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Retrospective evaluation of the prevalence of endodontic-periodontal lesions on panoramic images in the latest classification of periodontal and peri-implant diseases

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ABSTRACT

Aims: This study aimed to determine the prevalence of endodontic-periodontal lesions (EPLs) and EPL grades 1–3 without root damage in patients with and without periodontitis according to the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases.

Methods: This study included 500 panoramic radiographs from the Faculty of Dentistry at the University of İstanbul Medipol. Each radiograph was evaluated by a calibrated investigator for diagnostic signs. Patients' age, sex, total number of teeth, total number of implants, number of filled teeth, number of missing teeth, number of caries, presence of fixed prosthesis, full mouth periodontal diagnosis and determination of the region with the highest radiographic bone loss without EPL were recorded in all patients. For patients with EPL, the presence of EPL and its grading according to the 2017 World Workshop on Classification of Periodontal and Peri-Implant Diseases, the presence of furcation involvement, degree of furcation involvement, the presence of caries in the related tooth, and restoration in the relevant tooth material were also evaluated.

Results: The mean age was higher for patients with EPL teeth than without EPL teeth ($p<0.05$). The mean number of teeth was higher for patients without EPL teeth than patients with EPL teeth ($p<0.05$). Patients with stage 1 or 2 bone loss mostly had EPL teeth, while patients with stage 3 or 4 mostly did not have EPL teeth ($p<0.05$). Patients with full mouth stage 1 or 2 diagnoses mostly had teeth with EPL. Patients with grade A or B bone loss mostly had teeth with EPL. Maxillary incisors, mandibular premolars, and mandibular incisors mostly had a "j" profile.

Conclusion: The presence of EPL is affected by age, number of teeth, and different periodontal conditions. EPLs were most frequently observed in molars. These results are unsurprising due to the difficulty in brushing the molar areas and periodontal treatment in this area. Because of the complexity of concurrent endodontic and periodontic treatments, the clinical treatment procedure is difficult, the sequence of procedures must be rigorous, and the selection of appropriate materials is critical for optimal and successful treatment in these EPL cases.

Keywords: Endo-perio lesions, panoramic radiographs, periodontal disease, j-shape, cone shape

INTRODUCTION

The prognosis and treatment of teeth with combined endodontic-periodontal lesions (EPLs) are challenging for dentists. Clinically, the prognosis of these teeth may be good, poor, and even hopeless. There is little evidence for guiding practitioners to decide which treatment should precede for the affected tooth, the endodontic or periodontic approach.[1] The factors affecting treatment success are not yet completely known.

Both anatomical and non-physiological pathways connecting endodontic and periodontal tissues can cause EPLs. The anatomical pathways are the root canal system's apical foramina, accessory canals, or dentinal tubules, often located in the apical third of the root. The non-physiological pathways may be iatrogenic perforations or vertical root fractures.[2]

Different classification systems have been established to describe and categorize EPLs. Older classifications focused on the lesion's history and origin. The new classification was proposed by the Working Group 2 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions.[1,3]

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This new classification system focuses on the current disease status and prognosis of the teeth. It has often been suggested to overcome the problem of unknown history and origin of the disease. It is based on the assumption that there is no meaningful outcome on the treatment method since treatment always comprises endodontic and periodontal methods.[1,4]

EPLs are categorized as with or without root damage. EPLs without root damage are differentiated into those in patients with and without periodontitis. Grades I to III are defined by the spread around the tooth. Epidemiological data supporting this classification are lacking.

Therefore, this study aimed to determine the prevalence of EPLs and EPL grades 1–3 without root damage in patients with and without periodontitis, according to the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases.

METHODS

The study was approved by the Non-invasive Clinical Studies Ethics Committee of İstanbul Medipol University (Date: 31.01.2023, Decision No: 64). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Patients' panoramic radiographs were evaluated in this study who applied to the Dental School Clinic of İstanbul Medipol University. It comprised patients who needed treatment by specialist dentists or who came for routine dental visits.

The sample size was calculated at a 95% confidence level using the G*Power programme (version 3.1.9.2).[5] Based on a previous study comparing two independent groups,[6] considering an α of 0.05, a standardized effect size of 0, and a theoretical power of 80%, the minimum size for each group was estimated to be 50.

Inclusion and Exclusion Criteria

This study retrospectively included 500 patients' panoramic radiographs were assessed from the Faculty of Dentistry. Radiographs belonging to patients who were over 18 years of age were evaluated. In our study, an experienced dentomaxillofacial radiologist (K.A.) and periodontist (C.A.), performed the initial examination of these teeth and performed both endodontic vitality tests and periodontal examination of the patients. X-rays of patients who underwent these tests and who actually had periodontal examinations were included in the study. But also, radiographs were excluded which had poor image quality (e.g., focus, artifacts, or orientation) or which were duplicates (e.g., second radiograph of an included patient). The radiographic archive was evaluated and the systemic status of the patients was not taken into account.

Radiograph Evaluation

Each radiograph was evaluated by a calibrated investigator (T.P.) in the same room on an approved monitor. For calibration, the investigator evaluated the diagnostic signs of 10 panoramic images. If there were differences, they were discussed with a second investigator.

Patients' age, sex, total number of teeth, total number of implants, number of filled teeth, number of missing teeth, number of caries, presence of fixed prosthesis, full mouth periodontal diagnosis and determination of the region with the highest radiographic bone loss without EPL were recorded in all patients. For patients with EPL, the presence of EPL and its grading according to the 2017 World Workshop on Classification of Periodontal and Peri-Implant Diseases; the presence of furcation involvement, degree of furcation involvement, the presence of caries in the related tooth, and restoration in the relevant tooth material were also evaluated.

Grades 1 and 2 were combined into a single group (later referred to as grade 1/2) since no critical width value was given in the classification to distinguish between narrow and wide pockets. Therefore, the rating was made as either grade 1/2 or grade 3.[1]

Additional recordings in patients with EPL were RCT, restorations, or caries in teeth with EPL. It included radiographic bone destruction and root length of teeth 13–17, 23–27, 33–37, and 43–47 (according to the FDI World Dental Federation notation) to provide periodontal diagnosis according to the staging recommended by the new classification.

Radiographic bone loss was categorized based on its extension into the coronal third (<15%; stage I), the upper coronal third (15%–33%; stage II), or the middle third and beyond (stage III/IV) of the root. The extension differed further by the number of teeth affected: ≥30% led to a generalized form and <30% to a localized form.

The radiographic profile of defects surrounding teeth with EPL was graded as cone-shaped or j-shaped. There are indications that vertical root fractures often cause j-shaped lesions on radiographs.[7] Teeth with and without RCT but with j-shaped lesions or significant signs of root damage (e.g., horizontal fractures) were excluded to enable the prevalence of EPLs without root damage to be determined as reliably as possible without clinical data. They were excluded to avoid over- or under-estimating results due to the indistinct representation of anterior teeth on panoramic images.

Teeth with EPL were excluded from staging and grading to achieve a higher variation in periodontal disease severity because they constituted their own periodontal disease entity in the 2017 classification.

Due to the lack of clinical information, stage III and IV periodontitis were combined as stage III/IV periodontitis.

Statistical Methods

This study reports descriptive statistics (number, percentage, minimum, maximum, mean, and standard deviation). The normal distribution assumption was checked with the Shapiro–Wilk test. The means of normally distributed variables between two groups were compared by using the independent samples t-test and The means of normally distributed variables among three or more groups were compared by using analyses of variance. The means of nonnormally distributed variables between two groups were compared by using the Mann–Whitney U test and the means of nonnormally distributed variables among three or more groups using the Kruskal–Wallis test. Fisher's exact test was used to assess the relationship between categorical variables All analyses were performed in using the IBM SPSS (version 25) software.

RESULTS

The patients' demographic and clinical characteristics are shown in Table 1. Thirty-two of the 500 examined panoramic radiographs were excluded from this study. The localization of bone loss (vertical vs. horizontal; data not shown) did not differ significantly by age (p=0.590), the number of missing teeth (p=0.923), or the total number of teeth (p=0.974).

The presence of furcation involvement (data not shown) did not differ significantly by age (p=0.626), the number of missing teeth (p=0.877), or the total number of teeth (p=0.957). Similarly, furcation grade (grades 1, 2, and 3/4; data not shown) did not differ significantly by age (p=0.631), the number of missing teeth (p=0.164), or the total number of teeth (p=0.171).

Table 1. Patients' characteristics

	n	Minimum	Maximum	Mean	Standard deviation
Age	468	18	80	43.32	14.20
Total number of teeth	468	4	32	25.22	5.66
Number of implants	468	0	12	0.18	0.89
Number of decayed teeth	468	0	14	4.03	2.60
Number of filled teeth	468	0	19	3.61	3.46
Number of missing teeth	468	0	28	6.81	5.69
			n		%
Sex	Male		209		44.7
	Female		259		55.3
Presence of fixed prosthesis	No		315		67.3
	Yes		153		32.7
Radiographic bone loss stage	Stage 1		63		13.5
	Stage 2		122		26.1
Extension	Stage 3/4		139		29.7
	<30%		62		13.2
	≥30%		261		55.8
Full mouth diagnosis	Stage 1		56		12.0
	Stage 2		122		26.1
	Stage 3		125		26.7
	Stage 4		19		4.1
Radiographic bone loss	Stage 1		173		37.0
	Stage 2		227		48.5
	Stage 3		68		14.5
EPL grade	Grade 1 or 2		74		50.0
	Grade 3		74		50.0
Radiographic bone loss localization	Vertical		79		53.4
	Horizontal		69		46.6
Radiographic profile	Cone-shaped		76		51.4
	j-shaped		72		48.6
Presence of furcation involvement	Yes		116		78.4
	No		32		21.6
Furcation involvement grade	Grade 1		6		5.2
	Grade 2		69		60.0
	Grade 3 or 4		40		34.8
Presence of restoration material in the related tooth	No		63		42.6
	Yes		85		57.4
Caries status of the related tooth	Yes		132		89.2
	No		16		10.8

The localization of bone loss (vertical vs. horizontal; p=0.503), furcation involvement status (p=0.931), and furcation grades (p=0.668) did not differ significantly by sex (Table 2). The diagnosis did not differ significantly by the localization of bone loss or its extent (p>0.05). However, the horizontal region mostly had stage 1 radiographic bone loss, while the vertical region mostly had stage 2 radiographic bone loss (p<0.05; Table 3).

The diagnosis did not differ significantly by furcation grade or extent (p>0.05). However, the patients with stage 1 or 2 bone loss mostly had grade 2 furcation levels, while those with stage 3 or 4 bone loss mostly had grade 3 or 4 furcation levels (p<0.05; Table 3). The localization of bone loss did not differ significantly by tooth group (p>0.05; Table 4).

The mean age was higher for patients with EPL teeth than patients having teeth without EPL (p<0.05). The mean number of teeth was higher for patients without EPLs than with teeth with EPL (p<0.05). The sex ratio did not differ significantly between patients with and without EPL (Table 5).

Table 2. Relationships between sex and the localization of bone loss, furcation involvement, and grade.

	Sex		Test statistic	p
	Male	Female		
Localization			0.449	0.503
Vertical				
n	41	38		
%	51.9	48.1		
%G	56.2	50.7		
Horizontal				
n	32	37		
%	46.4	53.6		
%G	43.8	49.3		
Presence of furcation involvement			0.007	0.931
Yes				
n	57	59		
%	49.1	50.9		
%G	78.1	78.7		
No				
n	16	16		
%	50.0	50.0		
%G	21.9	21.3		
Furcation grade			0.955**	0.668
Grade 1				
n	4	2		
%	66.7	33.3		
%G	7.1	3.4		
Grade 2				
n	32	37		
%	46.4	53.6		
%G	57.1	62.7		
Grade 3 or 4				
n	20	20		
%	50.0	50.0		
%G	35.7	33.9		

Key: G, sex; **, Fisher's exact test.

Table 4. Relationships between localization of bone loss and tooth groups

	Localization		Test statistic	p
	Vertical	Horizontal		
Groups			4.824**	0.433
Maxillary molars				
n	32	31		
%	50.8	49.2		
Maxillary premolars				
n	4	4		
%	50.0	50.0		
Maxillary incisors				
n	0	4		
%	0.0	100.0		
Mandibular molars				
n	29	30		
%	49.2	50.8		
Mandibular premolars				
n	8	2		
%	80.0	20.0		
Mandibular incisors				
n	3	1		
%	75.0	25.0		

Key: **, Fisher's exact test

The patients with stage 1 or 2 bone loss mostly had teeth with EPL, while those with stage 3 or 4 mostly did not have teeth with EPL (p<0.05). The patients with <30% localized extent mostly had teeth with EPL (p<0.05). The patients with full mouth stage 1 or 2 diagnoses mostly had teeth with EPL, while those with full mouth stage 3 or 4 diagnoses mostly did not have teeth with EPL (p<0.05). The patients with grade A or B bone loss mostly had teeth with EPL, while those with grade C bone loss mostly did not have teeth with EPL (p<0.05; Table 6). Maxillary incisors, mandibular premolars, and mandibular incisors mostly had a "j" profile (Table 7).

Table 6. Relationships between EPL tooth status and bone loss grade.

	Have an EPL		Test statistic	p
	Yes	No		
Bone loss grade			117.057	<0.001*
A				
n	164	9		
%	94.8	5.2		
B				
n	133	94		
%	58.6	41.4		
C				
n	23	45		
%	33.8	66.2		

Key: *, p<0.05

Table 3. Relationships between localization of bone loss, the furcation grade, EPL tooth status and radiographic bone loss stage, extent, and diagnosis.

	Localization		Furcation grade			Have an EPL	
	Vertical	Horizontal	Grade 1	Grade 2	Grades 3 and 4	Yes	No
Radiographic bone loss stage							
Stage 1							
n	4	8	1	6	0	51	12
%	33.3	66.7	14.3	85.7	0.0	81.0	19.0
Stage 2							
n	33	15	3	24	8	74	48
%	68.8	31.3	8.6	68.6	22.9	60.7	39.3
Stages 3 and 4							
n	41	45	2	38	31	53	86
%	47.7	52.3	2.8	53.5	43.7	38.1	61.9
Test statistic/p	7.839**/0.033*			11.762/0.040*		34,696/<0.001*	
Extent							
Localized form							
n	10	6	1	8	2	46	16
%	62.5	37.5	9.1	72.7	18.2	74.2	25.8
Generalized form							
n	68	61	5	60	37	132	129
%	52.7	47.3	4.9	58.8	36.3	50.6	49.4
Test statistic/p	1.107**/0.575			3.222**/0.503		11.297/<0.001*	
Full mouth diagnosis							
Stage 1							
n	4	7	1	6	2	45	11
%	36.4	63.6	11.1	66.7	22.2	80.4	19.6
Stage 2							
n	29	13	2	22	5	80	42
%	69.0	31.0	6.9	75.9	17.2	65.6	34.4
Stage 3							
n	39	38	3	37	24	48	77
%	50.6	49.4	4.7	57.8	37.5	38.4	61.6
Stage 4							
n	6	9	0	3	8	4	15
%	40.0	60.0	0.0	27.3	72.7	21.1	78.9
Test statistic/p	7.217/0.125			13.186**/0.066		42.818/<0.001*	

Key: *, p<0.05; **, Fisher's exact test

Table 5. Comparison of patients' age, sex, and number of teeth by EPL status.

	n	Mean	Standard deviation	Rank average	Test statistic	p
Age						
Without EPL	320	40.66	14.78	208.64	15403.5**	<0.001*
With EPL	148	49.08	10.83	290.42		
Total number of teeth						
Without EPL	320	25.43	5.81	244.00	20640.5**	0.025*
With EPL	148	24.77	5.32	213.96		

	Have an EPL		Test statistic	p
	Yes	No		
Sex				
Male			1.907	0.167
n	136	73		
%	65.1	34.9		
%S	42.5	49.3		
Female				
N	184	75		
%	71.0	29.0		
%S	57.5	50.7		

Key: **, Mann–Whitney U test; S, status.

Table 7. Relationships between radiographic profile and tooth number.

	Radiographic profile		Test statistic	p
	Cone-shaped	j-shaped		
Groups			11.324	0.031*
Maxillary molars				
n	33	30		
%	52.4	47.6		
%P	43.4	41.7		
Maxillary premolars				
n	4	4		
%	50.0	50.0		
%P	5.3	5.6		
Maxillary incisors				
n	1	3		
%	25.0	75.0		
%P	1.3	4.2		
Mandibular molars				
n	36	23		
%	61.0	39.0		
%P	47.4	31.9		
Mandibular premolars				
n	1	9		
%	10.0	90.0		
%P	1.3	12.5		
Mandibular incisors				
n	1	3		
%	25.0	75.0		
%P	1.3	4.2		

Key: *, p<0.05; P, profile.

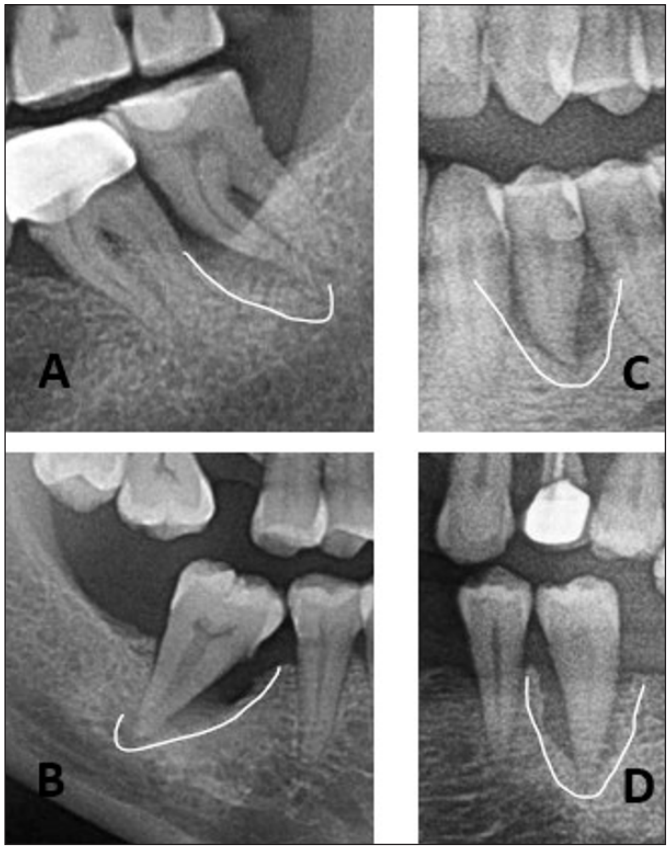

Figure 1. Different radiographic images: j-shape (A-B) and cone-shape (C-D)

DISCUSSION

This study explored the prevalence and radiographic characteristics of EPLs according to the 2017 World Workshop on Periodontal and Peri-Implant Disease Classification. Evaluation criteria include age, sex, the total number of teeth, the number of implants, the number of carious teeth, the number of filled teeth, the number of missing teeth, fixed prosthesis status, radiographic bone loss stage, extension status, full mouth diagnosis, radiographic bone loss, EPL grade, radiographic bone loss localization, furcation involvement, restorative material status of the relevant tooth, and the carious status of the relevant tooth. While previous classifications were used in studies on the presence of EPLs,[8-12] and there is only one study on the presence of EPL using the new classification has been published.[6] Therefore, our study is distinctive in detecting the presence of EPL according to the new classification. In addition, our study aimed to contribute to the literature by referring to the parameters not clarified in previous studies.

EPL was diagnosed in 148 of the 468 radiographs in this study, corresponding to 31.6% of this population. This rate varies widely in other studies,[8-10,12] possibly due to differences in the study population and the number of radiographs.

The EPL diagnosis should respond to tooth preservation or extraction. In evaluation, there are three types of EPL dental diagnoses: hopeless, classified for extraction; poor or good, classified for treatment.[1] EPLs have always been challenging to treat due to their lower success rate than endodontic or periodontal lesions alone. Periodontal involvement following endodontic lesions is complex because it is often accompanied by massive periodontal destruction that can compromise tooth viability.[13] Under the new classification in periodontology, EPLs are mainly classified by combining radiographic images with clinical findings, resulting in clearer classification concepts. In our study, importance was given to analyzing the shape of the lesions to reduce the impact of the lack of clinical data. It was found that mostly stage 1 radiographic bone loss was in the horizontal region and mostly stage 2 radiographic bone loss was in the vertical region. In addition, the patients with stage 1 or 2 bone loss mostly had grade 2 furcation involvements, while those with grade 3 or 4 mostly had grade 3 or 4. These results are consistent with the characteristics of the furcation lesions.[14]

In our study, the mean age was higher for patients with EPLs than teeth without EPL. These results are similar to the study by Walton,[6] suggesting that EPL development may be an age-related condition. A higher prevalence of EPLs in patients aged 31–40 years was shown in the

study by Prashaanthi et al.[10] That range is similar to the age of our study cohort. The mean number of teeth was higher for patients without EPL than teeth with EPL. The high number of teeth may also reduce the risk of EPL development by reducing the number of caries due to regular oral hygiene habits. Considering behavioral factors such as oral hygiene habits in future studies is valuable in determining the validity of this parameter.

In our study, the patients with stage 1 or 2 bone loss mostly had teeth with EPL, while those with stage 3 or 4 mostly did not have teeth with EPL. The patients with full mouth stage 1 or 2 diagnoses mostly had teeth with EPL, while those with full mouth stage 3 or 4 diagnoses mostly did not have teeth with EPL. The patients with grade A or B bone loss mostly had teeth with EPL, while those with grade C bone loss mostly did not have teeth with EPL. This finding suggests that more tooth extraction is preferred in cases with advanced periodontitis. This interpretation can be made for population reasons since age is more advanced in these patient groups.

Teeth with a j-shape or cone-shape in radiographic images are usually extracted because of the coexistence of EPLs and a hopeless prognosis. Historically, clinicians have attempted to save these teeth with various treatments, including scaling and root planning, periodontal regeneration techniques, and endodontic surgery. However, the prognosis is unfavorable.[15,16] Therefore, the prevalence of teeth with a j-shape or cone-shape in radiographic images was comparable and similar to the study by Ruetters et al.[6]

Similar to previous studies,[6,8] EPLs were most frequently observed in molars in our study. This result is unsurprising due to lack of access for brushing molar areas and the periodontal treatment of those areas.[1] Restorations (57.4%) or caries (89.2%) were detected in most teeth with EPL. Restorations with inadequate coronal closure may affect the development of EPL. The presence of caries may also increase the risk of EPL by causing pulp infections.

One limitation of this study was that only panoramic radiographs were used since periapical radiographs, cone beam computed tomography (CBCT) images, and additional clinical findings were unavailable. Clinical findings and CBCT may help for distinguishing patients with active and inactive periodontal disease states, which is impossible with two-dimensional radiographic images alone. In addition, staging by radiographs alone is not as valid as staging with additional clinical and anamnestic information, and grading is not possible. Nevertheless, each image should be examined for common or rare findings to provide a complete assessment of the radiographic anatomy. Panoramic radiographs have also some limitations in image clarity and reliability. Therefore, they were not used to measure precise radiographic bone loss for anterior teeth staging to avoid inaccurate estimates. In addition, visual disturbances due to superposition caused by imaging or improper positioning of the patient's head were also excluded from this study. Caries, periapical inflammation, periodontal bone loss (PBL), and EPLs were considered easily detectable on periapical radiographs, further justifying scientific research. CBCT is also increasingly used in daily practice.[17] A three-dimensional image is more precise than a two-dimensional image and allows multiple viewing layers to be displayed. A problem with CBCT use may be inexperience, leading to misreading the image for artifacts and grayscales.[18] In addition, our study population does not reflect an entire population since it comprised patients attending a university hospital-based clinic with many patients. Therefore, care should be taken when interpreting the study's results.

CONCLUSION

This prevalence study detecting caries, periodontal status, PBL, and EPLs using panoramic radiographs documented moderate to significant reliability data for the classifications proposed by Working Group 2 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. Besides the complexity of concurrent endodontic and periodontic treatments, the clinical procedure is complex, the sequence of procedures must be rigorous, and selecting appropriate materials is critical for optimal and successful treatment in these EPL cases.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of İstanbul Medipol University Non-invasive Clinical Studies Ethics Committee (Date: 2023, Decision No: 64).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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