

Original Article

Odontogenic Lesions and Their Frequency in Patients with Impacted Maxillary Canines in Relation to Impaction Characteristics

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ABSTRACT

Maxillary canine impaction is a common dental anomaly, and identifying its potential causes is crucial. Odontogenic lesions located near the impacted canine may contribute to the occurrence of impaction. This study aimed to determine how frequently odontogenic lesions occur in patients with impacted canines and to explore their relationship with specific impaction characteristics. A cross-sectional study analyzed 93 impacted maxillary canines from cone-beam computed tomography (CBCT) scans obtained at three radiology centers. Inclusion criteria encompassed male and female patients over 12 years of age with unilateral or bilateral maxillary canine impaction, regardless of the presence of odontogenic lesions. Evaluations included the impaction position, sector, presence of dentigerous cysts, odontomas, or follicular enlargements, and lesion size. Statistical analyses were conducted using the χ^2 test and logistic regression, with significance determined at $p < 0.05$. Overall, odontogenic lesions near impacted canines were uncommon: dentigerous cysts were present in 7.5% of cases, follicular enlargement in 6.5%, and mesiodens in 3.2%. Dentigerous cysts were significantly more frequent in buccal and mid-alveolar impactions ($p = 0.032$). Logistic regression revealed that a larger alpha angle increased the likelihood of dentigerous cyst formation ($B = 1.22$; $p = 0.041$), whereas a higher beta angle reduced the risk by approximately 18% ($p = 0.024$). The occurrence of odontogenic lesions in impacted maxillary canines is low, primarily involving dentigerous cysts and follicular enlargements associated with buccal or mid-alveolar impactions. Impaction angles, particularly alpha and beta, appear to influence the development of dentigerous cysts.

Keywords: Odontogenic lesions, Impacted maxillary canines, Cone-beam computed tomography

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Introduction

Eruption of teeth can sometimes deviate from the normal path due to obstructions along the eruption route, resulting in dental impactions. These impactions are often clinically silent and are typically first detected during orthodontic evaluations using panoramic radiographs [1-3]. Among all teeth, the maxillary canine is the second most frequently impacted, with a prevalence ranging from 0.8% to 2.8%. The impacted

canine may deviate palatally or buccally and can lie inside or outside the dental arch, with palatal impactions generally more common, reported in ratios of 2:1 or 3:1 [2-5]. Significant variations have also been noted in canine eruption anomalies when comparing children with Down syndrome to age-matched controls [6].

Impacted canines may coexist with odontogenic lesions, which can serve as mechanical barriers that inhibit eruption. Conversely, impaction itself may damage adjacent tissues, potentially leading to the

formation of lesions [3, 4]. CBCT studies indicate that the prevalence of pathologies associated with impacted canines ranges from 1.0% to 9.9%, second only to third molars [3-5]. Measurements of dental follicle thickness in impacted maxillary canines have shown that 22% of cases exceed 3 mm, although no significant relationship was found with sex, side, or location of impaction [5, 7]. While conventional panoramic and periapical radiographs remain useful for initial detection, odontogenic tumors often require three-dimensional imaging to overcome overlapping structures and provide a more detailed evaluation [8]. It is important to identify lesions such as odontomas, supernumerary teeth, root dilacerations, trauma-related abnormalities, retained deciduous teeth, congenital defects, and cysts in association with impacted maxillary canines [9-11]. Three-dimensional imaging offers improved visualization of anatomical variations and lesion extent, facilitating more precise diagnoses [12, 13]. Among these lesions, dentigerous cysts are the most frequently observed, with a prevalence of 9.9%, and can impact neighboring bones and dental roots [14, 15].

A thorough assessment of surrounding tissues and any associated lesions is critical for treatment planning of impacted maxillary canines, guiding appropriate therapeutic decisions [16, 17]. Although prior studies have explored the frequency of odontogenic lesions in this context, few have incorporated three-dimensional evaluations or sufficiently large samples to allow extrapolation [18-21]. A detailed analysis is therefore necessary to quantify how many canine impactions may result from odontogenic lesions and to clarify their etiological role. Accordingly, the present study aimed to determine the frequency of odontogenic lesions in patients with impacted maxillary canines and evaluate their association with specific impaction characteristics using CBCT.

Materials and Methods

This cross-sectional study was approved by the Ethics and Research Committee of the School of Dentistry, Scientific University of the South (Universidad Científica del Sur), Lima, Peru (approval no. 704-2021-POS70), and conducted in line with the principles outlined in the Declaration of Helsinki.

The sample consisted of CBCT scans of 93 impacted maxillary canines, including 30 scans from male patients (mean age 16.92 ± 4.24 years) and 63 from female patients (mean age 16.70 ± 4.58 years), collected from radiology centers in Mexico, Colombia, and Peru. These scans were originally obtained for purposes unrelated to this study. Inclusion criteria

were: patients aged over 12 years (after the expected eruption of maxillary canines), unilateral or bilateral impactions, both sexes, and impactions located in any sector as classified by Ericson and Kuroi [22], with or without associated pathologies such as compound odontomas, dentigerous cysts, or follicular cysts. Exclusion criteria included prior orthodontic treatment, craniofacial syndromes or anomalies, dental agenesis, ankylosis, or localized infections.

Sample size was calculated to achieve a 95% confidence level with 5% precision, based on an estimated 6.5% frequency of odontogenic lesions associated with impacted maxillary canines from a pilot study, resulting in a required minimum of 93 impacted canines.

Collection of CBCT scans

CBCT images were obtained from three radiology centers situated in Mexico, Colombia, and Peru. The scans had fields of view (FOV) of either 8×8 cm or 10×10 cm. For image assessment, the software platforms CS 3D Imaging (Carestream Health, Inc., Rochester, USA), Blue Sky Plan (<https://www.blueskyplan.com>), and Xelis Dental-3DViewer (INFINITT Europe, Frankfurt am Main, Germany) were used, chosen specifically for their compatibility with the CBCT machines employed (Vatech Co., Ltd., Yongin, South Korea, and Carestream Health, Inc.).

Training and calibration

A single researcher was trained and calibrated under the guidance of three experienced orthodontists, each with over a decade of clinical practice, to perform the qualitative assessments. Calibration reliability was tested using the weighted Cohen's kappa statistic, and repeated until intra- and inter-evaluator agreement exceeded 0.9 across all measurements.

Assessment of impacted maxillary canines

The spatial location of each impacted maxillary canine was recorded as palatal, buccal, or mid-alveolar, and categorized as either unilateral or bilateral. Impaction sectors were defined according to the Ericson and Kuroi classification [22] as follows:

- Sector 1: from the mesial edge of the first premolar to the distal edge of the lateral incisor
- Sector 2: from the distal edge of the lateral incisor to its median axis
- Sector 3: from the median axis of the lateral incisor to the distal edge of the central incisor
- Sector 4: from the distal edge of the central incisor to its median axis

- Sector 5: from the median axis of the central incisor to the dental midline (**Figure 1A**) [22-25]

Vertical impaction height was measured relative to the occlusal plane in millimeters. Additionally, canine angulation was quantified using two angles: the alpha angle, measured relative to the mid-sagittal plane, and the beta angle, measured in relation to the long axis of the lateral incisor (**Figure 1B**) [22].

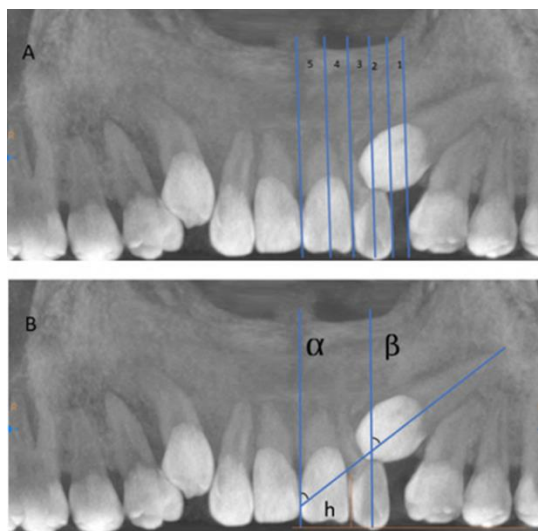


Figure 1. (A) Impaction sectors classified according to the Ericson and Kurol system [22]. (B) Measurement of the impacted maxillary canine, including vertical height relative to the occlusal plane, the angulation relative to the mid-sagittal plane (alpha angle, α), and the angulation relative to the long axis of the lateral incisor (beta angle, β)

Evaluation of odontogenic lesions

The study investigated whether impacted maxillary canines were associated with odontogenic lesions, specifically dentigerous cysts, follicular cysts, and compound odontomas. Dentigerous cysts were defined as well-circumscribed hypodense areas surrounding the crown of the impacted tooth, with a sclerotic border and a size exceeding 5 mm. Follicular cysts were characterized as smaller epithelial proliferations of the eruption follicle, not exceeding 3 mm in diameter.

Compound odontomas were identified as clusters of miniature tooth-like structures within the epithelial tissue, obstructing or adjacent to the impacted canine, appearing as small hyperdense masses on CBCT. Lesions measuring 4–5 mm were excluded to avoid ambiguity in distinguishing between follicular enlargement and small cysts.

Statistical analysis

All analyses were performed using IBM SPSS Statistics for Windows, version 24.0 (IBM Corp., Armonk, USA). The χ^2 test was used to examine relationships between categorical variables. Additionally, logistic regression was employed to evaluate the influence of predictor variables on the presence of odontogenic lesions, with a significance threshold of $p < 0.05$.

Results

Impaction patterns revealed that palatally displaced canines were most frequently located in sectors 3 and 5, whereas buccal impactions were concentrated in sectors 1 and 3 ($p = 0.001$) (**Table 1**). Overall, the occurrence of odontogenic lesions in the vicinity of impacted canines was low: dentigerous cysts were observed in 7.5% of cases, follicular enlargement in 6.5%, and mesiodens in 3.2% (**Table 2**). No statistically significant associations were found between impaction type (palatal, buccal, or mid-alveolar) and follicular enlargement or other lesions ($p > 0.05$). However, dentigerous cysts showed a significant relationship with buccal and mid-alveolar impactions, occurring in roughly 15% of these cases ($p = 0.032$) (**Table 3**).

When examining potential predictors—sex, impaction type, impaction sector, alpha and beta angles, and vertical height of impaction—only the angular measurements influenced the likelihood of dentigerous cysts. Each 1° increase in the alpha angle raised the risk of a dentigerous cyst by 1.22 times ($p = 0.041$), while each 1° increase in the beta angle reduced the risk by approximately 18 percent ($p = 0.024$) (**Table 4**).

Table 1. Characteristics of maxillary canine impaction in the sample evaluated

Impaction type	Impaction sector					Total	p-value
	1	2	3	4	5		
Palatal	1 (2.3)	8 (18.2)	12 (27.3)	8 (18.2)	15 (34.1)	44 (100.0)	0.001*
Buccal	8 (34.8)	3 (13.0)	8 (34.8)	3 (13.0)	1 (4.3)	23 (100.0)	
Mid-alveolar	11 (42.3)	1 (3.8)	3 (11.5)	4 (15.4)	7 (26.9)	26 (100.0)	
Total	20 (21.5)	12 (12.9)	23 (24.7)	15 (16.1)	23 (24.7)	93 (100.0)	

Data presented as number (percentage) (n (%)).

*statistically significant (χ^2 test).

Table 2. Frequency of odontogenic lesions near the area of canine impaction in the sample evaluated

Odontogenic lesion	Condition	Percentage [%]
Dentigerous cyst	absent	92.5
	present	7.5
	total	100.0
Follicular enlargement	absent	93.5
	present	6.5
	total	100.0
Odontoma	absent	100.0
	present	0.0
	total	100.0
Other alterations	none	94.6
	mesiodens	3.2
	sinusitis	2.2
	total	100.0

Table 3. Association between the type of impaction and the presence of an odontogenic lesion

Odontogenic lesion	Condition	Impaction type				p-value
		palatal	buccal	mid-alveolar	total	
Dentigerous cyst	absent	44 (100.0)	20 (87.0)	22 (84.6)	86 (92.5)	0.032*
	present	0 (0.0)	3 (13.0)	4 (15.4)	7 (7.5)	
	total	44 (100.0)	23 (100.0)	26 (100.0)	93 (100.0)	
Follicular enlargement	absent	41 (93.2)	22 (95.7)	24 (92.3)	87 (93.5)	0.885
	present	3 (6.8)	1 (4.3)	2 (7.7)	6 (6.5)	
	total	44 (100.0)	23 (100.0)	26 (100.0)	93 (100.0)	
Other alterations	none	43 (97.7)	23 (100.0)	22 (84.6)	88 (94.6)	0.091
	mesiodens	1 (2.3)	0 (0.0)	2 (7.7)	3 (3.2)	
	sinusitis	0 (0.0)	0 (0.0)	2 (7.7)	2 (2.2)	
	total	44 (100.0)	23 (100.0)	26 (100.0)	93 (100.0)	

Data presented as n (%).

*statistically significant (χ^2 test).

Table 4. Binary logistic regression analysis to evaluate the occurrence of a dentigerous cyst according to the predictor variables

Predictor variable	p-value	Exp (B)	95% CI to Exp (B)		
			inferior	superior	
Sex	F	–	–	–	
	M	0.315	0.36	24.76	
Impaction type	0.174	2.90	0.62	13.46	
Impaction sector	1	0.865	–	–	
	2	0.999	0.00	.	
	3	0.957	1.07	0.08	13.80
	4	0.930	1.15	0.06	23.86
	5	0.334	0.18	0.01	5.87
Alpha angle	0.041*	1.22	1.01	1.48	
Beta angle	0.024*	0.82	0.70	0.98	
Impaction height	0.647	1.06	0.84	1.34	

CI – confidence interval; F – female; M – male; * statistically significant.

Discussion

Considering the high frequency of impacted maxillary canines detected during initial radiographic evaluations in patients older than twelve years, this study prioritized investigating the presence of odontogenic

lesions as a potential cause of canine impaction, since such lesions can create mechanical obstacles to normal eruption [26-29]. In this context, dentigerous cysts, compound odontomas, and follicular sac enlargements were specifically assessed, as they are most frequently linked to impacted maxillary canines according to existing literature [29, 30]. Moreover, to gain a

comprehensive understanding of this complex condition, the study also examined the severity of canine impaction, alpha and beta angles, and impaction sector as relevant variables [31].

CBCT scans of patients over twelve years with impacted maxillary canines were analyzed, as maxillary canine eruption should typically be complete by this age. Impactions were categorized according to the Ericson and Kurol classification, which, despite being originally designed for panoramic radiographs, has been validated in studies using panoramic images derived from CBCT, confirming its reliability [22, 23, 24, 25]. It is important to note that all researchers involved were trained and calibrated to ensure accurate measurement of the evaluated variables.

Untreated canine impaction can lead to severe root resorption of adjacent teeth, highlighting the importance of radiographic assessment of canine eruption between ages 9 and 11, either as a diagnostic measure or for treatment planning [32-34]. Findings from this study indicate that palatally impacted canines most commonly occurred in sectors 3 and 5, whereas buccally impacted canines were more frequent in sectors 1 and 3 ($p = 0.001$). Clinicians should be aware of these patterns, even though odontogenic lesions associated with impaction predominantly involve buccally impacted canines. The study observed lesion frequencies of 7.5% for dentigerous cysts, 6.5 percent for follicular enlargement, and 3.5 percent for mesiodens, which, despite being relatively low, should be considered potential etiological factors by orthodontists.

The results have practical clinical relevance, given the limited evidence regarding the precise proportion of maxillary canine impactions caused by cystic lesions. Dentigerous cysts were identified in approximately 8% of cases, exclusively associated with buccal or mid-alveolar canine impactions, suggesting that such lesions are uncommon in palatal impactions. Furthermore, alpha and beta angles were shown to influence the likelihood of impacted canine presence. Specifically, each degree increase in the alpha angle was associated with a 1.22-fold higher risk of a dentigerous cyst ($p = 0.041$), whereas each degree increase in the beta angle reduced the risk by 18 percent ($p = 0.024$). These angular measures should therefore be considered in early treatment planning. Early diagnosis and intervention are critical for minimizing treatment complexity and preventing complications, including root resorption of adjacent teeth in cases of buccal or mid-alveolar impacted canines [32-34].

The scientific literature offers extensive guidance on measurement techniques, differentiating diagnoses

through radiographic and tomographic evaluation, classification and features of odontogenic lesions, interpretation of imaging results, and even genetic factors that can inform clinical strategies [35-38]. In line with this, our study provides practical data that may support the development of standardized approaches for assessing volumetric images, including positional and metric analyses, as well as establishing protocols for CBCT data management and storage.

The findings of this study suggest that the role of odontogenic lesions in the occurrence of maxillary canine impaction is minimal. Although these lesions can occasionally be involved in buccal or mid-alveolar impactions, there is no consistent or direct link, highlighting the need for additional research across diverse populations to further investigate these associations.

Conclusions

The contribution of odontogenic lesions to impacted maxillary canines is generally limited, predominantly involving dentigerous cysts and follicular enlargements, which are most frequently observed in buccal or mid-alveolar impactions. Additionally, angular measurements—specifically the alpha and beta angles—appear to modulate the risk of dentigerous cyst development, with higher alpha angles increasing the likelihood and higher beta angles reducing it.

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References

1. Becker A, Chaushu S. Etiology of maxillary canine impaction: A review. *Am J Orthod Dentofacial Orthop.* 2015;148(4):557–67. doi:10.1016/j.ajodo.2015.06.013
2. Kaczor-Urbanowicz K, Zadurska M, Czochrowska E. Impacted teeth: An interdisciplinary perspective. *Adv Clin Exp Med.* 2016;25(3):575–85. doi:10.17219/acem/37451
3. Sarica I, Derindag G, Kurtuldu E, Naralan ME, Caglayan F. A retrospective study: Do all impacted teeth cause pathology? *Niger J Clin Pract.* 2019;22(4):527–33. doi:10.4103/njcp.njcp_563_18

4. Açıkgöz A, Uzun-Bulut E, Özden B, Gündüz K. Prevalence and distribution of odontogenic and nonodontogenic cysts in a Turkish population. *Med Oral Patol Oral Cir Bucal.* 2012;17(1):e108–15. doi:10.4317/medoral.17088
5. Ericson S, Kurol J. Incisor resorption caused by maxillary cuspids. A radiographic study. *Angle Orthod.* 1987;57(4):332–46. doi:10.1043/0003-3219(1987)057<0332:IRCBMC>2.0.CO;2
6. Mayoral-Trias MA, Llopis-Perez J, Pérez AP. Comparative study of dental anomalies assessed with panoramic radiographs of Down syndrome and non-Down syndrome patients. *Eur J Paediatr Dent.* 2016;17(1):65–9. PMID:26949243.
7. Dağsuyu İM, Okşayan R, Kahraman F, Aydın M, Bayrakdar İŞ, Uğurlu M. The relationship between dental follicle width and maxillary impacted canines' descriptive and resorptive features using cone-beam computed tomography. *Biomed Res Int.* 2017;2017:2938691. doi:10.1155/2017/2938691
8. Jing W, Xuan M, Lin Y, Wu L, Liu L, Zheng X, et al. Odontogenic tumours: a retrospective study of 1642 cases in a Chinese population. *Int J Oral Maxillofac Surg.* 2007;36(1):20-5. doi:10.1016/j.ijom.2006.10.011. Epub 2006 Dec 6. PMID: 17156974.
9. Caprioglio A, Comaglio I, Siani L, Fastuca R. Effects of impaction severity of treated palatally displaced canines on periodontal outcomes: A retrospective study. *Prog Orthod.* 2019;20(1):5. doi:10.1186/s40510-018-0256-7
10. Paradowska-Stolarz A, Mikulewicz M, Duś-Ilnicka I. Current concepts and challenges in the treatment of cleft lip and palate patients – a comprehensive review. *J Pers Med.* 2022;12(12):2089. doi:10.3390/jpm12122089
11. Ariawan D, Vitria EE, Sulistyani LD, Anindya CS, Adrin NSR, Aini N, et al. Prevalence of Simonart's band in cleft children at a cleft center in Indonesia: A nine-year retrospective study. *Dent Med Probl.* 2022 Oct-Dec;59(4):509-15. doi:10.17219/dmp/145065. PMID: 36534430.
12. Ajami S, Shahidi S, Azadeh N, Jalali HN, Zare M. Difficulty of palatal impacted canine treatment in different sagittal and vertical skeletal malocclusions: A retrospective 3D evaluation. *Int Orthod.* 2020;18(1):89–95. doi:10.1016/j.ortho.2019.11.001
13. Hajeer MY, Al-Homsi HK, Alfaily DT, Murad RM. Evaluation of the diagnostic accuracy of CBCT-based interpretations of maxillary impacted canines compared to those of conventional radiography: An in vitro study. *Int Orthod.* 2022;20(2):100639. doi:10.1016/j.ortho.2022.100639
14. Dhupar A, Yadav S, Dhupar V, Mittal HC, Malik S, Rana P. Bi-maxillary dentigerous cyst in a non-syndromic child – review of literature with a case presentation. *J Stomatol Oral Maxillofac Surg.* 2017;118(1):45–8. doi:10.1016/j.jormas.2016.12.001
15. Nahajowski M, Hnitecka S, Antoszevska-Smith J, Rumin K, Dubowik M, Sarul M. Factors influencing an eruption of teeth associated with a dentigerous cyst: A systematic review and meta-analysis. *BMC Oral Health.* 2021;21(1):180. doi:10.1186/s12903-021-01542-y
16. Sivasankar V, Ranganathan K, Praveen B. Keratinizing dentigerous cyst. *Contemp Clin Dent.* 2014;5(1):127–9. doi:10.4103/0976-237X.128691
17. Mousa MR, Hajeer MY, Burhan AS, Heshmeh O. The effectiveness of conventional and accelerated methods of orthodontic traction and alignment of palatally impacted canines in terms of treatment time, velocity of tooth movement, periodontal, and patient-reported outcomes: A systematic review. *Cureus.* 2022;14(5):e24888. doi:10.7759/cureus.24888
18. da Silva VAdA, Pedreira RdPG, Sperandio FF, Nogueira DA, de Carli ML, Hanemann JAC. Odontomas are associated with impacted permanent teeth in orthodontic patients. *J Clin Exp Dent.* 2019;11(9):e790–4. doi:10.4317/jced.56101
19. Aher V, Chander PM, Chikkalingaiah RG, Ali FM. Dentigerous cysts in four quadrants: A rare and first reported case. *J Surg Tech Case Rep.* 2013;5(1):21–6. doi:10.4103/2006-8808.118607
20. Chaushu S, Kaczor-Urbanowicz K, Zadurska M, Becker A. Predisposing factors for severe incisor root resorption associated with impacted maxillary canines. *Am J Orthod Dentofacial Orthop.* 2015;147(1):52–60. doi:10.1016/j.ajodo.2014.09.012
21. Grisar K, Piccart F, Al-Rimawi AS, Basso I, Politis C, Jacobs R. Three-dimensional position of impacted maxillary canines: Prevalence, associated pathology and introduction to a new classification system. *Clin Exp Dent Res.* 2019;5(1):19–25. doi:10.1002/cre2.151
22. Ericson S, Kurol J. Radiographic assessment of maxillary canine eruption in children with clinical signs of eruption disturbance. *Eur J Orthod.* 1986;8(3):133–40. doi:10.1093/ejo/8.3.133
23. Arriola-Guillén LE, Ruíz-Mora GA, Rodríguez-Cárdenas YA, Aliaga-Del Castillo A, Boessio-

- Vizzotto M, et al. Influence of impacted maxillary canine orthodontic traction complexity on root resorption of incisors: A retrospective longitudinal study. *Am J Orthod Dentofacial Orthop.* 2019;155(1):28–39. doi:10.1016/j.ajodo.2018.02.011
24. Melchor-Soto ME, Arriola-Guillén LE, Aliaga-Del Castillo A, Ruíz-Mora GA, Rodríguez-Cárdenas YA. Root morphology of lateral incisors adjacent to impacted maxillary canines: A cone-beam computed tomography retrospective cross-sectional study. *Int Orthod.* 2022;20(4):100692. doi:10.1016/j.ortho.2022.100692
25. Rodríguez-Cárdenas YA, Arriola-Guillén LE, Aliaga-Del Castillo A, Ruíz-Mora GA, Janson G, Cevitanes L, et al. Three-dimensional changes in root angulation of buccal versus palatal maxillary impacted canines after orthodontic traction: A retrospective before and after study. *Int Orthod.* 2021 Jun;19(2):216–27. doi: 10.1016/j.ortho.2021.04.003. PMID: 33967011.
26. Pillai A, Moghe S, Gupta MK, Pathak A. A complex odontoma of the anterior maxilla associated with an erupting canine. *BMJ Case Rep.* 2013;2013:bcr2013200684. doi:10.1136/bcr-2013-200684
27. Ravi I, Srinivasan B, Kailasam V. Radiographic predictors of maxillary canine impaction in mixed and early permanent dentition – a systematic review and meta-analysis. *Int Orthod.* 2021;19(4):548–65. doi:10.1016/j.ortho.2021.07.005
28. Lin HP, Wang YP, Chen HM, Cheng SJ, Sun A, Chiang CP. A clinicopathological study of 338 dentigerous cysts. *J Oral Pathol Med.* 2013;42(6):462–467. doi:10.1111/jop.12042
29. Allison JR, Garlington G. The value of cone beam computed tomography in the management of dentigerous cysts – a review and case report. *Dent Update.* 2017;44(3):182–4. doi:10.12968/denu.2017.44.3.182
30. Kämmerer PW, Schneider D, Schiegnitz E, Schneider S, Walter C, Frerich B, et al. Clinical parameter of odontoma with special emphasis on treatment of impacted teeth—a retrospective multicentre study and literature review. *Clin Oral Investig.* 2016;20(7):1827–35. doi: 10.1007/s00784-015-1673-3. PMID: 26612404.
31. Alejos-Montante K, Martínez-Zumarán A, Torre-Delgadillo G, Rosales-Berber MÁ, Garrocho-Rangel A, Pozos-Guillén A. Early identification of permanent maxillary canine impaction: A radiographic comparative study in a Mexican population. *J Clin Exp Dent.* 2019;11(3):e282–6. doi:10.4317/jced.55285
32. Ismail AF, Sharuddin NFA, Asha'ari NH, Ali MAM, Zainol IZ, Alotaibi LH, et al. Risk Prediction of Maxillary Canine Impaction among 9-10-Year-Old Malaysian Children: A Radiographic Study. *Biomed Res Int.* 2022;2022:5579243. doi: 10.1155/2022/5579243. PMID: 36119931; PMCID: PMC9481328.
33. Lai CS, Bornstein MM, Mock L, Heuberger BM, Dietrich T, Katsaros C. Impacted maxillary canines and root resorptions of neighbouring teeth: A radiographic analysis using cone-beam computed tomography. *Eur J Orthod.* 2013;35(4):529–38. doi:10.1093/ejo/cjs037
34. Shin JH, Oh S, Kim H, Lee E, Lee SM, Ko CC, et al. Prediction of maxillary canine impaction using eruption pathway and angular measurement on panoramic radiographs. *Angle Orthod.* 2022;92(1):18–26. doi: 10.2319/030121-164.1. PMID: 34929035; PMCID: PMC8691482.
35. Alhummayani FM, Mustafa ZA. A new guide using CBCT to identify the severity of maxillary canine impaction and predict the best method of intervention. *J Orthod Sci.* 2021;10:3. doi:10.4103/jos.JOS_41_20
36. Vitria EE, Tofani I, Kusdhany L, Bachtiar EW. Genotyping analysis of the Pax9 gene in patients with maxillary canine impaction. *F1000Res.* 2019;8:254. doi:10.12688/f1000research.17147.1
37. Aquino-Valverde AJ, Barrientos-Sanchez DM, Atoche-Socola KJ. Orthodontic treatment in impacted maxillary canines. A review of the literature. *Rev Cient Odontol (Lima).* 2021;9(4):e085. doi:10.21142/2523-2754-0904-2021-085
38. Díaz-Reissner C, Pistilli E, Cajé R, Maldonado C, Jolay E, Ferreira-Gaona M. Prognosis of impacted canines according to their position in the upper maxillary using different radiographic analyzes [in Spanish]. *Rev Cient Odontol (Lima).* 2022;10(1):e096. doi:10.21142/2523-2754-1001-2022-096