JDB Journal of Dental and Biosciences
Volume 03, Number 02, July 2026, pp. 1-7
ISSN: 3089-2619 DOI: 10.20884/1.jdentbios.2026.3.02.21654

ORIGINAL ARTICLE

Severity and location of root dilaceration in permanent maxillary anterior and premolar teeth on panoramic radiographs

Firzana Nurul Izza Taufik[1], Haris Budi Widodo[1], Mahindra Awwaludin Romdlon[1], Irfan Dwiandhono[1], Rinawati Satrio[1]

[1]*School of Dentistry, Medical Faculty, Universitas Jenderal Soedirman, Purwokerto, Central Java-Indonesia*
Correspondence e-mail to: mahindra.ar@unsoed.ac.id

ABSTRACT

Background. Root dilaceration is an anatomical variation characterized by a sharp angulation of the tooth root that may complicate diagnosis and influence treatment planning, particularly in endodontic and surgical procedures. **Objective.** To analyze the severity and location of root dilaceration in permanent maxillary anterior and premolar teeth on panoramic radiographs. **Methods.** A retrospective analytical cross-sectional study was conducted using 224 permanent maxillary teeth with root dilaceration identified on panoramic radiographs. Dilaceration severity was categorized as mild, moderate, or severe, while the location of root curvature was classified into coronal, middle, or apical thirds. Statistical analysis was performed using the Kruskal–Wallis test followed by the Mann–Whitney U test for severity comparison, and the Chi-Square test for distribution of curvature location. **Result.** Mild root dilaceration was the predominant finding (78.1%) and was mainly located in the apical third (64.3%). Significant differences were observed in both the degree and anatomical location of root dilaceration among maxillary lateral incisors, canines, first premolars, and second premolars ($p < 0.001$). Maxillary lateral incisors exhibited significantly greater curvature severity than the other tooth groups, whereas canines and premolars predominantly showed mild dilaceration**. Conclusion.** Significant differences were observed in both the degree and location of root dilaceration among permanent maxillary anterior and premolar teeth, with mild dilaceration predominantly located in the apical third. Maxillary lateral incisors exhibited the greatest morphological variation, followed by canines and premolars.

Keywords: dental radiology, morphological variation, panoramic radiography, permanent teeth, root dilaceration

Tingkat keparahan dan lokasi dilaserasi akar pada gigi anterior dan premolar rahang atas permanen berdasarkan radiograf panoramik

Firzana Nurul Izza Taufik[1], Haris Budi Widodo[1], Mahindra Awwaludin Romdlon[1], Irfan Dwiandhono[1], Rinawati Satrio[1]

[1] *Program Studi Kedokteran Gigi, Fakultas Kedokteran, Universitas Jenderal Soedirman, Purwokerto, Jawa Tengah-Indonesia*
e-mail korespondensi: mahindra.ar@unsoed.ac.id

ABSTRAK

Latar Belakang. Dilaserasi akar merupakan variasi anatomi berupa angulasi tajam pada akar gigi yang dapat mempersulit diagnosis dan memengaruhi perencanaan perawatan gigi, terutama pada prosedur endodontik dan bedah. **Tujuan.** Menganalisis derajat dan lokasi dilaserasi akar pada gigi permanen anterior dan premolar rahang atas melalui radiografi panoramik. **Metode.** Penelitian analitik potong lintang retrospektif dilakukan pada 224 gigi permanen rahang atas dengan dilaserasi akar yang diperoleh dari radiografi panoramik di RSGMP Unsoed pada periode Januari 2024-December 2025 dan dipilih dengan teknik *purposive sampling*. Derajat dilaserasi dikategorikan menjadi ringan, sedang, dan berat, sedangkan lokasi kelengkungan akar diklasifikasikan pada sepertiga koronal, tengah, atau apikal. Analisis statistik menggunakan uji Kruskal–Wallis dilanjutkan uji Mann–Whitney U untuk membandingkan derajat dilaserasi serta uji Chi-Square untuk distribusi lokasi kelengkungan. **Hasil:** Dilaserasi akar ringan merupakan temuan terbanyak (78,1%) dan terutama ditemukan pada sepertiga apikal (64,3%). Terdapat perbedaan signifikan pada derajat dan lokasi anatomis dilaserasi akar antara insisivus lateral, kaninus, premolar pertama, dan premolar kedua rahang atas ($p < 0,001$). Insisivus lateral rahang atas menunjukkan derajat kelengkungan yang secara signifikan lebih besar dibandingkan kelompok gigi lainnya, sedangkan kaninus dan premolar didominasi dilaserasi ringan. **Simpulan:** Derajat dan lokasi dilaserasi akar

berbeda bermakna antar gigi permanen anterior dan premolar rahang atas, dengan pola tersering berupa dilaserasi ringan pada sepertiga apikal dan variasi morfologi terbesar pada insisivus lateral.

Kata kunci: radiologi kedokteran gigi, variasi morfologi, radiografi panoramik, gigi permanen, dilaserasi akar

INTRODUCTION

Dental developmental anomalies arise from disturbances during odontogenesis and may present as variations in tooth number, morphology, position, or eruption pattern [1,2]. Among these conditions, root dilaceration represents a clinically significant morphological anomaly characterized by an abnormal curvature or deviation of the tooth crown or root [3]. This anomaly poses considerable challenges in dental practice, particularly in endodontic, orthodontic, and oral surgical procedures, as complex root morphology may hinder canal access, alter eruption trajectories, and increase the risk of procedural failure [4]. The biological basis of root dilaceration is closely related to disruptions in Hertwig's epithelial root sheath (HERS), which plays a central role in directing root formation and dentin deposition during odontogenesis [5,6].

The etiology of root dilaceration is multifactorial and involves both traumatic and non-traumatic mechanisms. Trauma to primary teeth, especially intrusive luxation, may alter the spatial orientation of the developing permanent tooth germ due to close anatomical proximity, resulting in permanent root curvature. Non-traumatic factors such as dentigerous cysts, supernumerary teeth, genetic predisposition, and space limitation have also been reported to influence root development [1,7]. Maxillary teeth are particularly susceptible to dilaceration because of their anterior position and increased exposure to orofacial trauma during early childhood, a critical period for root formation [3,8]. Epidemiological studies consistently demonstrate a higher prevalence of dilaceration in maxillary teeth, with frequent involvement of lateral incisors, canines, and premolars [9].

Although previous studies have reported the prevalence and general distribution of root dilaceration, most investigations have focused on either overall occurrence or single tooth groups and often relied on cone-beam computed tomography [10,11]. Data derived from panoramic radiography remain limited, particularly regarding comparative evaluation of both the degree and anatomical location of root curvature among specific maxillary tooth groups. Furthermore, existing studies in Southeast Asian populations are scarce and rarely provide detailed analysis of morphological variation across maxillary lateral incisors, canines, and premolars, despite their important roles in esthetics, occlusal stability, and orthodontic treatment planning [12,13]. This lack of detailed, population-based data represents a significant research gap in dental radiology.

Panoramic radiography remains widely used in routine dental practice due to its accessibility, efficiency, and ability to visualize multiple teeth within a single image, making it particularly suitable for large-scale morphological assessment [14,15]. However, its potential for evaluating root dilaceration patterns has not been fully explored in comparative studies focusing on both severity and location of curvature. Therefore, this study aimed to analyze differences in the degree and location of root dilaceration among permanent maxillary lateral incisors, canines, first premolars, and second premolars using panoramic radiographs. By providing detailed morphological characterization within an Indonesian population, this study provides regional insight into root curvature patterns relevant to clinical risk assessment and contributes to the limited regional data on maxillary root morphology.

METHODS

This analytical cross-sectional study employed a quantitative approach with a retrospective cross-sectional design. Ethical approval was obtained from the Health Research Ethics Committee of the Faculty of Medicine, Universitas Jenderal Soedirman (No. 001/KEPK/PE/I/2026), and institutional permission was granted by the Dental Teaching Hospital of Universitas Jenderal Soedirman (RSGMP Unsoed). The study was conducted at the Radiology Unit of RSGMP Unsoed using panoramic radiographs acquired between January 2024 and December 2025.

The unit of analysis was the individual tooth rather than the individual patient. Permanent maxillary lateral incisors, canines, first premolars, and second premolars that met the eligibility criteria were evaluated, and each eligible tooth was considered a separate sample unit. Therefore, more than one eligible tooth from the same patient could be included. However, duplicate panoramic radiographs from the same patient were excluded to prevent repeated assessment of the same subject.

Root curvature was measured using the Schneider method with ImageJ software. Two reference lines were drawn: the first along the longitudinal axis of the root from the cemento-enamel junction (CEJ) to the point at which the curvature began, and the second from the point of curvature to the apical foramen. The angle formed by these lines represented the degree of root curvature. Based on the classification used in this study, dilaceration was categorized as mild (20°–40°),

moderate (41°–60°), or severe (>60°). Consequently, root curvatures of <20° did not meet the operational threshold for dilaceration and were not included in the dilaceration categories analyzed in this study.

Prior to data collection, observer standardization was performed through training and consensus between the researcher and a dental and maxillofacial radiology specialist. Sample panoramic radiographs were jointly reviewed to standardize the identification of anatomical landmarks, longitudinal root axes, points of curvature, and boundaries of the coronal, middle, and apical thirds. Image measurements were calibrated by establishing a reference distance in Cliniview and transferring the corresponding scale to ImageJ using the Set Scale function. Interobserver reliability was subsequently assessed on 25 samples independently evaluated by two observers using Cohen's Kappa. The Kappa coefficients were 0.841 for dilaceration severity and 0.783 for curvature location, indicating very good and good interobserver agreement, respectively.

Ethical approval was obtained from the Health Research Ethics Committee of the Faculty of Medicine, Universitas Jenderal Soedirman, and institutional permission was granted by the Dental Teaching Hospital of Universitas Jenderal Soedirman (RSGMP Unsoed). The study was conducted at the radiology unit of RSGMP Unsoed using panoramic radiographs acquired between January 2024 and December 2025.

Subject Recruitment

The study population consisted of permanent maxillary lateral incisors, canines, first premolars, and second premolars exhibiting root dilaceration on panoramic radiographs. Purposive sampling was applied because not all panoramic images demonstrated dilaceration in each tooth group, and the unit of analysis was an individual tooth. The minimum sample size was calculated using the Lemeshow formula for an unknown population size, with an estimated prevalence of 17.32% based on panoramic radiographic evaluation reported previously [9,11]. A minimum of 221 teeth was required, and equal sampling was applied to obtain 56 teeth per group to minimize intergroup comparison bias, as recommended for quantitative comparative studies [10].

Panoramic radiographs were included if they had diagnostically acceptable image quality, displayed fully formed permanent maxillary lateral incisors, canines, first premolars, or second premolars. Radiographs were excluded if they showed active pathological lesions, severe tooth rotation, mixed or primary dentition, incomplete root formation, or duplicate patient records. Because this study used retrospective radiographic data, direct informed consent from patients was not required. However, patient identity and confidentiality were maintained throughout the study.

Specific Methods Used

Panoramic radiographs that met the inclusion criteria were evaluated to determine the degree and location of root dilaceration. Image analysis was performed using ImageJ software after calibration with Cliniview software to convert pixel measurements into millimeters. Calibration was conducted to improve measurement accuracy and standardize radiographic morphometric assessment.

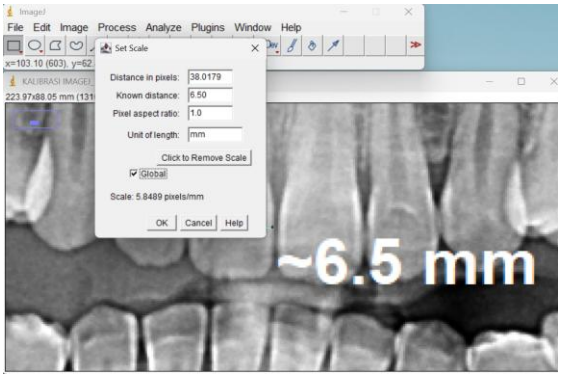

Figure 1. Calibration procedure and standardization of root length measurement using ImageJ software.

Root length was measured by tracing two linear segments along the long axis of the tooth, from the cementoenamel junction to the point of curvature and from the point of curvature to the apical foramen. The location of root curvature was classified into three anatomical regions: coronal third, middle third, and apical third of the root. The degree of root dilaceration was measured using the Schneider method. Based on the curvature angle, dilaceration was classified as mild when the angle was 20°–40°, moderate when the angle was 41°–60°, and severe when the angle was greater than 60° [10,12]. All measurements were performed independently by two observers to reduce measurement bias. Interobserver reliability was assessed before statistical analysis to ensure consistency between observers in classifying both the degree and location of root dilaceration.

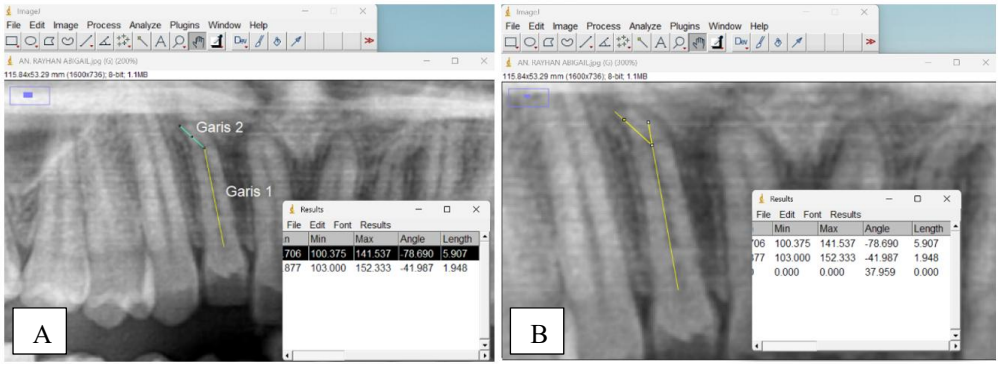

Figure 2. (A). Assessment of root dilaceration location on panoramic radiographs. The root length was divided into coronal, middle, and apical thirds, and the position of curvature was classified according to its anatomical location using calibrated ImageJ measurement. (B). Measurement of root dilaceration angle using the Schneider method on panoramic radiographs.

Data Analysis

Data were analyzed using SPSS version 30. Descriptive analysis was used to present the distribution of samples according to tooth type, degree of dilaceration, and location of root curvature. The degree of root dilaceration was analyzed using the Kruskal–Wallis test to determine differences among maxillary lateral incisors, canines, first premolars, and second premolars. When significant differences were found, post hoc analysis was performed using the Mann–Whitney U test with Bonferroni correction.

The distribution of root dilaceration location among tooth groups was analyzed using the Chi-Square test. Interobserver reliability was assessed using Cohen's Kappa test. A p-value of <0.05 with a 95% confidence interval was considered statistically significant, while post hoc comparisons were interpreted using the adjusted significance level based on Bonferroni correction.

RESULTS

A total of 224 permanent maxillary teeth were included, with equal distribution across lateral incisors, canines, first premolars, and second premolars (56 teeth each). For anatomical grouping, Region 1 referred to the right side of the maxilla, whereas Region 2 referred to the left side of the maxilla. The distribution by tooth type and region is presented in Table 1.

Table 1. Distribution of Sample Characteristics by Tooth Type and Region

Tooth type	Region 1: Right maxilla, N (%)	Region 2: Left maxilla, N (%)	Total N (%)
Lateral incisor (I2)	27 (22,1)	29 (28,4)	56 (25,0)
Canine (C)	27 (22,1)	29 (28,4)	56 (25,0)
First premolar (P1)	33 (27,0)	23 (22,5)	56 (25,0)
Second premolar (P2)	35 (28,7)	21 (20,6)	56 (25,0)
Total	122 (100)	102 (100)	224 (100)

Interobserver reliability analysis demonstrated satisfactory agreement between observers. The Cohen's Kappa value for the assessment of dilaceration degree was 0.841, indicating very good agreement, while the evaluation of dilaceration location yielded a Kappa value of 0.783, classified as good agreement. These results confirmed the reliability of the measurement procedures used in this study.

Descriptive analysis revealed that mild root dilaceration was the most prevalent finding across all maxillary tooth groups, accounting for 78.1% of the total samples. Moderate dilaceration was observed in 21.0% of cases, whereas severe dilaceration was rare (0.9%) (Table 2). Regarding anatomical distribution, root curvature was predominantly located in the apical third (64.3%), followed by the middle third (33.9%), with coronal involvement observed only in a small proportion of samples (Table 3).

Table 1. Distribution of Degree of Root Dilaceration by Tooth Type

Tooth type	*Mild* N (%)	*Moderate* N (%)	*Severe* N (%)	Total
Lateral incisors (I2)	23 (41,1)	31 (55,4)	2 (3,6)	56
Canine (C)	51 (91,1)	5 (8,9)	0 (0,0)	56
First premolar (P1)	53 (94,6)	3 (5,4)	0 (0,0)	56
Second premolar (P2)	48 (85,7)	8 (14,3)	0 (0,0)	56
Total	175 (78,1)	47 (21,0)	2 (0,9)	224

Table 2. Distribution of Dilaceration Location by Tooth Type

Tooth type	Apical N (%)	Midle N (%)	Coronal N (%)	Total
Lateral incisors (I2)	50 (89,3)	6 (10,7)	0 (0,0)	56
Canine (C)	34 (60,7)	22 (39,3)	0 (0,0)	56
First premolar (P1)	27 (48,2)	25 (44,6)	4 (7,1)	56
Second premolar (P2)	33 (57,1)	23 (42,9)	0 (0,0)	56
Total	144 (64,3)	76 (33,9)	4 (1,8)	224

Comparative analysis demonstrated significant differences in the degree of root dilaceration among tooth types. Lateral incisors exhibited the highest proportion of moderate and severe dilaceration, while canines and premolars were predominantly associated with mild curvature (Table 2). The Kruskal–Wallis test confirmed a statistically significant difference in dilaceration degree among the four tooth groups ($H = 61.689$; $p < 0.001$). Post hoc analysis using the Mann–Whitney U test with Bonferroni correction revealed that lateral incisors differed significantly from canines, first premolars, and second premolars ($p < 0.008$), while no significant differences were observed among the latter three groups (Table 4).

Table 3. Post Hoc Mann–Whitney U Test Results for Dilaceration Degree

Tooth comparison	p-value
Lateral incisors (I2) vs Canine (C)	<0.001*
Lateral incisors (I2) vs First premolar (P1)	<0.001*
Lateral incisors (I2) vs Second premolar (P2)	<0.001*
Canine (C) vs First premolar (P1)	0.465
Canine (C) vs Second premolar (P2)	0.378
First premolar (P1) vs Second premolar (P2)	0.114

*Significant at $p < 0.008$

Analysis of dilaceration location also revealed significant variation among tooth types. Apical third involvement was the most frequent location across all groups, particularly in lateral incisors. Middle third involvement was commonly observed in canines and premolars, whereas coronal third involvement was identified exclusively in first premolars (Table 3). The Chi-Square test demonstrated a statistically significant difference in the distribution of dilaceration location among tooth types ($\chi^2 = 32.703$; $df = 6$; $p < 0.001$), indicating non-uniform anatomical patterns of root curvature formation.

DISCUSSION

This study demonstrated that root dilaceration in permanent maxillary anterior and premolar teeth exhibits significant variation in both degree and location across different tooth types. The findings confirm that root curvature is not a uniform anatomical feature but rather reflects tooth-specific developmental and morphological characteristics. Variations were observed not only in curvature severity but also in the root segment involved which may be associated with differences in odontogenic timelines and local anatomical environments. These findings are consistent with previous descriptions of an association between odontogenic disturbances and variations in root morphology in a non-homogeneous manner depending on the tooth involved.

A statistically significant difference in the degree of root dilaceration was identified among lateral incisors, canines, first premolars, and second premolars. Mild dilaceration was the most prevalent finding, whereas moderate and severe curvatures occurred less frequently. Lateral incisors showed greater variation in curvature severity than the other tooth groups and included the only cases of severe dilaceration. This pattern aligns with previous reports indicating that maxillary lateral incisors are particularly susceptible to morphological deviations due to their prolonged developmental period, anterior position, and vulnerability to early traumatic or spatial disturbances [4,6–8]. In contrast, canines and premolars predominantly exhibited mild curvature, suggesting a more stable root development trajectory to disruptive etiological factors [6,8,9].

The predominance of mild dilaceration observed in this study may be consistent with less pronounced developmental disturbances described in previous studies interference during radicular morphogenesis, whereas moderate and severe curvatures have been associated in previous literature with more pronounced developmental disturbances involving Hertwig's epithelial root sheath [3,4,6,16]. Traumatic injury to primary predecessors remains the most frequently cited etiological factor, particularly when occurring during early root formation stages [6,9]. However, non-traumatic influences—including space limitation, ectopic tooth germs, pressure from adjacent erupting teeth, and surrounding anatomical constraints—also have also been proposed as factors associated with altered root growth patterns in altering

root growth direction [7,17–19]. These previously reported factors may be associated with the observed variation in curvature severity and support the multifactorial nature of root dilaceration.

Regarding location, a significant association was found between tooth type and the root segment affected by dilaceration. The apical third was the most frequently involved region across all tooth groups, particularly in anterior teeth. This distribution is consistent with the biological principle that apical segments represent the final stage of root development and which has been proposed as a possible explanation for their susceptibility to developmental disturbances during active elongation [3,20,21]. The high prevalence of apical dilaceration in lateral incisors further is consistent with previous reports that have associated apical dilaceration with early-life trauma and anterior space dynamics during critical growth periods [6,7]. Premolars showed a more balanced distribution between the middle and apical thirds, a pattern that has previously been discussed in relation to later developmental chronology and posterior anatomical structures, including the maxillary sinus and eruptive pathways of adjacent teeth [8,11,13].

This study has several limitations. Panoramic radiography provides a two-dimensional representation of three-dimensional dental structures and is therefore susceptible to magnification, geometric distortion, and superimposition, which may affect the assessment of root curvature. In addition, purposive sampling included only teeth with root dilaceration; therefore, the findings should not be generalized to the overall population or interpreted as prevalence estimates, and the retrospective cross-sectional design does not allow causal or etiological conclusions to be drawn.

CONCLUSION

In this sample, mild root dilaceration was the most common severity category, and curvature was most frequently located in the apical third. Maxillary lateral incisors showed greater curvature severity than canines and premolars. Panoramic radiography may assist initial screening and treatment planning for root morphology, although its two-dimensional limitations should be considered.

ACKNOWLEDGMENT

The authors gratefully acknowledge the support of the Radiology Unit, Dental Teaching Hospital, Universitas Jenderal Soedirman, in facilitating data collection and expert validation for this study.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] Enache AM, Festilă D, Boboc F, Nagy EB, Ghergie M, Dorobantu M. Root dilaceration and dentigerous cyst: a cause–effect relationship? A case-series study. Medicina (Kaunas). 2022;58(12):9854.
[2] Sulistiawati IDAN, Astuti NKA, Sariasih NK. Prevalensi dilaserasi akar gigi ditinjau dari radiografi panoramik di RSGM Universitas Mahasaraswati Denpasar tahun 2017–2021. Bali Dent Sci. 2025;9(3):538–549.
[3] Jin C, Skilbeck M, Low A, Lin W, Au C, Mei L. Root dilaceration: a case report and literature review. Australas Orthod J. 2023;39(1):109–119.
[4] Hasan HS, Al-Talabani SZ, Hamad Ali S, Andraws Yalda F, Fawzi Chawshli O, Kolemen A, et al. Prevalence and distribution pattern of dilacerated teeth among orthodontic patients using cone-beam computed tomography: a prospective multicenter study. Int J Orthod Rehabil. 2024;14(4):33–44.
[5] Nanci A. Ten Cate's Oral Histology: Development, Structure, and Function. 9th ed. St. Louis: Elsevier; 2018.
[6] Andreasen JO, Andreasen FM, Andersson L. Textbook and Color Atlas of Traumatic Injuries to the Teeth. 5th ed. Hoboken (NJ): Wiley-Blackwell; 2019.
[7] Caeiro-Villaseñín L, Serna-Muñoz C, Pérez-Silva A, Vicente-Hernández A, Poza-Pascual A, Ortiz-Ruiz AJ. Developmental dental defects in permanent teeth resulting from trauma in primary dentition: a systematic review. Int J Environ Res Public Health. 2022;19:754.
[8] Gehlot PM, Bhojraj ABMN, KP L. Prevalence of traumatic dental injuries to anterior teeth among 14- to 60-year-old patients in Mysuru, India: a hospital-based cross-sectional study. J Clin Diagn Res. 2025;19(3):2206–2211.
[9] Tantanapornkul W. Prevalence and distribution of dental anomalies in Thai orthodontic patients. Int J Med Sci Diagn Res. 2015;2:165–172.
[10] Sahebi S, Sahebi S, Razavian A, Maddahi N, Asheghi B. Evaluation of root dilaceration in permanent anterior and canine teeth in the southern subpopulation of Iran using cone-beam computed tomography. J Dent. 2023;24:320–327.
[11] Qutieshat A, Al-Harthy N, Javanmardi S, Singh G, Chopra V, Aouididi R, et al. Prevalence of mesiodistal dilaceration in patients presenting for initial orthodontic care: a retrospective study. J Orthod Sci. 2023;12(1):1–7.
[12] Asheghi B, Sahebi S, Rafiee Z, Booshehri MZ, Habibi A. Cone-beam computed tomography-based evaluation of

root dilaceration in permanent premolars: a retrospective study. J Dent. 2024;25:155–161.
[13] Siddiq M, Shakeel J, Khan BN, Mehdi SZ, Hameed S, Chaudhary FA. Root morphology of maxillary first premolar teeth in orthodontic extraction cases. J Pak Dent Assoc. 2021;30(2):1013–1017.
[14] Almeida-Marques M, Ingold MSM, Silva-Junior AF, Franco A, Junqueira JLC, Oenning AC. Maxillary third molar roots: a radiographic assessment. Dentomaxillofac Radiol. 2023;52:1–10.
[15] Costa TD, Meireles N, Silva TP, Takeshita WM. Is panoramic radiography reliable for evaluating the relationship between maxillary premolar and molar roots and the maxillary sinus? Oral Radiol. 2023;39:1–8.
[16] Pałka J, Gawda J, Zawadka M. Impact of spatial limitation on root morphology development. Arch Oral Biol. 2022;139:105426.
[17] Jayasinghe RM, Thilakumara IP, Hettiarachchi PVKS, Fonseka MCN. Morphometric analysis of maxillary arch dimensions using cone-beam computed tomography. J Oral Biol Craniofac Res. 2022;12(5):500–504.
[18] Küchler EC, de Oliveira Stroparo JL, Reis CLB, Ullrich N, Olsson B, Scariot R, et al. Oral cleft-related genes may be involved in root curvature of maxillary lateral incisors. Am J Orthod Dentofacial Orthop. 2022;161(5):e1–e9.
[19] Luder HU. Malformations of the tooth root in humans. Front Physiol. 2015;6:307.
[20] Walia PS, Rohilla AK, Choudhary S, Kaur R. Review of dilaceration of maxillary central incisor: a multidisciplinary challenge. Int J Contemp Dent Med Rev. 2016;2016:1–8.
[21] Kayal RA. Distortion of digital panoramic radiographs used for implant site assessment. J Oral Maxillofac Radiol. 2016;4(4):117–120.