Original Article

Do erupting maxillary canines resorb adjacent teeth? A study focusing both on the ipsilateral and contralateral sides among individuals with unilaterally impacted canines

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ABSTRACT

Objectives: To determine the prevalence of root resorption of teeth adjacent to permanent maxillary canines on both sides, by cone-beam computed tomography (CBCT), in pretreatment adolescent subjects with unilaterally impacted maxillary canines, and to define predictive factors for the root resorption.

Materials and Methods: This retrospective sample included 76 adolescents (38 boys, 38 girls, mean age 12.3 $\pm$ 2.1 years; range 8–17 years) who had CBCT after detection of a unilateral impacted maxillary canine before any active orthodontic treatment. Both ipsilateral and contralateral sides were examined, and 14 qualitative and quantitative variables were collected. Descriptive statistics were calculated, and multiple logistic regression was used to predict root resorption.

Results: On the impaction side, 57.9% of canines resorbed at least one adjacent tooth compared with 13.2% on the contralateral side ($P < .001$). On the impaction side, resorption was slight in 59.6%, moderate in 5.8%, and severe in 34.6% of the cases. On the contralateral side, resorption was slight in 91.7%, moderate in 0%, and severe in 8.3% of the cases. On both sides, upper lateral incisors were the teeth most frequently resorbed, followed by the upper first premolars and upper central incisors. The presence of contact between the canine and the adjacent roots was the only statistically significant risk factor for resorption for both ipsilateral and contralateral sides.

Conclusions: Orthodontists should look for root resorption on both sides in cases of unilaterally impacted maxillary canines. (*Angle Orthod*. 2024;94:541–548.)

KEY WORDS: Unilateral impacted maxillary canine; Unerupted maxillary canine; Maxillary canine; Root resorption prevalence; Risk factors; Cone-beam computed tomography

INTRODUCTION

Maxillary canine displacement and impaction have a prevalence ranging from 0.9% to 3.0% in the general population.[1,2] Root resorption of teeth adjacent to maxillary impacted canines was reported in almost two-thirds of the cases when assessed by cone-beam computed tomography (CBCT).[3–5]

Root resorption of adjacent teeth might also occur during the normal eruption process of the permanent maxillary canines. Due to the lack of routine CBCT examination in the absence of pathology, the exploration of these lesions remains limited. Cases of unilaterally impacted maxillary canines offer the opportunity to explore the contralateral normal side if it is located in the field of view (FOV) of a three-dimensional (3D) imaging technique. Previously, only five studies assessed resorption on the contralateral side,[6–10] with prevalence ranging from 5.5% to 36.3%.[6,7] However, study design and reporting of data were variable and presented

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disparities. Knowledge of the extent of this phenomenon can serve as a benchmark to define the prevalence of root resorption caused by impacted canines.

The aims of this study were to assess the prevalence of root resorption of adjacent teeth on the contralateral side in cases of unilateral maxillary canine impaction, to compare it with the impaction side, and to define the risk factors associated with this resorption. Secondary objectives were to obtain descriptive data regarding the resorbed teeth, resorption severity, and the vertical location of the root resorption.

MATERIALS AND METHODS

Materials

This retrospective cross-sectional study included patients referred to the Department of Dental Radiology, University Hospitals of Strasbourg, between July 2010 and January 2021, for a CBCT exploration of a unilaterally displaced or impacted maxillary permanent canine. Sample size calculation revealed that at least 52 subjects were needed to detect a difference in prevalence of root resorption between the groups, with a power of 90% and an α of .05.[5,7]

Inclusion Criteria

- Patients between 8 and 17 years of age.
- Fully erupted contralateral maxillary canine or without clinical or radiological signs of abnormal eruption.
- No active orthodontic treatment had been implemented.

Exclusion Criteria

- Bilateral maxillary canine impaction or any additional maxillary tooth impaction or eruption anomalies.
- Past orthodontic treatment.
- Syndromes, cleft lip and palate, dentigerous cysts, odontomas, supernumerary teeth, and cysts related to the impacted canine.

The study was approved by the Institutional Review Board of the University of Strasbourg (number FC/2017-28).

METHODS

All CBCTs were taken with the same NewTom™ VGi machine (QR s.r.l, Verona, Italy). Images were obtained with the patients sitting. A high-resolution protocol, with 150 μm^3 voxel size and an 8 $\times$ 8 cm FOV was used. Tube voltage was 110 kV, and the exposure time varied from 3.6 seconds to 5.4 seconds, according to the manufacturer.

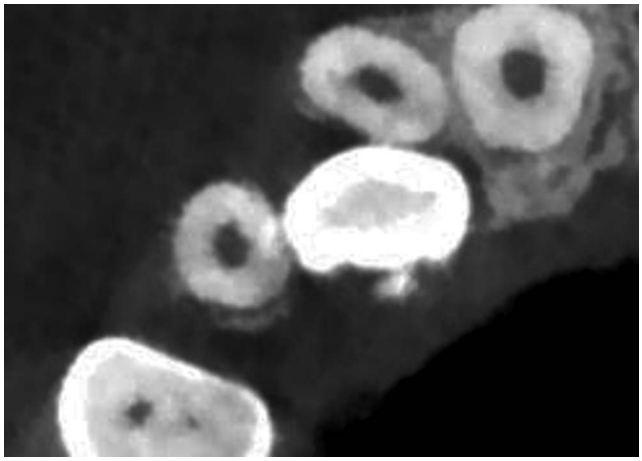

Figure 1. Contact relationships between the canine and the adjacent roots.

The obtained DICOM files were imported in the medical imaging software OsiriX™ (Version 8.0.1; Pixmeo SARL, Geneva, Switzerland). Images were evaluated in a room with dimmed light conditions on a 27-inch monitor (2560 $\times$ 1440 pixel resolution), using 3D multiplanar reconstruction (MPR) and curved planar reconstruction (CPR) simulating a panoramic view.

The following 14 measurements were taken for every maxillary canine:

1. Age
2. Gender
3. Tooth number
4. Side (left/right)
5. Labiopalatal location of the canine: palatal, labial, or center of the arch as defined on axial CBCT views.[7]
6. Mesiodistal position of the canine tip on the CPR, according to Ericson and Kurol.[11]
7. Distance (d) from the canine tip to the occlusal plane on the CPR, according to Ericson and Kurol.[11]
8. Inclination of the canine to the midsagittal plane (α angle) on the CPR, according to Ericson and Kurol.[11]
9. Maximum width of the canine follicle, measured perpendicularly from the crown to the follicle periphery on axial views along the canine long axis. The follicle was considered enlarged if the width was greater or equal to 3 mm.[12–14]
10. Contact relationship between the canine and the adjacent roots. Contact was considered if the distance between two teeth was less than 0.5 mm (Figure 1).[3,13]
11. Morphology or agenesis of the adjacent upper lateral incisor: normal, peg-shaped, or missing.
12. Presence or absence of root resorption for the central incisor, lateral incisor, first premolar, second premolar, and first molar in cases of proximity

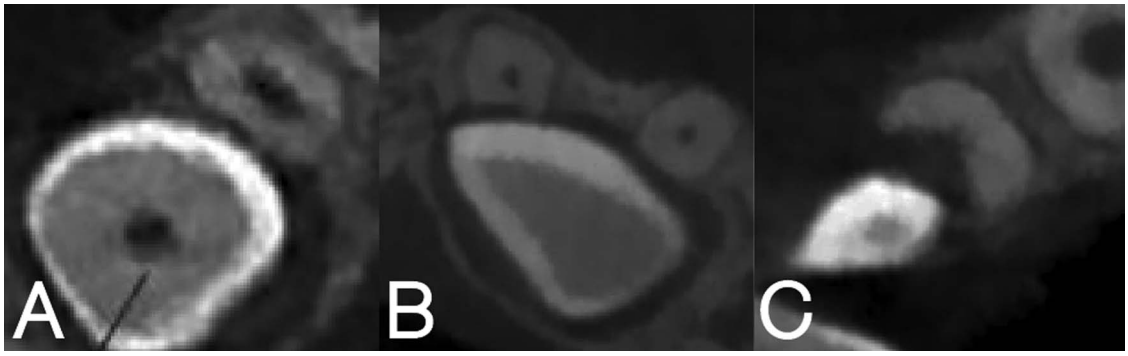

Figure 2. Severity of root resorption, according to Ericson and Kurol. (A) Slight root resorption. (B) Moderate root resorption. (C) Severe root resorption.

to the displaced canine was assessed on 3D MPR views along the long axis of each single adjacent root.

13. Root resorption severity was defined according to the classification of Ericson and Kurol (Figure 2):[15]
    a. slight: if the tooth was resorbed up to half its dentin thickness.
    b. moderate: if the tooth was resorbed midway to the pulp or more, the pulp lining being unbroken.
    c. severe: when the pulp was exposed by the resorption.
14. Vertical level of the root resorption lesion: cervical, middle, or apical third of the root.

To calibrate the main investigator (ML, third-year orthodontic resident) and the two other investigators (CG, specialist in dentomaxillofacial radiology, and FR, orthodontist with >5 years of experience), 10 cases of bilaterally impacted maxillary canines were randomly selected in the radiology department database. All 14 study variables were evaluated on the 20 impacted canines jointly. To accurately identify slight root resorption, the following consensus was established among the investigators: a section of a circle was traced to mimic the initial root contour. If this outline was touching or at a distance from the enamel of the canine, no resorption was present. On the other hand, if the outline was overlapping the enamel, the root was resorbed (Figure 3).

Statistical Analysis

Intrarater and interrater agreement was calculated on 20 canines (displaced or normal), randomly selected among the study sample, 1 month after data collection. Cohen's κ and intraclass correlation were used.

Descriptive statistics (means $\pm$ standard deviations) were used to report the results. A multiple logistic regression was performed to identify possible association between the absence or presence of root resorption on all adjacent teeth on the impaction side and different factors such as age, gender, upper lateral incisor morphology, canine follicle size, contact between the canine and the adjacent roots, labiopalatal and mesiodistal position of the canine, α angle, and distance to the occlusal plane. The same multiple logistic regression was repeated on the contralateral side and analyzed together on both sides. Additional multiple logistic regression was also carried out to identify possible associations between the absence or presence of root resorption on individual teeth (upper laterals, upper centrals, upper first premolars) and the same factors mentioned previously, on both impaction and contralateral sides. Results were presented as odds ratios (ORs) with two-sided 95% confidence intervals and *P* values. Finally, prevalence of displaced and contralateral canines resorbing adjacent teeth were compared with a χ^2 test. Level of significance was set at $P < .05$. All statistical analyses were performed with the R project for statistical computing, version 4.0.2 (R Core Team [2020], Vienna, Austria).

RESULTS

Intrarater and Interrater Agreement

Both interrater and intrarater reliabilities showed substantial agreement (Table 1). Intrarater agreement of

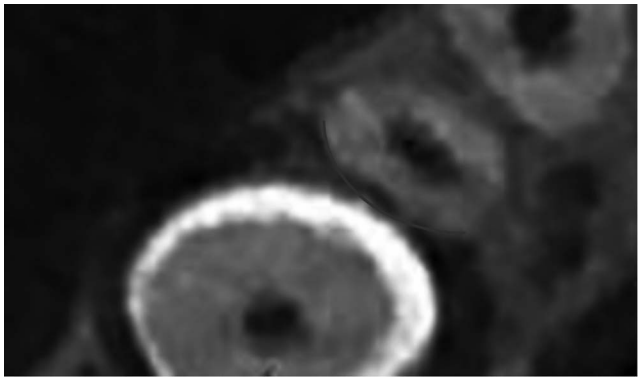

Figure 3. In cases of slight root resorption, the gray outline overlaps the canine enamel.

Table 1. Intrarater and Interrater Agreement

Variables	Test	Intrarater Agreement	Global Interrater Agreement
Presence of root resorption	Cohen's κ	0.88	0.92
Upper lateral resorption		1	1
Upper central resorption		–	–
Upper first bicuspid resorption		1	1
Labiopalatal location of the canine		0.65	0.66
Maximum width of the canine follicle		1	1
Contact		1	1
Morphology or agensis of the adjacent upper lateral incisor		1	1
Root resorption severity		0.88	0.92
Vertical position of the resorption lesion		0.89	0.93
Mesiodistal position of the canine tip	Intraclass correlation	0.85	0.90
α angle		0.99	1
Distance to the occlusal plane (d)		0.99	0.97

the main investigator was 0.88 for detection of root resorption. Global interrater agreement for the detection of root resorption was 0.92 among the 3 investigators, 0.88 between FR and ML, and 1.00 between CG and ML.

Descriptive Statistics

Seventy-six subjects were included in the study, 38 boys and 38 girls, with a mean age of 12.3 years (SD 2.1 years; range 8–17 years). Descriptive data regarding the sample are presented in Table 2. Considering all degrees of severity of resorption and all the adjacent teeth, root resorption was found in 57.9% on the impaction side and in 13.2% on the contralateral side ($P < .001$). On the impaction side, it was found that 46.7% of all lateral incisors, 5.3% of all central incisors, and 17.1% of all first premolars were resorbed. On the contralateral side, 12.2% of all lateral incisors, no central incisors, and 4.0% of all first premolars were resorbed. On both sides, most of the resorption identified was slight. However, it was severe in 34.6% on the impaction side and 8.3% on the contralateral side (Table 3). On both the impaction and contralateral sides, the vast majority of root resorption was in the middle and apical thirds of the roots (Table 3). If all adjacent teeth were considered, severe resorption was mainly found in the apical third of the root, whereas slight resorption was mostly found in the middle third (Table 4).

Table 2. Descriptive Data Regarding the Sample[a]

Variable	Impaction Side	Contralateral Side
Side		
Left	40.8%	59.2%
Right	59.2%	40.8%
Lateral incisor		
Missing	1.3%	2.6%
Normal	81.6%	88.2%
Peg-shaped	17.1%	9.2%
Follicle size		
<3 mm	67.1%	100%
≥3 mm	32.9%	0%
Contact with the roots of the adjacent teeth		
Yes	94.7%	22.4%
No	5.3%	77.6%
Canine buccolingual position		
Palatal	35.5%	–
Center	34.2%	–
Buccal	30.3%	–
Canine mesiodistal position (sectors)		
1	30.3%	98.7%
2	23.7%	1.3%
3	11.8%	0%
4	27.6%	0%
5	6.6%	0%
Distance to the occlusal plane, mean ± SD	13.5 ± 7.8 mm	3.6 ± 4.4 mm
α angle, mean ± SD	37.8° ± 21.6°	9.6° ± 8.8°

[a] SD indicates standard deviation.

Risk Factors

Tables 5 through 7 show the results of the multiple logistic regression. The presence of contact between the canine and the adjacent tooth roots (OR = 227.03; CI = 15.68–328.82; $P < .001$) and an older age (OR = 1.72; CI = 1.20–2.47; $P = .003$) were the only statistically significant risk factors of resorption when all adjacent teeth were considered, and the impaction and contralateral sides were analyzed together. An enlarged canine dental

Table 3. Severity and Vertical Location of Root Resorption

	Impaction Side	Contralateral Side
Resorption severity		
Slight	59.6%	91.7%
Moderate	5.8%	0%
Severe	34.6%	8.3%
Resorption location		
Cervical third	5.8%	16.7%
Middle and apical thirds	94.2%	83.3%

Table 4. Relationship Between Root Resorption Severity and Vertical Location

	Impaction Side				Contralateral Side			
	Cervical Third	Middle Third	Apical Third	Apical + Middle Thirds	Cervical Third	Middle Third	Apical Third	Apical + Middle Thirds
Reception								
Slight	9.7%	41.9%	38.7%	9.7%	11.1%	55.6%	11.1	22.2%
Moderate	0%	0%	100%	0%	0%	0%	0%	0%
Severe	0%	0%	88.9%	11.1%	0%	0%	100%	0%

follicle, peg-shaped upper lateral or upper lateral agenesis, and gender were not significantly associated with root resorption of adjacent teeth. When analyzed separately, on the impaction side only, the presence of contact between the canine and the adjacent tooth roots (OR = 69.35; CI = 1.97–2444; $P = .02$) and increasing age (OR = 1.54; CI = 1.05–2.24; $P = .03$) were significant risk factors for resorption. On the other hand, on the contralateral side only, the presence of contact between the canine and the adjacent tooth roots (OR = 89.19; CI = 5.35–1488.34; $P = .002$) was the only statistically significant risk factor for the presence of root resorption when all adjacent teeth were considered.

Table 5. Results of Multiple Logistic Regression Regarding Possible Risk Factors of Root Resorption, Contralateral and Impaction Side[a]

	Contralateral + Impaction Side		
	All Teeth		
	OR	CI	*P*
Age	1.72	1.2–2.47	.003**
Sex			
Female	1	Ref	–
Male	0.44	0.14–1.30	.14
Adjacent lateral incisor			
Normal	1	Ref	–
Peg-shaped	0.59	0.74–2.50	.48
Missing	3.80	0.02–931.6	.63
Enlarged follicle	1.54	0.46–5.16	.48
Root contact	227.03	15.68–328.82	<.001***
Labiopalatal location			
Palatal	0.66	0.10–4.22	.66
Centre	1	Ref	–
Labial	0.68	0.14–3.24	.63
Mesiodistal position			
Sector 1	1	Ref	–
Sector 2	0.23	0.05–1.06	.06
Sector 3	0.81	0.12–5.76	.84
Sector 4	0.79	0.15–4.10	.78
Sector 5	5.92	0.07–513.66	.43
α angle	1.00	0.97–1.03	.92
Distance to the occlusal plane	1.11	0.96–1.29	.16

[a] OR indicate odds ratio; CI indicates 95% confidence interval; Ref indicates reference; * $P = .05$; ** $P = .01$; *** $P = .001$; **** $P = .0001$.

DISCUSSION

Study Sample and Methods

This was the first study in adolescent patients with unilaterally impacted canines in which a CBCT was performed prior to any orthodontic treatment and both sides were explored on the same individuals. The contralateral side could, therefore, specifically be analyzed. Seventy-six contralateral normal canines were explored in this study, like other works, in which 31 to 156 contralateral canines were analyzed.[9,10] Of importance was the fact that the same CBCT unit with the same settings was used over the years by the same operators. With the retrospective inclusion of patients in this study, there was no exposure to supplementary radiation for study purposes.

Few other studies explored the presence of root resorption adjacent to normally erupted canines.[6–10] However, previous study designs and reporting of the data presented disparities. For instance, Guarnieri et al.[9] did not separate the resorption caused by ectopically erupting canines from those of normally erupting canines. Yan et al.[10] compared the prevalence of root resorption adjacent to impacted canines (unilateral and bilateral) with both a control group without any impacted canines and a group of contralateral normal canines in cases of unilateral impaction. The studies by Ericson and Kurol[6] and Hadler-Olsen et al.[7] limited themselves to patients under 17 years of age but did not specify if patients with past or ongoing orthodontic treatment were excluded or not. Finally, Guarnieri et al.[9] and Aleman et al.[8] only included subjects prior to any orthodontic treatment, but their mean age was 20.84 years in the second study.

RESULTS

In the sample, prevalence of root resorption was in accordance with previously reported prevalence ranging from 31.3% to 69.6% on the impaction side,[4,13] and 5.5% to 36.3% on the normal side.[6,7] On both sides, the lateral incisors were the most frequently resorbed teeth, followed, surprisingly, by the first premolars. Authors of three studies reported root resorption rates of the central incisor of 0% to 2.9% adjacent

Table 6. Results of Multiple Logistic Regression Regarding Possible Risk Factors of Root Resorption, Impaction Side[a]

	Impaction Side											
	All Teeth			Lateral Incisor			Central Incisor			First Premolar		
	OR	CI	*P*	OR	CI	*P*	OR	CI	*P*	OR	CI	*P*
Age	1.54	1.05–2.24	.03*	1.37	0.96–1.95	.08	2.55	1.10–5.90	.03*	1.05	0.69–1.62	.81
Sex												
Female	1	Ref	–	1	Ref	–	1	Ref	–	1	Ref	–
Male	0.33	0.10–1.05	.06	0.18	0.06–0.58	.004**	0.47	0.03–7.06	.58	1.94	0.47–8.04	.36
Adjacent lateral incisor												
Normal	1	Ref	–	1	Ref	–	1	Ref	–	1	Ref	–
Peg-shaped	0.54	0.13–2.24	.40	0.32	0.08–1.34	.12	0.62	0.015–25.29	.80	0.91	0.14–5.87	.92
Missing	2.40	0.08–74.64	.62	1.00	0.007–134.29	1.00	0.995	0.008–129.28	.99	2.52	0.08–82.5	.60
Enlarged follicle	1.53	0.51–4.61	.45	1.15	0.38–3.49	.80	1.43	0.071–28.64	.82	0.70	0.16–3.08	.64
Root contact	69.35	1.97–2444	.02*	13.50	0.57–321	.11	1.32	0.02–77.39	.89	11.06	0.51–241.81	.13
Labiopalatal location												
Palatal	0.75	0.15–3.71	.73	0.86	0.19–3.91	.84	0.25	0.01–4.89	.36	4.60	0.55–38.65	.16
Center	1	Ref	–	1	Ref	–	1	Ref	–	1	Ref	–
Labial	0.68	0.17–2.64	.57	0.69	0.18–2.67	.59	1.51	0.075–30.66	.79	0.73	0.11–4.95	.75
Mesiodistal position												
Sector 1	1	Ref	–	1	Ref	–	1	Ref	–	1	Ref	–
Sector 2	0.33	0.08–1.32	.12	0.69	0.18–3.23	.76	0.23	0.003–16.64	.50	0.07	0.007–0.68	.02*
Sector 3	0.99	0.19–5.15	.99	2.57	0.49–13.57	.27	0.6	0.01–23.33	.76	0.03	0.0009–0.81	.04*
Sector 4	0.98	0.24–3.95	.97	2.32	0.57–9.33	.24	4.99	0.26–97.62	.29	0.09	0.01–0.66	.02*
Sector 5	2.80	0.24–38.3	.44	3.04	0.31–29.5	.34	3.74	0.10–110.95	.46	1.15	0.12–10.88	.90
α angle	0.99	0.98–1.04	.6	0.99	0.97–1.02	.86	1.03	0.96–1.11	.37	1.01	0.98–1.05	.39
Distance to the occlusal plane	1.07	0.96–1.20	.24	0.99	0.94–1.07	.98	1.13	1.01–1.26	.04*	1.00	0.92–1.10	.86

[a] OR indicate odds ratio; CI indicates 95% confidence interval; Ref indicates reference; * $P = .05$; ** $P = .01$; *** $P = .001$; **** $P = .0001$.

to a normally erupting canine[7,8,10]: none were found in the current sample. The reason could be that the normally erupting canine does not have proximity to the central incisor, except in cases of lateral incisor agenesis. Finally, the data revealed root resorption in 4.0% of the first premolars on the normal side, while Yan et al. reported no resorption.[10] The explanation might be that normally erupting canines do not commonly interact with first premolars.

The predominance of slight resorption on the impaction side was confirmed by Mitsea et al.[16] but exceeded the values found in a meta-analysis of 18 studies,[17] in which it was concluded that root resorption was predominantly slight (43.2%), and severe in 30.9% of cases. On the contralateral normal side, resorption was slight in 91.7% and, quite unexpectedly, severe in 8.3% of the cases. On the normal side, however, the results can only be compared with two other studies in which authors specified the severity of root resorption in lateral incisors.[7,8]

On both sides, vertical location of root resorption was in accordance with the meta-analysis by Schroder et al.[17] in which it was reported that the apical third was the most frequently resorbed (56.87%) and the cervical third the least frequent (6.1%). Mitsea et al. also found the cervical third to be the least often resorbed.[16] Hadler-Olsen et al.[7] were the only authors to identify the location of root resorption on the normal side. They found that the middle and apical thirds were affected to a similar extent (58.3% and 41.7%, respectively). Table 4 allows a better appreciation of the amount of root tissue loss. In the sample, on both the impaction and the normal sides, severe and moderate damage was never cervical but mainly apical, which is of better prognosis for the affected tooth.

The only significant risk factors, all teeth being considered, were contact between the canine and the adjacent tooth roots and increasing age. This physical proximity of less than 0.5 mm has been described in the literature as the most important risk factor for impacted canine associated root resorption[3,5,6,8,10,13,18,19] and was confirmed by Schroder et al.[17] No significant relationship between root resorption and an enlarged dental follicle was found, contrary to Chaushu et al.[20] and Dağsuyu et al.[21] Neither did female gender, buccolingual or mesiodistal canine position, and shape and size of the lateral incisor constitute risk factors, all adjacent teeth being considered on both sides. However, lateral incisors adjacent to impacted canines demonstrated a higher risk of root resorption in female patients (OR = 5.45; CI = 1.71–17.33; $P = .004$), as was found by Chaushu et al.[20] They identified a 4.2 times higher risk in female patients than in males. Finally, first premolars had a lower risk of root resorption

Table 7. Results of Multiple Logistic Regression Regarding Possible Risk Factors of Root Resorption, Contralateral Side

	Contralateral Side											
	All Teeth			Lateral Incisor			Central Incisor			First Premolar		
	OR	CI	*P*	OR	CI	*P*	OR	CI	*P*	OR	CI	*P*
Age	1.57	0.92–2.70	.10	1.57	0.92–2.66	.10	–	–	–	.94	0.49–1.81	.85
Sex												
Female	1	Ref	–	1	Ref	–	1	Ref	–	1	Ref	–
Male	2.09	0.36–12.17	.41	2.65	0.45–15.59	.28	–	–	–	.13	0.006–2.68	.18
Adjacent lateral incisor												
Normal	1	Ref	–	1	Ref	–	1	Ref	–	1	Ref	–
Peg-shaped	0.92	0.10–8.34	.94	0.97	0.10–8.93	.98	–	–	–	.50	0.002–15.49	.70
Missing	0.89	0.01–72.6	.96	1	0.0007–134.29	1	–	–	–	.79	0.013–48.84	.91
Enlarged follicle	–	–	–	–	–	–	–	–	–	–	–	–
Root contact	89.19	5.35–1488.34	.002**	75.54	4.44–1286.18	.003**	–	–	–	6.81	0.26–179.49	.25
Labiopalatal location												
Palatal	–	–	–	–	–	–	–	–	–	–	–	–
Centre	1	Ref	–	1	Ref	–	1	Ref	–	1	Ref	–
Labial	–	–	–	–	–	–	–	–	–	–	–	–
Mesiodistal position												
Sector 1	1	Ref	–	1	Ref	–	1	Ref	–	1	Ref	–
Sector 2	0.65	0.01–36.05	.83	0.39	0.008–18.2	.63	–	–	–	0.97	0.009–109.30	.99
Sector 3	–	–	–	–	–	–	–	–	–	–	–	–
Sector 4	–	–	–	–	–	–	–	–	–	–	–	–
Sector 5	–	–	–	–	–	–	–	–	–	–	–	–
α angle	0.94	0.84–1.05	.29	0.99	0.89–1.09	.81	–	–	–	.91	0.79–1.06	.22
Distance to the occlusal plane	1.21	0.91–1.61	.19	1.13	0.86–1.48	.39	–	–	–	1.33	0.90–1.97	.15

[a] OR indicate odds ratio; CI indicates 95% confidence interval; Ref indicates reference; * $P = .05$; ** $P = .01$; *** $P = .001$; **** $P = .0001$.

when impacted canines were located further away in sectors 2, 3, and 4 than sector 1, as was found in the previous study.[5]

Limitations

CBCT examinations have technical limitations (maximum spatial resolution, partial volume effect, presence of beam hardening artefacts), especially relevant in the accurate diagnosis of small structures such as for the identification of slight root resorption.[5] In this study, excellent interrater agreement for the detection of root resorption was achieved by developing a consensus to differentiate slight resorption from beam hardening artifacts.

Resorption occurring on the contralateral/normal side is a new finding that authors of few previous studies have analyzed. The exact extent of this phenomenon was, however, underestimated in different studies due to the absence of routine 3D exploration during the normal eruption of maxillary canines. Future work on CBCT collections is needed to extrapolate these results to patients without maxillary canine impaction.

CONCLUSIONS

- Root resorption was found in 57.9% on the impaction side and 13.2% on the contralateral, normal side.
- Most of the resorption was slight, and the lateral incisors were the most affected teeth.
- The main etiological factors were contact between the canine and the adjacent tooth roots and older age.
- Orthodontists should look for root resorption on both sides in cases of unilaterally maxillary impacted canines, not only on the lateral and central incisors but also on the first premolars adjacent to the maxillary canines.

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