Original Article

Dental anomalies and clinical features in patients with maxillary canine impaction

A retrospective study

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ABSTRACT

Objective: To analyze the prevalence, distribution, clinical features, and relationship with dental anomalies of maxillary canine impaction.

Materials and Methods: The complete pretreatment records of 1674 orthodontic patients were examined. Subjects with maxillary impacted canines were divided into two study groups: a palatally displaced canine (PDC) group (114 patients) and a buccally displaced canine (BDC) group (37 patients). These were compared to a control group of 151 patients who were randomly selected from the initial sample without maxillary canine impaction. The significance of associations between canine impaction and dental and clinical features and anomalies was examined with the chi-square test.

Results: PDC patients presented with normal overjet and facial profile and a lower degree of dental arch crowding in comparison to the control patients. PDC patients showed a higher prevalence of impaction of other teeth, dental aplasia, transposition, and peg-shaped maxillary lateral incisors (odds ratios 3.3, 2.6, 8.3, and 5.8, respectively).

Conclusion: PDC was frequently the only orthodontic problem of patients. BDC group patients did not present with notable differences in clinical and dental features or dental anomalies compared to control subjects. (*Angle Orthod.* 2013;83:22–28.)

KEY WORDS: Canine impaction; Dental anomalies; Palatal displacement; Buccal displacement

INTRODUCTION

The maxillary canine is the second most common tooth affected by impaction after the third molar, with a prevalence of 1%–3%.[1–3] The etiology of maxillary canine impaction is still under discussion. Although numerous possible factors are under assessment, it is certain that the buccally displaced canine (BDC) and the palatally displaced canine (PDC) are characterized by different etiopathogeneses.[4]

A BDC is thought to be a result of crowding, ie, insufficient space in the maxilla for the eruption of the maxillary canine culminates in its impaction.[5] On the other hand, a PDC often occurs in patients without crowding; indeed, in many cases there is an excess of space in the canine area.[4–6] It has therefore emerged that the etiology of PDCs is still unclear. Some authors believe that the absence of lateral incisor guidance (guidance theory) could lead to palatal canine impaction by allowing the canine to cross back from the buccal to the palatal side.[7–11] An association between maxillary lateral incisor anomalies and PDCs was

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demonstrated[11]; moreover, an association with a smaller mesiodistal crown width and shorter roots of the maxillary lateral incisor[7] was reported. In spite of these considerations, a great number of studies suggested the "genetic theory"[4] of PDCs: given the simultaneous occurrence of PDCs and congenital dental anomalies, these authors believed that a PDC was only one aspect of a general dental eruption disorder that could be genetic in origin.[12–21]

Evidence has been mounting regarding the association of PDCs with congenital missing teeth[4,12]; in particular, associations with maxillary lateral incisor[1,3,12,14] and second premolar[17] aplasia have been observed. Numerous studies have highlighted the association between PDCs and tooth size reduction, especially of the maxillary lateral incisor.[4,14,17] Also, the transposition of maxillary canine/first premolar[16,18] and maxillary lateral incisor/canine[19] have been associated with PDCs.

Few studies have been conducted to determine the association of BDCs with congenital dental anomalies.[22] Therefore, the aims of this study were to evaluate the prevalence and the distribution of PDCs and BDCs, to analyze the clinical and dental features of canine impaction, and to evaluate the association of canine displacement with other dental congenital anomalies.

MATERIALS AND METHODS

This retrospective study was carried out on the complete pretreatment records of 1674 patients. From these patients, a group of subjects with at least one impacted maxillary canine was selected. This study followed the Declaration of Helsinki on medical protocol and ethics, and the regional Ethical Review Board of the "Umberto I" General Hospital of Rome approved the study.

The impaction diagnosis and the impaction site were determined on the basis of clinical examinations and standardized radiographs (panoramic radiographs, computed tomography, intraoral radiographs) and confirmed visually during surgery. Non-White patients and those with craniofacial syndromes associated with tooth aplasia or displacement, trauma, and multiple-agent chemotherapy were excluded. The patients with maxillary canine impaction were divided into two study groups: a PDC group (PDCG) and a BDC group (BDCG).

The two study groups were compared with a control group (CG) of White patients without maxillary canine impaction who had been randomly selected from the initial sample. The clinical and dental features analyzed by clinical and photographic examination and study of dental casts were:

- Overjet: the horizontal distance between the maxillary and mandibular incisors (normal, increased, and decreased, with normality defined as 2 to 3 mm);
- Overbite: the vertical distance between the maxillary and mandibular incisors (normal, deep, or open, with normality defined as 2 to 3 mm);
- Space problems: comparison of the arch lengths (maxillary and mandibular) from the mesial contact of the first molar to the mesial contact of the opposite-side molar to the sums of the dimensions of all the teeth anterior to the first molars of the respective arches (no crowding, mandibular crowding, maxillary crowding, mandibular and maxillary crowding, maxillary excess);
- Facial type: normofacial, dolicofacial, brachifacial;
- Facial profile: normal, convex, concave;
- Molar relationships: following the Angle classification (classes I, II, III) and distinguished between the nonimpacted side and the impacted side (in unilateral patients) to verify the possible influence of maxillary canine impaction on this parameter; and
- Upper midline deviation: none, to the right, to the left.

Congenital dental anomalies were identified from direct observation of the dental casts and confirmed by clinical observation, photographic examination, and analysis of panoramic radiographs. The dental anomalies analyzed were:

- Agenesis: Agenesis of each tooth (excluding the maxillary and mandibular third molars); in addition, maxillary lateral incisor agenesis and mandibular second premolar agenesis were evaluated separately;
- Impaction of other teeth (maxillary and mandibular third molars were excluded because of the more delayed eruption of these teeth);
- Peg-shaped maxillary lateral incisors: The dimensions of the maxillary lateral incisors were measured using established criteria[7];
- Supernumerary teeth; and
- Transposition.

The reproducibility of diagnoses was assessed by re-examining the records of 50 patients 2 weeks after the first examination by a single operator. Reproducibility was 100% for all variables except for facial type (95%), facial profile (94%), and peg-shaped maxillary lateral incisors (98%).

Statistical descriptive analysis was performed and the data were analyzed using SPSS software (Statistical Package for the Social Sciences, IBM Corporation, New York, NY). The analysis for significant associations was performed using the chi-square test; results were assumed to be significant when the P value was $\leq .05$. When the expected counts in some of the table cells were small, the Fisher exact test was

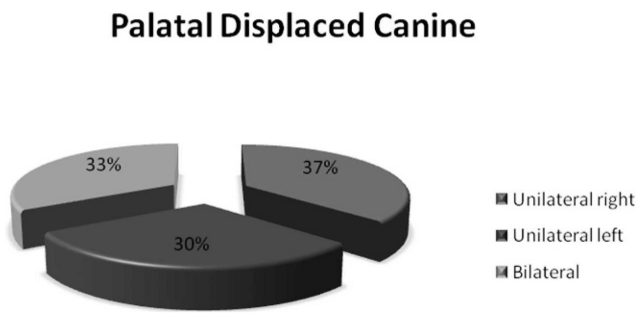

Figure 1. Distribution of PDCG.

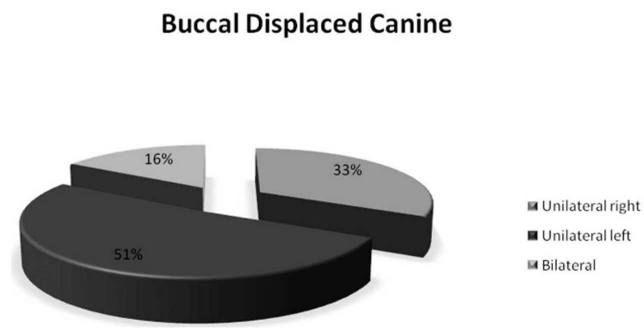

Figure 2. Distribution of BDCG.

used. Taking the significant variables of dental anomalies into consideration, the odds ratios were evaluated (PDC/control and BDC/control) as an approximation of the relative risk. The higher the odds ratio, the higher the risk of PDC and BDC in the presence of the relevant dental anomaly.

RESULTS

One hundred fifty-one patients between 9 and 40 years of age were affected by maxillary canine impaction (101 female and 50 male patients); 114 presented with PDC (mean age, 14 ± 5 years) and 37 with BDC (mean age, 14 ± 3 years). The CG (151 patients) was composed of 82 female and 69 male subjects between 9 and 42 years of age (mean age, 12 ± 4 years). The prevalence of PDC was 6.81%, whereas the prevalence of BDC was 2.21%. The distribution of the PDCG showed similar values for unilateral right impaction (36.8%) and unilateral left impaction (29.8%), with a high percentage of bilateral impaction (33.3%); the unilateral:bilateral ratio was 2:1 (Figure 1). The BDCG was characterized by a higher number of unilateral left impactions (51.4%) compared to unilateral right impactions (32.4%), and only 16.2% presented with bilateral impactions; the unilateral:bilateral ratio was 6:1 (Figure 2).

With respect to gender distribution, the PDCG consisted of 65.8% females and 33.2% males (female:male ratio of 2:1) and the BDCG consisted of 70.3% females and 29.8% males (female:male ratio slightly higher than 2:1) (Table 1). No statistically significant relationship was found between gender and both PDC and BDC (Table 2).

A comparison between unilateral right and left PDC or BDC and gender did not show statistically significant differences, whereas a comparison of bilateral PDC or BDC and gender revealed statistically significant associations (Table 2). The evaluation of the risk factors showed a bilateral odds ratio for PDCG/CG for gender of 2.356, whereas it was not possible due to the limited sample size to calculate an odds ratio for bilateral BDCG/CG for gender.

Table 3 reports the prevalence and distribution of the investigated parameters in PDCG, BDCG, and CG. The PDCG was characterized by a high prevalence of deep bite (50.9%), a low rate of arch discrepancy in both arches (no crowding, 58.8%), normal facial type (58.8%), and normal facial profile (54.4%). The PDCG presented statistically significant associations with space problems, overjet, and facial profile, but there was not a significant association between PDC and overbite and facial type (Table 4). On the other hand, the BDCG showed a high prevalence of deep bite (51.4%), normal overjet (45.9%), absence of arch discrepancy in both arches (no crowding, 56.8%), normal facial type (54.8%), and normal facial profile (54.1%). Only overjet showed a statistically significant association with BDC (Table 4). The distributions of molar relationships (impacted and nonimpacted sides) and upper midline deviation in PDCG and BDCG are reported in Table 5.

The frequencies of dental anomalies in PDCG, BDCG, and CG are shown in Table 6. Dental aplasia was found often in the PDCG (24.6%) and the BDCG (24.3%). PDCG subjects frequently presented with impaction of other teeth (17.5%), whereas this anomaly was less common in BDCG patients (10.8%) and CG (6%) subjects. Supernumerary teeth and the presence of transposition were not frequent findings in any group, although 5.3% of PDC patients presented a transposition. The prevalence of peg-shaped maxillary lateral

Table 1. Distribution and Prevalence of Gender and Site of Impaction (PDC, BDC, and Control Groups)

			PDC						BDC					
Gender	Control		Right		Left		Bilateral		Right		Left		Bilateral	
Female	82	54.3%	23	54.8%	24	70.6%	28	73.7%	9	75.0%	11	57.9%	6	100.0%
Male	69	45.7%	19	45.2%	10	29.4%	10	26.3%	3	25.0%	8	42.1%	0	.0%

Table 2. *P* Values for Gender

	PDC			
	Unilateral Right	Unilateral Left	Bilateral	Total
PDC	.958[a]	.0829[a]	.0304[a*]	.0596[a]
BDC	.1647[a]	.7670[a]	.0287[b*]	.0783[a]

[a] Chi-square test;
[b] Fisher exact test.
* Significant difference versus the control group ($P \leq .05$).

incisors was 10.5% in the PDCG, 8.1% in the BDCG, and 2% in the CG.

Comparison of the PDCG (114 subjects) and the CG (151 subjects) revealed a statistically significant association with dental agenesis and impaction of other teeth (Table 7). When the agenesis of a particular type of tooth was considered, the data were not statistically significant, although the maxillary lateral incisor was frequently affected by aplasia in PDCG patients, whereas mandibular second premolar aplasia presented a similar prevalence in the CG and both the PDCG and the BDCG (Table 7). The comparison of PDC and supernumerary teeth did not show a statistically significant association, whereas the comparison of PDC and transposition and peg-shaped lateral incisors revealed statistically significant associations (Table 7). BDC presented a statistically significant association only with dental aplasia; the other variables did not reveal any significant relationships (Table 7). The evaluation of the risk factors for PDCG/CG showed an odds ratio of 2.566 for agenesis, 3.357 for impaction of other teeth, 8.333 for transposition, and 5.808 for peg-shaped lateral incisors. The comparison BDCG/CG demonstrated an odds ratio of 2.534 for agenesis.

DISCUSSION

The epidemiological data reported in this study confirmed the higher prevalence of PDC compared to BDC reported by others,[1,5,7,8] with a palatal:buccal canine impaction ratio of 3:1. The 6.81% prevalence of PDC and 2.21% prevalence of BDC were higher compared to the values reported in the literature, presumably because the studied participants were selected from orthodontic departments.[1–3,13,19] In the PDCG, the unilateral:bilateral ratio was 2:1, similar to ratios reported in the literature.[1,3] In contrast, BDC was characterized by fewer bilateral impactions (unilateral:bilateral ratio of 6:1).

Female subjects were more affected by maxillary canine impaction than male subjects, with a male:female ratio of 1:2 (in both PDCG and BDCG); in the orthodontic CG, there was also a high prevalence of females. These data are similar to reports in previous studies.[7,11,13,20] However, no statistically significant gender association was found with either the PDCG or the BDCG, as similarly reported in other studies[1–3];

Table 3. Dental and Clinical Features

	Control		PDC		BDC	
	Patients	%	Patients	%	Patients	%
Overbite						
Normal	38	25.2%	34	29.8%	10	27.0%
Deep bite	76	50.3%	58	50.9%	19	51.4%
Open bite	37	24.5%	22	19.3%	8	21.6%
Overjet						
Normal	38	25.2%	45	39.5%	17	45.9%
Increased	87	57.6%	41	36.0%	14	37.8%
Decreased	26	17.2%	28	24.6%	6	16.2%
Space problems						
No crowding	78	51.7%	67	58.8%	21	56.8%
Mandibular crowding	16	10.6%	14	12.3%	3	8.1%
Maxillary crowding	8	5.3%	10	8.8%	2	5.4%
Mandibular and maxillary crowding	33	21.9%	9	7.9%	6	16.2%
Maxillary excess	16	10.6%	14	12.3%	5	13.5%
Facial type						
Normofacial	73	48.3%	67	58.8%	21	56.8%
Dolichofacial	47	31.1%	27	23.7%	7	18.9%
Brachyfacial	31	20.5%	20	17.5%	9	24.3%
Facial profile						
Normal	62	41.1%	62	54.4%	20	54.1%
Convex	81	53.6%	35	30.7%	13	35.1%
Concave	8	5.3%	17	14.9%	4	10.8%

Table 4. Chi-Square Test *P* Values for Dental and Clinical Features

	PDC	BDC
Space problems	.039*	.908
Overbite	.519	.928
Overjet	.002*	.037*
Facial type	.232	.339
Facial profile	.000*	.100

* Significant difference versus the control group ($P \leq .05$).

however, with respect to bilateral displacement, both the PDCG and BDCG showed statistically significant associations.

The evaluation of the prevalence of each variable that presented a statistically significant association with PDCs showed a higher frequency of noncrowding, normal overjet, and normal profile versus that of the orthodontic CG. In fact, PDC was frequently the only orthodontic problem that PDCG patients presented. No statistically significant associations between BDCs and clinical features, except for overjet, were found; indeed, similar distributions and characteristics in both BDCG and CG were observed.

The frequent absence of malocclusion in PDC patients plays an important role in its diagnosis and prognosis; indeed, it could explain the delayed identification of this problem, which does not allow for the use of preventive therapies.[23] The coexistence of malocclusion was the usual reason that the PDC patients sought an orthodontic examination and treatment. These patients are generally not otherwise conscious of their problem and sometimes lack motivation.[23]

With regard to the space problems, no association was found between PDCs and dental crowding of the maxilla, in contrast to reports of other authors.[4–6,24] However, a PDC was often found in patients characterized by a normal arch form and sufficient space for canine eruption.[22]

The distributions of overbite classes in both the CG and PDCG showed a similar frequency, close to 50%. This percentage could be explained by the high frequency of Angle Class II, division 2, patients in the CG and the possible association reported in the literature of PDCs to facial hypodivergence and Class II, division 2.[3,20,25]

A statistically significant association between overjet and PDCs was found. The CG presented numerous cases of increased overjet, whereas PDC patients were often characterized by normal overjet. A similar prevalence and statistically significant association characterized the BDCG.

No association emerged between PDCs and facial type. Regarding facial profile, the PDCG showed a statistically significant association, presenting with a higher prevalence of normal profiles, whereas the CG

Table 5. Distribution of Molar Class (Healthy and Impacted Sides) and Upper Midline Deviations in PDC and BDC Groups

	Group			
	PDC		BDC	
	Patients	%	Patients	%
Molar class, impacted side				
Class I	36	47.4%	11	35.5%
Class II	30	39.5%	19	61.3%
Class III	10	13.2%	1	3.2%
Molar class, nonimpacted side				
Class I	38	50.0%	17	54.8%
Class II	28	36.8%	13	41.9%
Class III	10	13.2%	1	3.2%
Upper midline deviation				
None	61	80.3%	25	80.6%
To the healthy side	6	7.9%	1	3.2%
To the impacted side	9	11.8%	5	16.1%

presented a higher frequency of convex profiles. Both PDCG and BDCG patients with unilateral impaction were characterized by a normally centered midline, which characterized close to the 80% of these patients.

The association between PDC and molar relationships was previously described, and, although there was not a clear and unique relationship, some authors associated a PDC with Class II, whereas others associated PDCs with Class I.[1,2,11,14,22,25–27] The molar class distributions for PDCG subjects mostly showed Angle Class I (50%) for both the impacted and the nonimpacted sides. BDCG patients were characterized by a prevalence of Angle Class II in the impacted side (61.3%) compared to a higher prevalence of Angle Class I in the nonimpacted side (54.8%).

The comparison of PDCG and CG supported a statistically significant association with dental agenesis, impaction of other teeth, transposition, and peg-shaped lateral incisors, whereas the comparison of BDCG and CG revealed a statistically significant relationship only with dental aplasia. This study did not demonstrate any association between PDCs and supernumerary teeth. Analysis of the BDCG did not reveal any statistically significant association with impaction of other teeth, transposition, or peg-shaped lateral incisors.

The close association observed here between PDCs and dental aplasia is supported by growing scientific evidence.[1,3,4,12,14,17,18] This study confirmed the close link between PDCs and agenesis except for the third molars. When a single type of tooth was considered, the association was not statistically significant; maxillary lateral incisor aplasia showed a higher prevalence only in the PDCG, whereas mandibular second premolar aplasia presented a similar prevalence among the CG, PDCG, and BDCG. Some authors

Table 6. Distribution of Dental Anomalies

Anomaly	Control		PDC		BDC	
	Patients	%	Patients	%	Patients	%
Agenesis	17	11.3%	28	24.6%	9	24.3%
Maxillary lateral incisor agenesis	3	2.0%	7	6.1%	0	0.0%
Mandibular second premolar agenesis	4	2.7%	3	2.7%	1	2.7%
Impaction of other teeth	9	6.0%	20	17.5%	4	10.8%
Supernumerary teeth	0	0%	1	0.9%	1	2.7%
Transposition	1	.7%	6	5.3%	0	0%
Peg-shaped maxillary lateral incisors	3	2.0%	12	10.5%	3	8.1%

related PDCs to the congenital absence of the maxillary lateral incisor[1,3,11,14,20,22,27] or the second premolar[17]; this evidence was not supported by the present study. The previously recognized relationship between PDCs and impaction of other teeth was confirmed.[14]

The PDCG showed a relatively high prevalence of peg-shaped maxillary lateral incisors (10.5%) compared to the CG (2%); in fact, a statistically significant association was verified, as previously reported.[4,7,8,11,14,20,22,24,27] Different authors have also related transposition to PDCs[16,18,19]; the present PDCG presented some cases of concomitant transposition, and a statistically significant association was found. However, this study did not confirm the association of BDCs with impaction of other teeth.[22]

Finally, the PDCG often showed the presence of maxillary lateral incisors characterized by a normal dimension and shape, which does not support the guidance theory.

CONCLUSIONS

- PDCs were more common than BDCs. PDCs and BDCs occurred more often in female subjects.
- Female PDCG patients had a 2.4 times greater risk of bilateral canine impaction than male patients.

Table 7. *P* Values for Dental and Clinical Features

Anomaly	PDC	BDC
Agenesis	.004[a*]	.039[a*]
Maxillary lateral incisor agenesis	.077[b]	.516[b]
Mandibular second premolar agenesis	.646[b]	.670[b]
Impaction of other teeth	.003[a*]	.237[b]
Supernumerary teeth	.430[b]	.197[b]
Transposition	.026[b*]	.803[b]
Peg-shaped maxillary lateral incisors	.003[a*]	.092[b]

[a] Chi-square test;
[b] Fisher exact test.
* Significant difference versus the control group ($P \leq .05$).

- PDCG had mostly normal clinical features except for the dental anomalies. They presented normal overjet and facial profile and a lower frequency of dental arch crowding in comparison to the CG.
- There was a statistically significant association between PDCs and the presence of other tooth impactions, agenesis, peg-shaped maxillary lateral incisors, and transposition that led to an approximately 3.3, 2.5, 8.3, and 5.8 times greater risk of PDC, respectively.
- BDCG patients did not show important differences in the clinical features and congenital dental anomalies compared to the orthodontic CG, except for overjet and dental aplasia (with a 2.5 times higher risk for BDCs).

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