PREVALENCE OF ROOT RESORPTION IN ENDODONTICALLY TREATED TEETH BY MEANS OF CONE-BEAM COMPUTED TOMOGRAPHY

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ABSTRACT

The aim of this article was to establish the prevalence of root resorption in endodontically treated teeth, by means of cone-beam computed tomography (CBCT). Material and method. We analysed 609 endodontically treated teeth from patients who visited two private dental offices over a period of 3 years (2020-2023). We searched for any sign of root resorption, internal, external and apical. Results. The overall prevalence of root resorption in root canal treated teeth was 6.57%. Of these, 82.5% had apical periodontitis (AP). 67.57% were external apical inflammatory resorption, 21.62% were external cervical resorption and 18.92% were internal resorption. Conclusions. Root resorption of permanent teeth is an unfavourable condition, which can involve endodontically treated teeth. The most frequent form of resorption was external apical. Posterior teeth presented the highest percentage of resorptions. From the prognosis point of view, it is crucial that they are diagnosed in the early stages. CBCT has an invaluable role in accurately diagnosing this condition.

Keywords: root resorption, endodontic treatment, CBCT, diagnose, prevalence

Introduction

Root resorption represents the process by which its mineralized tissues are progressively and irreversibly destroyed due to odontoclastic activity, both on external and internal surfaces [1-3]. The causes of root resorption can be related to trauma (acute or chronic, including parafunctional habits), chronic inflammation, pressure (impacted teeth, tumours), orthodontic treatment or intracoronal bleaching [4]. There are also host-related factors (age, gender, genetic predisposition), which were correlated with root resorption, but also unknown or not yet elucidated factors [4].

One of the classification criteria is the location of resorptions. Thus, they can be external, internal; cervical or apical [5-7].

Most of the time, this pathological process in permanent teeth is asymptomatic at an early stage and is discovered accidentally, on radiographs for neighbouring teeth or when the process is advanced enough to become clinically perceptible [8]. Radiographs, however, cannot show the true extent of this process, being 2D. CBCT, with its 3D rendering, provides accurate and valuable information related to the resorptive process, especially in the axial sections and buccal-oral plane [5,9]. Thus, we could establish based on the analysis of these sections, if the resorption led to a communication between the endodontic system and the periodontal space [10]. The treatment plan is highly influenced by these aspects: location, on which the access depends, the extent of the process, in relation to the weakening of the

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root resistance and the perforation of the root, with communication between the two spaces, endodontic and peri-radicular [11].
Early detection of resorption is essential for the prognosis of a conservative treatment, as key considerations are related to the extent of the resorptive defect. Unfortunately, the diagnosis of resorption is a difficult process in almost any situation, considering the asymptomatic nature of this condition [12,13]. However, this diagnostic problem is even greater for resorption in the case of endodontically treated teeth. This resorptive process is almost impossible to highlight on conventional radiographs, due to the radio-opaque materials in the canals, but also to the coronal restorations [14,15]. Only if the canal obturation is not done correctly and is incomplete or some canals are completely missed, it is possible to visualize these resorptive defects on radiographs. CBCT shows these resorptive defects in endodontically treated teeth, but even in this case the artifacts determined by the radiopaque materials could distort the image [16].
This study aims to determine the prevalence of root resorption and its main subcategories in endodontically treated teeth, by means of CBCT images.

Material and method

We analysed CBCT images from patients who visited two dental private offices in Romania over a period of 3 years (2020-2023). The scans were recommended for diagnosis purposes and treatment planning. The CBCT images were acquired with Veraviewepocs 3D P (R100) equipment (J. Morita MFG Corp., Kyoto, Japan). The scan parameters were 90 kV, 5 mA, 9.4 s exposure time, 125 μm spatial resolution and 40×40 mm field of view (FoV). All CBCT exposures were performed with the minimum exposure necessary for adequate image quality.
The selection of CBCT scan followed as inclusion criteria the good quality of radiographic images, of maxillary and mandibular root canal filled teeth. There were excluded the cases with insufficient field of view, bone abnormalities, root resected teeth. After applying these criteria, there were a total of 609 CBCT analysed teeth.
CBCT scans were viewed with the software provided with the CBCT unit. The images were analysed on a 27 inches Dell LCD screen with a resolution of 2560 × 1440 pixels in a darkroom. We adjusted the brightness and contrast of the images using the image processing device in the software to ensure optimal image. The CBCT imaging assessment methodology involved orienting the long axis of the tooth under examination with the reference lines within the visualization software, followed by an anatomical interpretation performed across the coronal, sagittal and axial planes.
We recorded the age, gender, root canal treated tooth type, apical periodontitis (AP) as any disruption of the lamina dura and any radiolucency at least twice the width of the periodontal space. Resorption was defined as a radiolucent defect along the root. We looked for the resorption type (internal, external, apical). For data analysis we used Microsoft Excel and MedCalc Software Ltd. 23.0.2.

Results

There were 419 female and 190 male patients, 20-80 years, mean age 47. The overall prevalence of root resorption was 6.57% (n=40). Of these 82.5% had apical periodontitis (AP), p=0.0017. The most common types of resorptions included external apical inflammatory (EAIR) (infection induced) (67.57%), followed by external (EXT) (21.62%), and lastly internal (INT) (18.92%) (Table 1).
The prevalence of resorption among males and females (4.74% and 7.4%, p=0.21) did

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not significantly vary across different age groups (Table 2, 3).
Most affected teeth were molars (83.78%), followed by anterior teeth (13.51%) and lastly premolars (10.81%). The prevalence of different resorption types significantly varied across different tooth groups ($p < 0.0001$) (Table 2, 4).

Resorption type		% of RES	AP	% AP
EAIR	25	67.57	23	92.00
EXT	8	21.62	4	50.00
INT	7	18.92	6	85.71

Table 1 Prevalence of resorption types

		No RES	%	RES	%	p-value
Gender	Male	181	95.26	9	4.74	0.2196
	Female	388	92.60	31	7.40	
Age	20-40	182	94.30	11	5.70	0.4512
	41-60	289	93.83	19	6.17	
	61-80	98	90.74	10	9.26	
Tooth type	Anterior	155	96.88	5	3.13	0.0001
	Premolar	196	98.00	4	2.00	
	Molar	218	87.55	31	12.45	
		No AP	%	AP	%	p-value
Resorption	Present	7	17.50	33	82.50	0.0017
	Absent	243	42.71	326	57.29	

Table 2 Prevalence of resorption by gender, age, tooth type (Two-way Chi-squared test)

Gender	total of type	RES	%	AP	% AP	EAIR	%	EXT	%	INT	%
Male	190	9	24.32	9	100.00	7	77.78	1	11.11	1	11.11
Female	419	31	83.78	24	77.42	18	58.06	7	22.58	6	19.35

Table 3 Resorption type by gender

Tooth type		RES	%	AP	% AP	EAIR	%	EXT	%	INT	%
Anterior	160	5	13.51	2	40.00	2	40.00	3	60.00	0	0.00
Premolar	200	4	10.81	3	75.00	3	75.00	0	0.00	1	25.00
Molar	249	31	83.78	28	90.32	20	64.52	5	16.13	6	19.35

Table 4 Resorption type by tooth type

Factor	Category	Reference	OR	CI	p-value
Gender	Female	Male	1.6068	0.74-3.44	0.223
Age	61-80	20-40	1.6883	0.69-4.11	0.2492
Age	61-80	41-60	1.5521	0.69-3.45	0.281
Tooth type	Molar	Anterior	4.4083	1.67-11.59	0.0026

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Tooth type	Molar	Premolar	6.9679	2.41-20.09	0.0003
RES factor for AP	Present	Absent	3.514	1.52-8.07	0.0031

Table 5 Risk factors for root resorption (z-statistic)

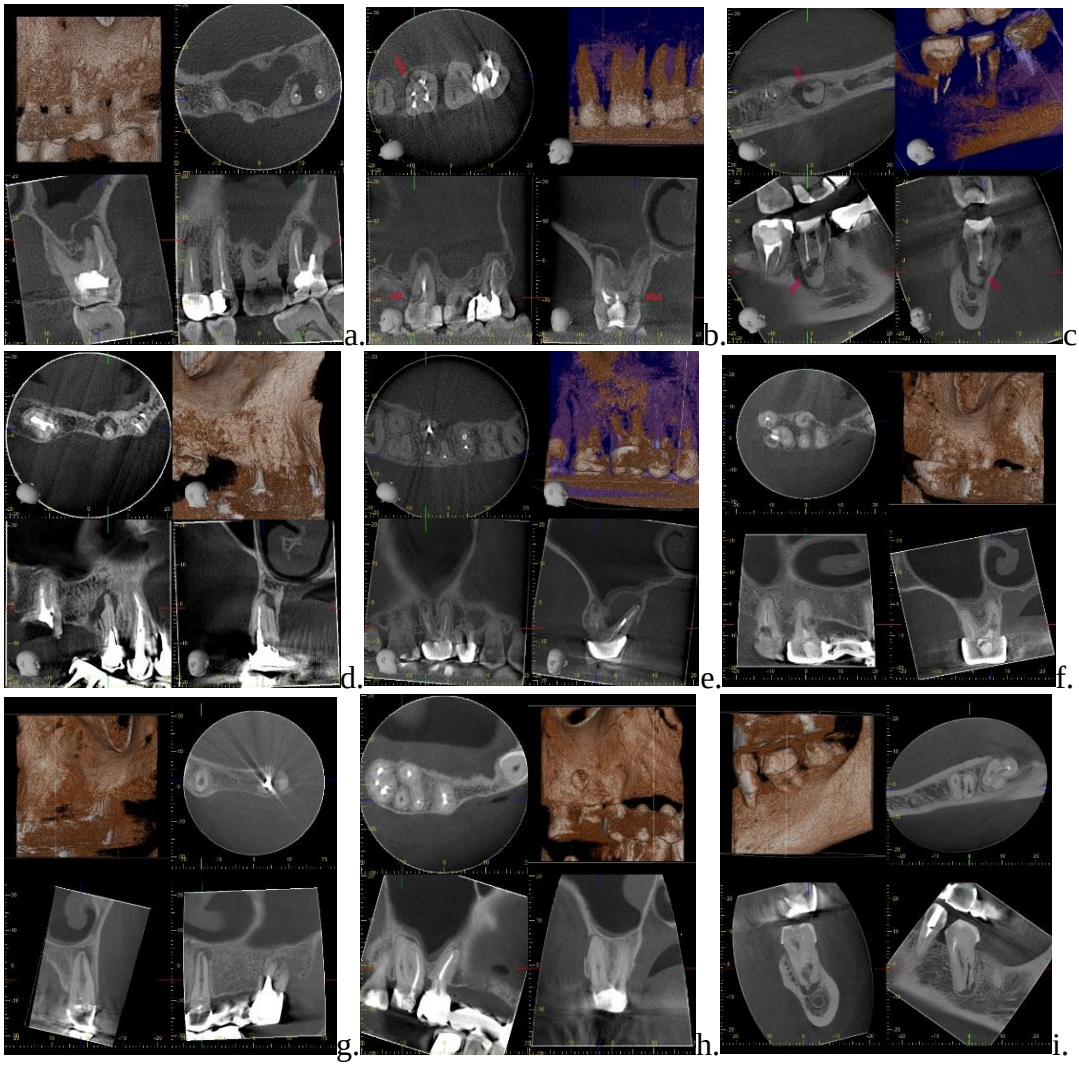

Figure 1.a. Tooth 27, EAIR mesio-buccal root; b. 26 mesial EXT; c. 47 EXT; d. 14 EAIR; e. 16 disto-buccal root INT; f. 16 EAIR; g. 25 INT; h. 16 DB root INT; i. 37 EAIR and INT distal root

Discussion

The identification and recognition of resorption and its type is crucial preoperatively. The presence of this resorptive defect radically changes the treatment plan and the application of endodontic principles [17-19]. Also, the treatment of this condition differs depending on the type of resorption. Chemo-mechanical treatment and canal obturation must be adapted for this condition. The lack of recognition of this condition preoperatively, can lead to serious accidents, such as the passage of irrigation solutions into the periodontal space, but also to obturation errors, either overfilling or non-homogeneous [20,21]. These mistakes have an unfavourable impact on the outcome of endodontic treatment [22,23].

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The presence of inflammatory apical resorption raises certain issues during endodontic treatment [24]. The determination of the working length is directly influenced by the way the apex locator is used. One of the important aspects is the adaptation of the diameter of the file that is attached to the file holder of the apex-locator to the calibre of the canal and especially to that of the apical foramen, which in resorptions is larger than the original one [25]. Confirming this length with an X-ray is a very sensitive point, as it may give the impression of an underestimated length, but the file is at the terminus of the canal. A possible off-centre radiography could be the solution for this problem [26]. Finally, the obturation of such a foramen is preferably made with bioceramic putty materials, which can seal a wide, oval foramen [27].

The most common type of resorption in this study was external inflammatory apical resorption. The group of molars presented the highest prevalence of resorptions. Most of the teeth with resorption in this study also presented AP. The presence of apical granulation tissue determines external apical resorption, which is why, 92% of the teeth with external inflammatory apical resorption also had AP. Internal resorptions were present in the case of incompletely filled or missed canals, these internal resorptive defects not being filled by previous endodontic treatment.

In our study, one patient had two teeth with resorptions, a maxillary molar with external cervical resorption and a maxillary premolar with internal resorption; another patient had a mandibular second molar which presented both internal and external inflammatory apical resorption. Thus, resorptions can be present in several teeth in the same patient, different types, and even in the same tooth. In this sense, if a resorption has been identified in a tooth of a patient, it would be useful to investigate the other teeth to exclude a possible resorption in other teeth as well [28-30].

The presence of resorption was strongly correlated with the presence of AP, that is resorption can be a risk factor for AP ($p=0.003$). Tooth type, namely, the molar group, was strongly associated with the presence of resorptions in this study, compared to the group of anterior teeth or premolars ($p=0.0026$, $p=0.0003$) (Table 5).

The identification of these resorptions in endodontically treated teeth was done accidentally, on CBCT images recommended for dental diagnosis and evaluation of endodontically treated teeth, with persistent AP, most likely (Fig. 1 a-h).

In one study the authors showed that the root canal treated teeth were significantly more likely to be affected by apical infection induced resorption (43.1%) compared to teeth without prior endodontic treatment (only 3.7%) [28]. In another study, the prevalence of resorptions in endodontically treated teeth was similar to that in our study, namely 5.4% [31].

External cervical resorption must be differentiated from a radicular cervical caries. The part of the root that is resorbed is in the bone tissue, unlike a root caries that occurs in the part of the root that is no longer in the bone. In this case, the diagnosis may be hindered by the coronal restorations and the radiological image may not show this defect. From this point of view, it is possible that the percentage of external cervical resorptions is higher [32].

Our study shows that root resorption also occurs in endodontically treated teeth, in a relatively small percentage. We used CBCT images for this study, being a 3D imaging tool, which exposes the axial and coronal plane, essential for accurately identifying

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the type and extent of the resorptive process.

Conclusions

Root resorption is a pathological clinical condition of permanent teeth. Due to the changes determined by the destruction of hard tissues, the endodontic retreatment of these teeth is challenging. The most common type of root resorption of teeth with root canal treatment is the external apical, but other types of resorptions can also be found. It is crucial that this condition is diagnosed preoperatively. The treatment plan must be adjusted accordingly, to avoid possible complications. If the resorption is early diagnosed, the large destruction of dental tissues and consequently the tooth loss, is avoided. CBCT is paramount for the approach of this condition, starting with an accurate and early diagnosis and followed by an appropriate treatment plan.

References

1. Heithersay GS. External root resorption. Ann R Australas Coll Dent Surg. 1994 Apr;12:46-59. PMID: 7993061.
2. Patel S, Krastl G, Weiger R, Lambrechts P, Tjäderhane L, Gambarini G, Teng PH. ESE position statement on root resorption. Int Endod J. 2023 Jul;56(7):792-801. doi: 10.1111/iej.13916. Epub 2023 Apr 7. PMID: 36942472.
3. Patel S, Saberi N, Pimental T, Teng PH. Present status and future directions: Root resorption. Int Endod J. 2022 Oct;55 Suppl 4(Suppl 4):892-921. doi: 10.1111/iej.13715. Epub 2022 Mar 30. PMID: 35229320; PMCID: PMC9790676.
4. Heboyan A, Avetisyan A, Karobari MI, Marya A, Khurshid Z, Rokaya D, Zafar MS, Fernandes GVO. Tooth root resorption: A review. Sci Prog. 2022 Jul-Sep;105(3):368504221109217. doi: 10.1177/00368504221109217. PMID: 35759366; PMCID: PMC10358711.
5. Patel S, Ricucci D, Durak C, Tay F. Internal root resorption: a review. J Endod. 2010 Jul;36(7):1107-21. doi: 10.1016/j.joen.2010.03.014. Epub 2010 May 20. PMID: 20630282.
6. Gabor C, Tam E, Shen Y, Haapasalo M. Prevalence of internal inflammatory root resorption. J Endod. 2012 Jan;38(1):24-7. doi: 10.1016/j.joen.2011.10.007. Epub 2011 Nov 16. PMID: 22152614.
7. Rossi-Fedele G, Figueiredo JA, Abbott PV. Teeth with double internal inflammatory resorption: report of two cases. Aust Endod J. 2010 Dec;36(3):122-9. doi: 10.1111/j.1747-4477.2009.00197.x. PMID: 21091845.
8. Patel S, Kanagasingam S, Pitt Ford T. External cervical resorption: a review. J Endod. 2009 May;35(5):616-25. doi: 10.1016/j.joen.2009.01.015. PMID: 19410071.
9. 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 Surg Oral Med Oral Pathol Oral Radiol. 2016 Dec;122(6):765-771. doi: 10.1016/j.oooo.2016.08.015. Epub 2016 Oct 7. PMID: 27727110.
10. Ricucci D, Siqueira JF Jr, Loghin S, Lin LM. Repair of extensive apical root resorption associated with apical periodontitis: radiographic and histologic observations after 25

DOI : 10.62610/RJOR.2025.1.17.46

years. J Endod. 2014 Aug;40(8):1268-74. doi: 10.1016/j.joen.2014.01.008. Epub 2014 Mar 6. PMID: 25069947.

11. Abbott PV, Lin S. Tooth resorption-Part 2: A clinical classification. Dent Traumatol. 2022 Aug;38(4):267-285. doi: 10.1111/edt.12762. Epub 2022 May 23. PMID: 35605161; PMCID: PMC9543863.
12. Krishnan U, Moule AJ, Alawadhi A. Cone beam CT assisted re-treatment of class 3 invasive cervical resorption. BMJ Case Rep. 2015 Mar 20;2015:bcr2014204615. doi: 10.1136/bcr-2014-204615. PMID: 25795743; PMCID: PMC4368940.
13. Patel S, Mavridou AM, Lambrechts P, Saberi N. External cervical resorption-part 1: histopathology, distribution and presentation. Int Endod J. 2018 Nov;51(11):1205-1223. doi: 10.1111/iej.12942. Epub 2018 Jun 1. PMID: 29704466.10.1136/bcr-2014-204615. PMID: 25795743; PMCID: PMC4368940.
14. Gonzales JR, Rodekirchen H. Endodontic and periodontal treatment of an external cervical resorption. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2007 Jul;104(1):e70-7. doi: 10.1016/j.tripleo.2007.01.023. Epub 2007 May 11. PMID: 17499526.
15. Chen Y, Huang Y, Deng X. A Review of External Cervical Resorption. J Endod. 2021 Jun;47(6):883-894. doi: 10.1016/j.joen.2021.03.004. Epub 2021 Mar 18. PMID: 33745945.
16. Goodell KB, Mines P, Kersten DD. Impact of Cone-beam Computed Tomography on Treatment Planning for External Cervical Resorption and a Novel Axial Slice-based Classification System. J Endod. 2018 Feb;44(2):239-244. doi: 10.1016/j.joen.2017.10.001. Epub 2017 Dec 8. PMID: 29229454.
17. Suhr Villefrance J, Kirkevang LL, Wenzel A, Væth M, Matzen LH. Long-term prognosis for teeth with external cervical resorption based on periapical images and cone beam CT: A clinical study. Int Endod J. 2024 Nov;57(11):1596-1607. doi: 10.1111/iej.14122. Epub 2024 Jul 8. PMID: 38976489.
18. Vaz de Souza D, Schirru E, Mannocci F, Foschi F, Patel S. External Cervical Resorption: A Comparison of the Diagnostic Efficacy Using 2 Different Cone-beam Computed Tomographic Units and Periapical Radiographs. J Endod. 2017 Jan;43(1):121-125. doi: 10.1016/j.joen.2016.09.008. Epub 2016 Dec 6. PMID: 27939734.
19. Ee J, Fayad MI, Johnson BR. Comparison of endodontic diagnosis and treatment planning decisions using cone-beam volumetric tomography versus periapical radiography. J Endod. 2014 Jul;40(7):910-6. doi: 10.1016/j.joen.2014.03.002. Epub 2014 Apr 16. PMID: 24935534.
20. Nilsson E, Bonte E, Bayet F, Lasfargues JJ. Management of internal root resorption on permanent teeth. Int J Dent. 2013;2013:929486. doi: 10.1155/2013/929486. Epub 2013 Nov 21. PMID: 24348560; PMCID: PMC3857824.
21. Malueg LA, Wilcox LR, Johnson W. Examination of external apical root resorption with scanning electron microscopy. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1996 Jul;82(1):89-93. doi: 10.1016/s1079-2104(96)80383-0. PMID: 8843460.
22. Durack C, Patel S, Davies J, Wilson R, Mannocci F. Diagnostic accuracy of small volume cone beam computed tomography and intraoral periapical radiography for the detection of simulated external inflammatory root resorption. Int Endod J. 2011 Feb;44(2):136-47. doi: 10.1111/j.1365-2591.2010.01819.x. Epub 2010 Nov 17. PMID: 21083575.
23. Venskutonis T, Plotino G, Juodzbalys G, Mickevičienė L. The importance of cone-beam computed tomography in the management of endodontic problems: a review of the

DOI : 10.62610/RJOR.2025.1.17.46

literature. J Endod. 2014 Dec;40(12):1895-901. doi: 10.1016/j.joen.2014.05.009. Epub 2014 Oct 3. PMID: 25287321.

24. Bardini G, Orrù C, Ideo F, Nagendrababu V, Dummer P, Cotti E. Clinical management of external cervical resorption: A systematic review. Aust Endod J. 2023 Dec;49(3):769-787. doi: 10.1111/aej.12794. Epub 2023 Sep 13. PMID: 37702252.
25. Krupp C, Bargholz C, Brüsehaber M, Hülsmann M. Treatment outcome after repair of root perforations with mineral trioxide aggregate: a retrospective evaluation of 90 teeth. J Endod. 2013 Nov;39(11):1364-8. doi: 10.1016/j.joen.2013.06.030. Epub 2013 Sep 5. PMID: 24139255.
26. Gulsahi A, Gulsahi K, Ungor M. Invasive cervical resorption: clinical and radiological diagnosis and treatment of 3 cases. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2007 Mar;103(3):e65-72. doi: 10.1016/j.tripleo.2006.10.005. Epub 2007 Jan 12. PMID: 17223591.
27. Darcey J, Qualtrough A. Resorption: part 2. Diagnosis and management. Br Dent J. 2013 May;214(10):493-509. doi: 10.1038/sj.bdj.2013.482. PMID: 23703177.
28. Dao V, Mallya SM, Markovic D, Tetradis S, Chugal N. Prevalence and Characteristics of Root Resorption Identified in Cone-Beam Computed Tomography Scans. J Endod. 2023 Feb;49(2):144-154. doi: 10.1016/j.joen.2022.11.006. Epub 2022 Dec 10. PMID: 36509167.
29. Wang N, Zhang M, Zhu J, Zhu Y, Wu J. Multiple idiopathic cervical root resorption: A systematic review. Oral Dis. 2023 Sep;29(6):2409-2422. doi: 10.1111/odi.14406. Epub 2022 Oct 31. PMID: 36251582.
30. Wu J, Lin LY, Yang J, Chen XF, Ge JY, Wu JR, Sun WB. Multiple idiopathic cervical root resorption: a case report. Int Endod J. 2016 Feb;49(2):189-202. doi: 10.1111/iej.12440. Epub 2015 Mar 27. PMID: 25688929.
31. Salceanu M, Dascalu C, Constantin A, Hamburda T, Topoliceanu C, Melian A. Evaluation of root-filled teeth by periapical and endodontic status scale (pess): a cbct study. RJOR 2024 july-sept; 16 (3): 90-99. doi : 10.6261/RJOR.2024.3.16.9
32. Spielman R, Ameh G, Brandes I, Berkowitz L, Elson N, Blum IR. Challenges in differential diagnosis and treatment of cervical root resorption vs. root caries. Prim Dent J. 2024 Jun;13(2):65-70. doi: 10.1177/20501684241256468. PMID: 38888079.

DOI : 10.62610/RJOR.2025.1.17.46