Duggal¹¹ reported a high probability of palatal canine impaction with congenitally missing lateral incisors. Al-Nimri and Bsoul³⁸ studied the prevalence of palatally impacted maxillary canines in subjects with congenitally missing maxillary lateral incisor teeth and reported that the prevalence rate of impaction was 12.6%.

CONCLUSIONS

The following conclusions were drawn from the present study:

1. The prevalence of maxillary canine impaction in association with anomalous lateral incisors was different among western Turkish males and females.
2. Maxillary palatal impaction was more common than buccal impaction.
3. Maxillary palatal and buccal impaction occurred more often in female subjects.

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