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A Narrative Review of The Impact of Impacted Maxillary Canines on Adjacent Tooth Root Resorption Using Cone Beam Computed Tomography

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ABSTRACT

Cone beam computed tomography (CBCT) is widely used for diagnosis and treatment planning in dentistry. Before being identified, CBCT scans of those impacted teeth can disclose traits. After the third molar, the tooth that is most often retained in the maxilla is the upper canine. The predominant adverse and detrimental consequence of maxillary canine impaction is the surrounding teeth's root resorption (RR), which results in severe damage and may even cause tooth loss. The impact of impacted maxillary canines (IMC) on root resorption of adjacent teeth was assessed in this narrative review by collecting several articles from a variety of sources, including manual cross-reference and textbook searches and electronic databases like PubMed, SCOPUS, COCHRANE library, and Science Direct. MeSH terms and keywords about root resorption, impacted maxillary canines, and cone beam computed tomography were used in the search. Following a comprehensive evaluation of the collected articles, fifty-three articles were chosen for this review.

KEYWORDS: Impacted maxillary canine, cone beam computed tomography (CBCT), root resorption.

1. INTRODUCTION

An impacted tooth does not erupt in the dental arch at the proper location during its normal eruption phase [1]. The most often impacted teeth, after third molars, are maxillary canines, which vary in frequency from 0.9% to 3.0% based on the population under study[2,3]. Although many authors reported varied locations for impacted canines, most investigators found that the canines were impacted palatally by 41-90% [4,5]. Research has shown that women experience impacted maxillary canines twice as frequently as men do [6]. Confirming the canine impaction always requires a radiographic assessment[7]. Radiographic methods, such as occlusal films, panoramic views, and lateral cephalometric radiographs, can be used to assess the canine position. With conventional radiographs, the visibility of impacted teeth may be somewhat restricted due to superimposition problems. Superior tissue contrast is made possible by three-dimensional (3D) volumetric imaging techniques, which also make it possible to locate impacted canines based on their spatial relationships. The use of CBCT in dental diagnoses and treatment planning has grown significantly. Because of its better image resolution and lower radiation exposure compared to computed tomography scans, CBCT is preferred when it comes to patient care [8]. Its cross-sectional imaging in three dimensions removes superimposition and distortion. Impacted canines can result in problems such as internal and external resorption of adjacent teeth, tooth displacement, loss of vitality, shortening of the dental arch, follicular cyst formation, ankyloses, recurrent infections and discomfort [9]. For preventing asymptomatic issues and implementing preventative interventions, like eliminating deciduous canines, early detection and clinical examination are essential [10]. One of the biggest challenges an

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orthodontist faces in terms of aesthetics and functionality is diagnosing and interpreting canine impaction. Several studies have tried to anticipate the direction of the canine eruption to avoid impaction by starting early intervention [11, 12]. There has been little research monitoring the effect of impacted canines on the resorption of adjacent teeth using CBCT. Therefore, the research question arises of how much root resorption occurs and where it occurs either vertically (apical, middle orcoronal) or horizontally (palatal, buccal, mesial, or distal).

2. METHODOLOGY

In this narrative review study, PRISMA-S—an addition to the PRISMA Statement for Reporting Literature Searches in Systematic Reviews—was utilized [13]. Several electronic databases were searched in 2024, as described in Table 1. We manually examined textbooks and cross-references for pertinent papers in addition to the electronic searches.

- **Table 1: Research engines with Mesh terms used.**

Research engine	MeSH term
PubMed	impacted canine, cone beam computed tomography
SCOPUS	impacted canine, root resorption
COCHRANE Library	cone beam computed tomography, impacted canine
Science Direct	impacted canine, root resorption

2.1. Eligibility Criteria

1. **Inclusion criteria:** The studies included in this narrative review were written in English and published between June 2016 and June 2024. For all the included studies, root resorption of teeth adjacent to impacted canines was assessed.
2. **Exclusion criteria:** This narrative review excludes studies that were published before June 2016 and June 2024, non-English manuscripts and case reports, and studies that did not use CBCT.

Fifty-three papers met the study's criteria and were selected for examination after the full texts were assessed and the inclusion and exclusion criteria were applied. Fig 1.

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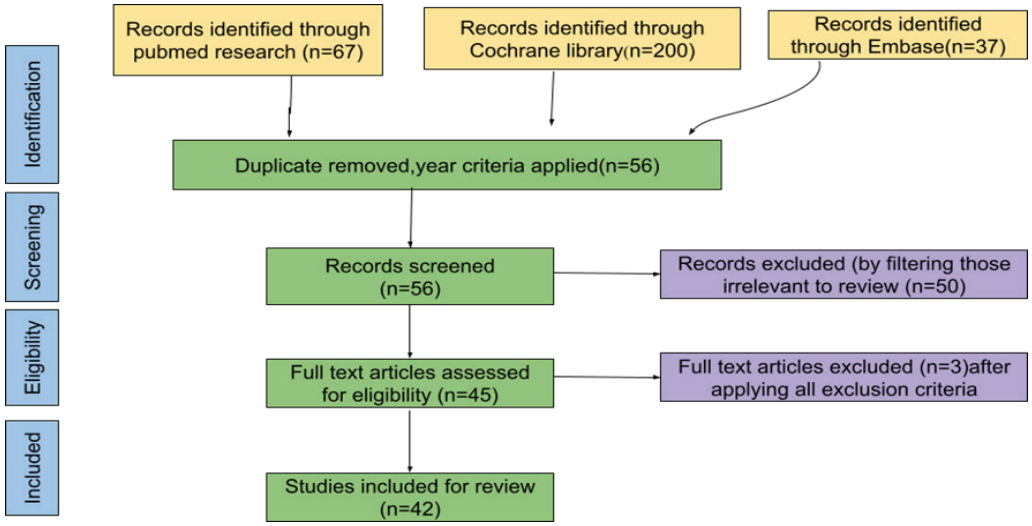

Fig 1: flowchart of study selection

3. IMPACTED CANINE INCIDENCE AND PREDOMINANCE

The majority of studies discovered that impaction of the maxillary canines occurred twice as frequently in females as in males. Impacted maxillary canines are more commonly displaced palatally than labially [14]. However, it was clear that Asians had more palatal than buccal canine impactions [15]. This may be due to different ethnic backgrounds.

4. ETIOLOGY OF IMPACTED CANINE

The specific cause of this anomaly is unknown. Genetic and environmental predisposing factors that disrupt the canine's eruption course have been identified, including odontomas, supernumerary teeth, congenitally absent lateral incisors, and other abnormalities [16]. Orthodontic therapy outcomes are greatly enhanced by early impaction identification since early management decreases or eliminates the consequences of impaction [17].

5. DIAGNOSTIC MODALITIES FOR IMPACTED CANINE

The diagnosis of impacted canines has traditionally been made using traditional two-dimensional methods (such as cephalometric, panoramic, periapical, and occlusal). However, due to the superimposition of structures in the film, the complication of maxillofacial structures, and the proximity between incisors, it has been very difficult to identify and determine root resorption. Numerous investigations have shown that two-dimensional (2D) intraoral radiography is ineffective in detecting root resorption that is less than 0.6 mm in diameter and 0.3 mm in depth [18]. On the other hand, panoramic dental x-rays can only be used to predict severe root resorption [19]. Because root resorption happens in three dimensions, 2D images are unable to quantify the amount of root loss or identify root resorption on the buccal or lingual surfaces. As a result, depending only on 2D pictures has attracted criticism [20].

In most circumstances, more than one radiograph is required [21. 22]. Impacted canines often have an inaccurate longitudinal axis. Distortion, artifacts, and magnification are also

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frequent. Evidence indicates that despite the presence of a highly skilled operator, numerous misdiagnoses and mishandlings nevertheless occurred. Spiral computed tomography (CT) scans are being used by several operators to get around these issues. Excellent tissue contrast and exact three-dimensional pictures are made feasible by this approach, but two major difficulties still exist: the relatively high radiation dosage and the high cost [23].

6. RELIABILITY OF CBCT IN DIAGNOSING IMPACTED CANINE

CBCT surpasses the drawbacks of two-dimensional (D) methods and provides more accurate results [24, 25]. It has an advantage over conventional dental radiography in that it provides more information, which should enable a more precise radiographic examination. The most frequent requests for CBCT scans in children and young adults were to evaluate an ectopic canine and check for neighboring tooth resorption [26]. CBCT showed better detection rates of root resorption associated with impacted canines when compared to plain film radiographs [24]. The root structure is clearly visible on CBCT, which leads to a more precise qualitative assessment of root resorption. For the RR study, CBCT provided more precise and dependable 3D measurements of the tooth and root resorption volumes [27, 28]. Achieving a favorable treatment outcome requires early detection of RR [29]. Nevertheless, it is particularly essential to choose a voxel size that minimizes radiation exposure without significantly compromising the diagnostic accuracy of cone beam computed tomography (CBCT). The 300 μm voxel size can be employed effectively for the diagnosis of root resorption abnormalities with the least amount of radiation to the patient and the shortest scanning time, given that all voxel sizes have equivalent diagnostic performance [30]. Volumetric measures in RR-simulated lesions can be greatly altered by using CBCT techniques with varying voxel sizes, whereas FOV doesn't seem to have much of an impact on the RR volumetric determination. To prevent underestimating or overestimating the size of the lesion, voxel size should be standardized in CBCT image capture techniques. This would help in clinical treatment decision-making for RR [31].

7. ROOT RESORPTION ASSOCIATED WITH IMPACTED CANINE

The most common unfavorable, permanent and detrimental effect of maxillary canine impaction is RR, which destroys neighboring teeth permanently and may result in tooth loss, especially in the lateral incisors [32]. Maxillary lateral incisor root resorption brought on by impacted canines happens commonly [33, 34]. Tooth-resorbing cells produce problems with the teeth that can lead to cementum or dentin loss. The etiology is unknown, and treatment is challenging. Several potential risk factors have been proposed, including the patient's gender, the canine's apex, the vertical location of the canine crown, canine magnification, and the canine's distance from the midline [35]. An additional risk factor for lateral incisor root resorption in impacted canines may be thinner alveolar bone thickness at the apical location of the incisors [36]. Practically all cases of root resorption happen where the impacted canine and adjacent teeth meet, suggesting that close contact may be the root resorption's etiology [18]. Because impacted canine-associated RR rarely exhibits symptoms, it is commonly misdiagnosed [37, 38]. The complexities of craniofacial anatomy might make resorption difficult to diagnose with conventional methods. Implementing a recommended treatment plan for incisor RR may also be legally possible using CBCT [39]. Because CBCT eliminates overlapping and blurring from neighboring teeth, it significantly enhances the detection of root resorption. Because CBCT is much more sensitive than conventional x-rays, it can accurately identify the position and extent of resorption cavities [40]. In [41] graded resorptions

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into four categories.

A. No resorption, resulting in undamaged root. The cementum layer could be lost (Fig. 2).

B. Dentine maybe resorbed up to 50% of its thickness to the pulp (Fig. 3).

C. Moderate resorption occurs when the pulp lining remains intact (Fig. 4).

D. Severe resorption (exposing the pulp).

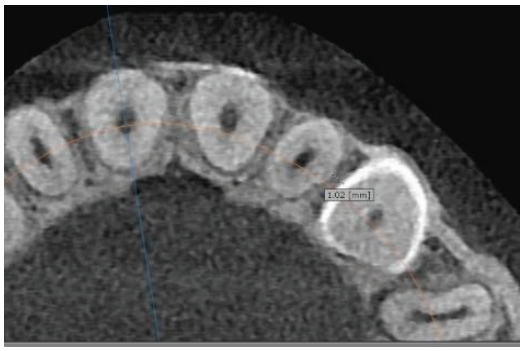

Fig. 2: No resorption—intact root surfaces. There is no contact between the lateral incisor and the impacted canine with a distance of 1.02 mm.

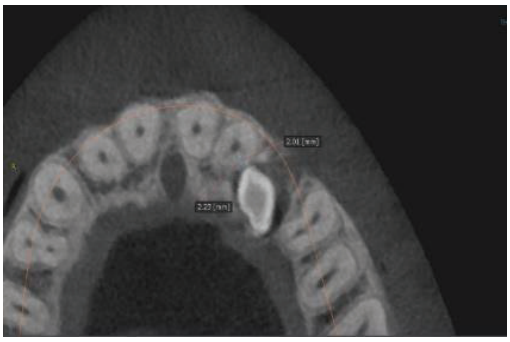

Fig. 3: Shows minimal dentine thickness resorption up to 50%.

Fig. 4: Shows moderate resorption.

Resorption in lateral incisors is more common than in central incisors due to impacted maxillary canines [42, 43]. Nevertheless, different researchers showed different outcomes

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depending on whether computed tomography (CT) or cone-beam computed tomography (CBCT) scans were used. There was very little difference between lateral (53.3%) and central (46.7%) incisor resorption in a follow-up CBCT study involving 105 incisors displaying resorption symptoms [44]. According to findings by other articles, of the 35 lateral incisors that were diagnosed, 74.2% showed signs of resorption [45].

8. LOCATION OF RESORPTION

The vertical and transverse positions, as well as the depth of root resorption found on CBCT images, are simply and clearly described by the Three-Dimensional Leeds Orthodontic Root Resorption Target Scale (3-D-LORTS) [46]. There are three parts to the scale: depth, transverse position, and vertical position. First, the resorption's vertical location with respect to the root's long axis is as follows: the apical third is represented by V_1, the mid-third by V_2, and the coronal third by V_3. Second, the following transverse dimensions were noted: buccal=TB; palatal =TP; mesial=TM; distal=TD. Next, the depth of the resorption-affected lesion was noted: 1 = contact with cementum layers; 2 = 50% depth of outer dentine; 3 = 50% depth of inner dentine; 4 = involvement of the pulp.

9. VERTICAL POSITION OF LATERAL INCISOR ROOT RESORPTION

Resorption of the roots can occur on any surface or level of the tooth, depending on the maxillary canine's displacement. Studies have revealed that the middle third of the adjacent tooth exhibits root resorption [47]. However, other research, such as a recent systematic review and meta-analysis, revealed that the apical third of the tooth related to an impacted maxillary canine is where root resorption most frequently happens [48-50].

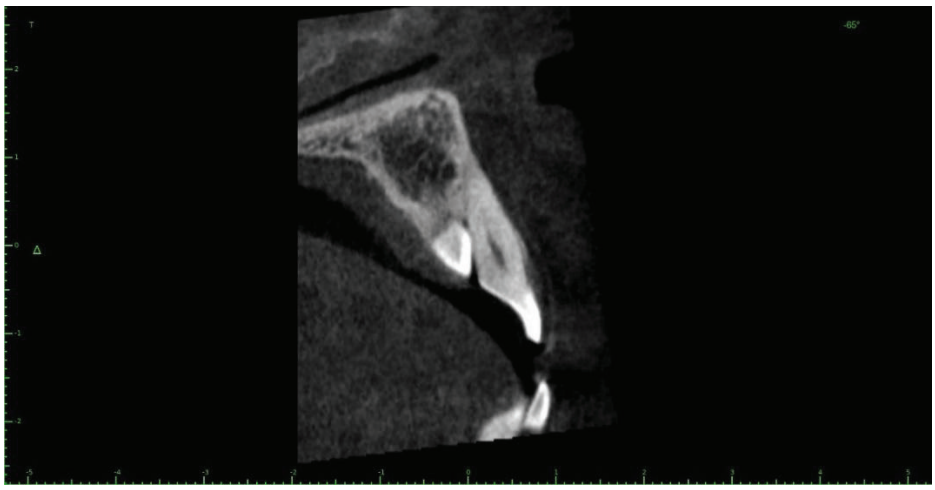

Fig. 5: The vertical position of the resorption relative to the long axis of the root, resorption presented in the middle third.

10. HORIZONTAL POSITION OF LATERAL INCISOR ROOT RESORPTION

Any root has resorption occurring on its surface [50]. According to [51], the eruption path of the erupting maxillary canine is implied to be in the palatal direction, with the crown of

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the canine being directed palatally regarding the primary canine and developing first premolar. This may explain why the greatest root resorption is associated with the apical one-third level and the palatal surface of the tooth's roots engaged in maxillary canine impaction [51].

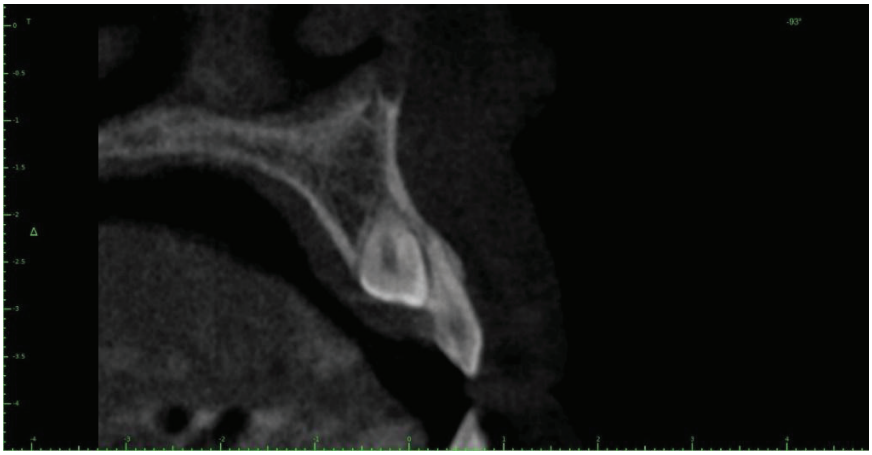

Fig. 6: Cone beam computed tomography (CBCT) scan showing resorption on the palatal surface of the upper lateral incisor.

11.CONCLUSION

There is a high significant, mild degree of root resorption exhibited at the apical-one third of the lateral incisor palatally when the distance between the impacted canine and the lateral incisor is less than 0.5 mm [52]. The resorption of impacted maxillary canines on neighboring teeth is clearly visible on CBCT. For an appropriate diagnosis and treatment approach, the CBCT examination of impacted maxillary canines is therefore essential [53].

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Conflicts of interest

The authors declare no conflicts of interest

Recommendation

This narrative review indicates that to prevent adjacent teeth's roots from resorbing, early intervention for impacted canines is recommended.

REFERENCE

[1.] Peralta-Mamani M, Rubira CM, López-López J, Honório HM, Rubira-Bullen IR. CBCT vs panoramic radiography in the assessment of impacted upper canine and root resorption of the adjacent teeth: A systematic review and meta-analysis. Journal of clinical and experimental dentistry. 2024; 16:198-222. doi.org/10.4317/jced.61285

[2.] 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. Clinical and experimental dental research. 2019;5: 19-25. doi.org/10.1002/cre2.151.

Online ISSN: 3009-7800
Print ISSN: 3009-6324

[3.] Di Carlo, G., Saccucci, M., Luzzi, V., Ierardo, G., Vozza, I., Sfasciotti, G. L., & Polimeni, A.Prevalence of maxillary canine impaction in skeletal Class III malocclusions compared to Class I malocclusions. Journal of Clinical and Experimental Dentistry. 2019;11: 264 - 68. doi.org/10.4317/jced.55478

[4.] Jain S, Debbarma S. "Patterns and prevalence of canine anomalies in orthodontic patients." Medicine and Pharmacy Reports .2019;92:72-8. doi.org/10.15386/cjmed-907

[5.] Alyami, B., Braimah, R. and Alharieth, S. Prevalence and pattern of impacted canines in Najran, South Western Saudi Arabian population. Saudi Dental Journal, King Saud University.2019;32: 300–305. doi.org/10.1016/j.sdentj.2019.10.002

[6.] Sathiyamoorthy, S. and Ravindra, J. Prevalence of maxillary canine impaction and associated factors in class I and class II malocclusion- a retrospective study. European Journal of Molecular and Clinical Medicine.2020;7:1964–69.doi.org/2515-8260

[7.] Dinu Ş, Todor L, Zetu IN, et al. Radiographic methods for locating impacted maxillary canines. Rom J Morphol Embryol. 2022;63:599-606. doi:10.47162/RJME.63.4.01

[8.] Mohammed, A.K., Sravani, G., Vallappareddy, D., Rao, A.R., Qureshi, A. and Prasad, A.N. Localization of Impacted Canines - A Comparative Study of Computed Tomography and Orthopantomography Journal of Medicine and Life.2020;13:56–63. doi.org/10.25122/jml-2020-0001.

[9.] Guarnieri, R., Cavallini, C., Vernucci, R., Vichi, M., Leonardi, R., & Barbato, E.Impacted maxillary canines and root resorption of adjacent teeth: A retrospective observational study. Medicina oral, patologia oral y cirugia buccal.2021;21:743-50. https://doi.org/10.4317/medoral.21337

[10.] Akkuc, S., Duruk, G., & Duman, S. Evaluation of impacted canines' localization and adjacent lateral incisors' root resorption with orthopantomography and cone-beam computed tomography. Oral radiology.2021; 37,476–86. https://doi.org/10.1007/s11282-020-00482-7

[11.] Padisar, P., Tofangchiha, M., Salari, B. and Oveisi, S. Comparison of Three-Dimensional and Conventional Orthodontic Imaging Modalities for Localization of Impacted Maxillary Canines in Patients with Alveolar Cleft. Cleft Palate-Craniofacial Journal.2021;58:202– 07.doi.org/10.1177/1055665620946

[12.] Andresen, A.K.H., Jonsson, M. V., Sulo, G., Thelen, D.S. and Shi, X.-Q.Radiographic features in 2D imaging as predictors for justified CBCT examinations of canine-inducedroot.resorption.Dentomaxillofacial.Radiology.2022;51.doi.org/10.1259/dmfr.20210165.

[13.] Rethlefsen, M. L., Kirtley, S., Waffenschmidt, S., Ayala, A. P., Moher, D., Page, M. J., Koffel, J. B., & PRISMA-S Group. PRISMA-S: an extension to the PRISMA statement for reporting literature searches in systematic reviews. Journal of the Medical Library Association .2021;109:174-200. doi:10.5195/jmla.2021.962

Online ISSN: 3009-7800
Print ISSN: 3009-6324

[14.] Leonardi, R., Muraglie, S., Crimi, S., Pirroni, M., Musumeci, G. and Perrotta, R. Morphology of palatally displaced canines and adjacent teeth, a 3-D evaluation from cone-beam computed tomographic images.BMC.Oral.Health.2018;18:1–9. doi.org/10.1186/s12903-018-0617-0

[15.] Koc, N., Boyacioglu Dogru, H., Cagirankaya, L.B., Dural, S. and van der Stelt, P.F. CBCT assessment of gubernacular canals in relation to eruption disturbance and pathologic condition associated with References 106 impacted/unerupted teeth", Oral Surgery,Oral Medicine, Oral Pathology and Oral Radiology.2019;127:175–84. doi.org/10.1016/j.oooo.2018.09.007

[16.] Koral, S., Özçırpıcı, A.A. and Tunçer, N.İ.Association Between Impacted Maxillary Canines and Adjacent Lateral Incisors: A Retrospective Study With Cone Beam Computed.Tomography.Turkish.Journal.of.Orthodontics.2021;34:207–13. doi.org/10.5152/TurkJOrthod.2021.20148

[17.] Hamada Y, Timotheus CJC, Shin D, John V. Canine impaction - A review of the prevalence, etiology, diagnosis and treatment. Seminars in Orthodontics.2019;25:117-23. doi.org/10.1053/j.sodo.2019.05.002

[18.] Ucar F, Celebi A, Tan E, Topcuoğlu T, Sekerci A. Effects of impacted maxillary canines on root resorption of lateral incisors. Journal of Orofacial Orthopedics. 2017;78:233-40. doi.org/10.1007/s00056-016-0077-6

[19.] Sosars P, Jakobsone G, Neimane L, Mukans M. Comparative analysis of panoramic radiography and cone-beam computed tomography in treatment planning of palatally displaced canines. American journal of orthodontics and dentofacial orthopedics. 2020;157:719-27. Doi.org/10.1016/j. ajodo.

[20.] Sarica I, Derindag G, Kurtuldu E, Naralan ME, Caglayan F. A retrospective study: Do all impacted teeth cause pathology? Nigerian Journal of Clinical Practice. 2019;22:527-33. Doi.org/10.4103/njcp.njcp_563_18.

[21.] Dağsuyu İM, Kahraman F, Okşayan R. Three-dimensional evaluation of angular, linear, and resorption features of maxillary impacted canines on cone-beam computed tomography. Oral Radiology. 2018;34:66-72. doi.org/10.1007/s11282-017-0289-5

[22.] Moshfeghi M, Hosseini M, Eslamiamirabadi N, Biria M. Predictors of root resorption in lateral incisors adjacent to maxillary impacted canines in CBCT images: A retrospective study.Research Square .2022.doi.org/10.21203/rs.3.rs-1527122/v1

[23.] Kim S-H, Kim Y-M, Oh S, Kim S-S, Park S-B, Son W-S, et al. How far is the root apex of a unilateral impacted canine from the root apices' arch form? American Journal of Orthodontics and Dentofacial Orthopedics.2017;151:351-6. doi.org/10.1016/j.ajodo.

[24.] De Grauwe A, Ayaz I, Shujaat S, Dimitrov S, Gbadegbegnon L, Vande Vannet B, et al. CbCT in orthodontics: a systematic review on Justification of CBCT in a paediatric population prior to orthodontic treatment. European Journal of Orthodontics .2019; 41: 381–9. doi.org/10.1093/ejo/cjy066

Online ISSN: 3009-7800
Print ISSN: 3009-6324

[25.] Oenning AC, Jacobs R, Pauwels R, Stratis A, Hedesiu M, Salmon B, et al. Cone-Beam CT in paediatric dentistry: DIMITRA project position statement. Pediatric Radiology. 2018; 48: 308–16. doi.org/10.1007/s00247-017-4012-9

[26.] Hajem S, Brogårdh-Roth S, Nilsson M, Hellén-Halme K. Cbct of Swedish children and adolescents at an oral and maxillofacial radiology department. A survey of requests and indications.Acta.odontologica.Scandinavica.2020;78:38-44.doi.org/10.1080/00016357.2019.1645879

[27.] Alfaleh W, Al Thobiani S. Evaluation of impacted maxillary canine position using panoramic radiography and cone beam computed tomography. The Saudi Dental Journal. 2021;33:738-44. doi.org/10.1016/j.sdentj.2020.03.014

[28.] Tsolakis, A. I., Kalavritinos, M., Bitsanis, E., Sanoudos, M., Benetou, V., Alexiou, K., & Tsiklakis, K. . Reliability of different radiographic methods for the localization of displaced maxillary canines. American journal of orthodontics and dentofacial orthopedics.2018;153: 308–14. https://doi.org/10.1016/j.ajodo.2017.06.026

[29.] Hamada, Y., Timotheus, C.J., Shin, D., John, v. Canine impaction – A review of the prevalence, etiology, diagnosis, and treatment. Seminars in orthodontics. 2019;25:117-23. https://doi.org/10.1053/j.sodo.2021.03.002

[30.] Nikneshan S, Valizadeh S, Javanmard A, Alibakhshi L. Effect of Voxel Size on Detection of External Root Resorption Defects Using Cone Beam Computed Tomography.Iranian.Journal.of.radiology.2016;13.https://doi.org/10.5812/iranjradiol.34985

[31.] Da Silveira PF, Fontana MP, Oliveira HW, Vizzotto MB, Montagner F, Silveira HL, Silveira HE. CBCT-based volume of simulated root resorption - influence of FOV and voxel size. International.endodontic.journal.2016;48:959-65. doi:10.1111/iej.12390

[32.] Dağsuyu İM, Kahraman F, Okşayan R. Three-dimensional evaluation of angular, linear, and resorption features of maxillary impacted canines on cone-beam computed tomography. Oral Radiology. 2018;34:66-72. doi.org/10.1007/s11282-017-0289-5

[33.] Goodarzi Pour, D., Golshani, S., Kheirandish, Y., & Aliasghari, S. Reliability of Cone-Beam Computed Tomography in Diagnosis of Root Resorption Due to Impacted Maxillary Canine. Avicenna Journal of Dental Research.2022;14:176-80.Doi.org/10.34172/ajdr.2022.1591

[34.] Al-Kyssi, Hana'a A et al. Predictive factors associated with adjacent teeth root resorption of palatally impacted canines in Arabian population: a cone-beam computed tomography analysis.BMC oral health.2022;22.Doi.org/10.1186/s12903-022-02249-4.

[35.] Razeghinejad, M. H., Bardal, R., Shahi, S., Mortezapoor, E., & Mostafavi, M. (2022). Volumetric Evaluation of Maxillary Lateral Incisor Root Resorption due to Positional Variations of Impacted Canine. International journal of dentistry, 2022. https://doi.org/10.1155/2022/2626222

Online ISSN: 3009-7800
Print ISSN: 3009-6324

[36.] Sun, W., Yang, Y., Liu, C., Li, H., & Lei, L. Influence of alveolar bone thickness and bucco-palatal inclination on root resorption of lateral incisors in unilateral maxillary impacted canines: a retrospective observational study. BMC Oral Health.2024;24:301. https://doi.org/10.1186/s12903-024-04076-1

[37.] Rafflenbeul, F., Gros, C.I., Lefebvre, F., Bahi-Gross, S., Maizeray, R. and Bolender, Y. Prevalence and risk factors of root resorption of adjacent teeth in maxillary canine impaction, among untreated children and adolescents", European Journal of Orthodontics, 2019; 41: 447–53. doi.org/10.1093/ejo/cjy078

[38.] Ardakani MP, Nabavizadeh A, Iranmanesh F, Hosseini J, Nakhaei M. Relationship of angulation of maxillary impacted canines with maxillary lateral incisor root resorption. Pesquisa Brasileira em Odontopediatria e Clínica Integrada. 2021;21:164. doi.org/10.1590/pboci.2021.070

[39.] Ali, I.H., Al-Turaihi, B.A., Mohammed, L.K. and Alam, M.K.Root Resorption of Teeth Adjacent to Untreated ImpactedMaxillary Canines: A CBCT Study", BioMed Research International.2021;6:1–8. doi.org/10.1155/2021/6635575

[40.] Deng Y, Sun Y, Xu T. Evaluation of root resorption after comprehensive orthodontic treatment using cone beam computed tomography (CBCT): a meta-analysis. BMC Oral Health. 2018;18:116. doi:10.1186/s12903-018-0579-2

[41.] Emad, M., Refat, H., Abd-Alfattah, A.,ELgameay, W ,E. Effect of Different Angulations of Impacted Maxillary Canine on Root Resorption of lateral incisor Using Cone Beam Computed Tomography: A Retrospective Study. Dental science updates.2024;5:1:109-115. Doi:10.21608/dsu.2024.205342.1170.

[42.] Yilmaz, H., Ozlu, F.C., Icen, M. and Icen, E.Impacted maxillary canines and their relationship with lateral incisor resorption: A cone beam computed tomography (CBCT) study", Australasian Orthodontic Journal.2020;36:160–7. doi.org/10.21307/aoj-2020-018

[43.] Aktı, A., Dolunay, U., Kaya, D. I., Gürses, G., & Yeşil, D. Evaluation of the Relationship between Impacted Maxillary Canine Teeth and Root Resorption in Adjacent Teeth: A Cross-Sectional Cone Beam Computed Tomography Study. Diagnostics.(Basel,Switzerland), 2024;14:1470.https://doi.org/10.3390/diagnostics14141470

[44.] Simić S, Nikolić P, Stanišić Zindović J, Jovanović R, Stošović Kalezić I, Djordjević A, et al. Root resorptions on adjacent teeth associated with impacted maxillary canines. Diagnostics. 2022;12:380. doi.org/10.3390/diagnostics12020380

[45.] Kalavritinos, M., Benetou, V., Bitsanis, E., Sanoudos, M., Alexiou, K., Tsiklakis, K. and Tsolakis, A.I.Incidence of incisor root resorption associated with the position of the impacted maxillary canines: A cone-beam computed tomographic study.American Journal.of.Orthodontics.and.Dentofacial.Orthopedics.2020;157:73–9. doi.org/10.1016/j.ajodo.2019.02.016

Online ISSN: 3009-7800
Print ISSN: 3009-6324

[46.] Jawad Z, Carmichael F, Houghton N, Bates C. A review of cone beam computed tomography for the diagnosis of root resorption associated with impacted canines, introducing an innovative root resorption scale. Oral Surgery Oral Medicine Oral Pathology Oral Radiology. 2016;122:765-71. doi:10.1016/j.oooo.2016.08.015

[47.] Mitsea, A., Palikaraki, G., Karamesinis, K., Vastardis, H., Gizani, S., & Sifakakis, I. Evaluation of Lateral Incisor Resorption Caused by Impacted Maxillary Canines Based on CBCT: A Systematic Review and Meta-Analysis. Children. (Basel, Switzerland).2022; 9:1006. https://doi.org/10.3390/children9071006

[48.] Schroder, A.G.D., Guariza-Filho, O., de Araujo, C.M., Ruellas, A.C., Tanaka, O.M. and Porporatti, A.L. To what extent are impacted canines associated with root resorption of the adjacent tooth?.Journal of the American Dental Association. 2018;149:765-77. doi.org/10.1016/j.adaj.2018.05.012.

[49.] Al-Ansari, N.B. and Nahidh, M. Association Between Maxillary Impacted Canine Position and Root Resorption of the Adjacent Incisors : A CT Study.Journal of Al Rafidain University College.2016;38:16–32. DOI: 10.55562/jrucs.v38i2.224

[50.] Alemam, A. A., Abu Alhaija, E. S., Mortaja, K., & AlTawachi, A. (2020). Incisor root resorption associated with palatally displaced maxillary canines: Analysis and prediction using discriminant function analysis. American Journal of Orthodontics and Dentofacial.Orthopedics.2024;157:80–90. https://doi.org/10.1016/j.ajodo.2019.08.008

[51.] Alassiry, A.M. Root Resorption of Adjacent Teeth Associated with Maxillary Canine Impaction in the Saudi Arabian Population: A Cross-Sectional Cone-Beam Computed Tomography Study", Applied Sciences. 2022;12:334. doi.org/10.3390/app12010334

[52.] Emad, M., Refat, H., Abd-Alfattah, A.,ELgameay, W ,E. Effect of Different Angulations of Impacted Maxillary Canine on Root Resorption of lateral incisor Using Cone Beam Computed Tomography: A Retrospective Study. Sapporo Medical Journal. 2023;57:4. doi:10.6084/m9.figshare.22800470.v6

[53.] Aktı, A., Dolunay, U., Kaya, D. I., Gürses, G., & Yeşil, D. Evaluation of the Relationship between Impacted Maxillary Canine Teeth and Root Resorption in Adjacent Teeth: A Cross-Sectional Cone Beam Computed Tomography Study. Diagnostics.(Basel,Switzerland).2024;14:1470.https://doi.org/10.3390/diagnostics14141470

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Print ISSN: 3009-6324