

EVALUATION OF ROOT-FILLED TEETH BY PERIAPICAL AND ENDODONTIC STATUS SCALE (PEES): A CBCT STUDY

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Abstract

Aim. The aim of study was to assess the root-filled teeth with periapical lesions by using Periapical and Endodontic Status Scale (PEES) index. **Materials and method.** The study group included 166 filled root canals (70 molars and premolars) in 42 patients (gender: 12 males, 32 females; mean age 35.90 ± 10.571 yrs.) treated in Clinical Base of Faculty of Dental Medicine, U.M.F. "Grigore T.Popa" Iasi. The evaluation of root canals and periapical areas was performed by using the two components of Periapical and Endodontic Status Scale (PEES) index, COPI and ETTI. **Results.** Distribution of COPI components in the study group was as follows: COPI D: 30,7% D1, 69,3% D3; COPI R: 27,1% R1, 70,5% R2, 2,4% R3; COPI S: S1 16,3%, S2 21,7%, S3 62%. Distribution of ETTI components in the study group was as follows: ETTI L: 42,2% L1, 43,4% L2, 5,4% L3, 5,4% L4, 3,6% L5; ETTI H: 36,7% H1, 63,3% H2; ETTI CS: 10,8% CS1, 89,2% CS2; ETTI CF: 3,6% CF1, 9% CF2, 5,4% CF3, 81,9% CF5. **Conclusions.** In endodontically treated teeth with apical periodontitis, PEES indices allowed to detect 62% of root canals with periapical lesions with diameter over 5 mm, while more than two thirds of teeth roots had periapical lesions extended in cortical bone (69,3%) affecting more than one root (70,2%). All teeth roots with apical radiolucency and non-treated root canals as well as roots with perforations or resorptions had apical lesions with diameter over 5 mm extended in cortical bone. The presence of apical radiolucency more than one root was associated to overfilling or root resorption.

Key words: root canals, periapical lesions, PEES, COPI, ETTI

INTRODUCTION.

Apical periodontitis, characterized by a radiolucent area at the apex of the tooth root, is monitored through clinical and radiographic evaluations, with radiological assessment being crucial for accurate and timely diagnosis [1]. Periapical digital radiographs have good diagnostic values and low to moderate agreement with the histopathological assessment, while CBCT imaging showed excellent diagnostic accuracy and good agreement with histopathology, according to research groups [2, 3, 4]. Considering the importance of imagistic diagnostic of periapical lesions, diagnostic indexes for the

evaluation of periapical area were implemented in the endodontic field [5].

Practitioners in endodontic field used many years periapical index (PAI), introduced by Orstavik et al. (1986), based on classification of periapical lesions into five categories according to periapical radiographs of teeth with confirmed histological diagnosis [6]. This PAI index, based on 2D periapical radiographs, had the disadvantage of super-imposition of anatomical structures and geometric distortion of the periapical area. While tooth type, number of roots, size and number of lesions, location influence treatment prognosis [7, 8], PAI index cannot

be used to assess these parameters. Patel et al (2007) proved the benefits of cone-beam computed tomography (CBCT) over radiographic examen, to provide more relevant information in the periapical area [9], while Estrela et al. (2008) developed and implemented periapical index (CBCT-PAI) useful both in the increase of sensitivity of positive diagnostic incidence and accuracy diagnostic in epidemiologic studies [10]. CBCT-PAI index express morphological changes of periapical bone give only the periapical bone lesion size in mm, with limited diagnostic and prognostic value [11]. CBCTPAI can be used to assess lesion size, plus two additional variables of cortical bone expansion and destruction, but some relevant parameters are not assessed.

In this context, Periapical and Endodontic Status Scale (PESS), based on periapical bone lesion and endodontic treatment quality evaluation by CBCT, was proposed by Venskutonis (2015) [12]. This index has the benefit of analyzing both, periapical pathology with surrounding tissues, as well as endodontic treatment quality evaluation [13]. This new index can bypass the challenges for periapical radiography given by 2D images properties, acquiring technique, morphologic variations of the roots, as well as the bone density in periapical area that might influence the possibility to detect periapical lesions in early stages [14, 15].

PESS is based on two components, Complex Periapical Index (COPI) and Endodontically Treated Tooth Index (ETTI) [12, 13].

COPI is used for radiological identification and classification of

periapical bone lesions, while ETTI is designed for the evaluation of the endodontic treatment quality. COPI parameters are related to the features of the periapical lesion: (1) size of the lesion (S), which may be directly related to endodontic treatment outcome results [16, 17]; (2) relationship between root and lesion (R), which is an important pretreatment factor, because the outcome of endodontic lesion treatment on multi-rooted teeth is worse [18, 19]; (3) location of bone destruction (D), which can be related to more complicated endodontic or surgical treatment due to the contact of radiolucency with important anatomical structures or destruction of cortical bone [20, 21]. Length of root canal filling, homogeneity, coronal seal, and existing complications all influence endodontic treatment outcome [22, 23].

ETTI index include four parameters related to the endodontic treatment assessment, associated to the treatment outcome prognostic [23]: length of the root canal filling (L), which is measured in terms of the distance between the apical end of the visible filling material till the radiographic root apex; homogeneity of the root canal fillings (H), evaluating filling condensation degree; coronal seal (CS), related to the treatment outcome; presence of complications/failures (CF) can significantly influence the prognosis. In this context, PESS gives more information about the disease over CBCTPAI [12, 13].

The aim of study was to assess the periapical area and quality of endodontic treatments of the root-filled teeth with periapical pathology by using PEES index (COPI, ETTI).

MATERIALS AND METHOD

The study group included 166 filled root canals (70 molars and premolars) in 42 patients (gender: 12 males, 32 females; mean age 35.90 ± 10.571 yrs.) treated in Clinical Base of Faculty of Dental Medicine, U.M.F. "Grigore T.Popa" Iasi. The evaluation of root canals and periapical areas was performed by using the two components of Periapical and Endodontic Status Scale (PEES) index, COPI and ETTI. Parameters of study

group are exposed in table 1.1 (per teeth) and table 1.2 (per filled root-canals). Most teeth are located in maxillary arch (54,3%) and molar dental group (78,6%). When arch and dental group are combined, mandibular molars are the most frequent root canals filled teeth (41,4%), followed by maxillary molars (37,1%). Most filled root canals in the study group were found in females (76,5%), patients in age group 20-40 yrs. (83,7%), and molars (83,7%).

Table 1.1. Features of study group (per teeth)

		n	%
Location (arch)	MD	32	45.7
	MX	38	54.3
Location (dental group)	M	55	78.6
	PM	15	21.4
Location (arch-dental group)	MX-PM	12	17.1
	MX-M	26	37.1
	MD-PM	3	4.3
	MD-M	29	41.4
Total		70	100.0

Table 1.2. Features of study group (root canals)

		n	%
Gender	F	127	76.5
	M	39	23.5
Age group	20-40 ani	139	83.7
	41-60 ani	27	16.3
Location (arch)	MD	84	50.6
	MX	82	49.4
Location (dental group)	M	139	83.7
	PM	27	16.3
Location (arch-dental group)	MX-PM	21	12.7
	MX-M	61	36.7
	MD-PM	6	3.6
	MD-M	78	47.0
Total		166	100.0

The components of PEES Index are exposed in Table 2.1 (Complex Periapical Index- COPI) and Table 2.2 (Endodontically Treated Tooth Index- ETTI).

Table 2.1. Components of Complex Periapical Index (COPI)
(adapted after Venskutonis, 2016)

S (Size of the radiolucent lesion)
S0: Widening of the periodontal ligament not exceeding two times the width of the lateral periodontal ligament S1: Diameter of small well-defined radiolucency up to 3 mm S2: Diameter of medium well-defined radiolucency 3-5 mm S3: Diameter of large well-defined radiolucency >5 mm
R (Relationship between root and radiolucent lesion)
R0: No radiolucency, when widening of the periodontal ligament is not exceeding two times the width of the lateral periodontal ligament R1: Radiolucent lesion appears on one root R2: Radiolucent lesion appears on more than one root R3: Radiolucent lesion with involvement of furcation
D (Location of bone destruction)
D0: No radiolucency, when widening of the periodontal ligament is not exceeding two times the width of the lateral periodontal ligament D1: Radiolucency around the root D2: Radiolucency is in contact with important anatomical structures D3: Destruction of cortical bone

Table 2.2. Endodontically Treated Tooth Index (ETTI)
(adapted after Venskutonis, 2016)

L (Length of the root canal filling)
L1: 0–2 mm from radiographic apex L2: >2 mm from radiographic apex L3: Overfilling (extrusion of material through the apex) L4: Filling material visible only in pulp chamber L5: Filled canal of a surgically treated root
H (Homogeneity of the root canal fillings)
H1: Complete obturation (homogenous appearance of the root canal filling) H2: Incomplete obturation (voids and porous appearance of the root canal filling)
CS (Coronal seal)
CS1: Adequate (coronal restoration appears intact radiographically) CS2: Inadequate (detectable radiographic signs of overhangs, open margins, recurrent caries, or lost coronal restoration)
CF (Complications/failures)
CF0: No complications CF1: Root perforation CF2: Root canal not treated/missed CF3: Root resorption CF4: Root/tooth fracture CF5: Endodontically treated root with radiolucency

Statistical analysis

The statistical analyses were performed in SPSS 29.0. The qualitative variables were characterized through

frequencies distributions. The quantitative variables were characterized through descriptive statistics (averages, standard

deviations). $P < 0.05$ was the threshold for significance.

RESULTS

Table 3 exposes the distribution of COPI and ETTI components in the study group (root canals).

Distribution of COPI components in the study group was as follows:

- COPI D: 30,7% D1, 69,3% D3;
- COPI R: 27,1% R1, 70,5% R2, 2,4% R3;
- COPI S: S1 16,3%, S2 21,7%, S3 62%.

Distribution of ETTI components in the study group was as follows:

- ETTI L: 42,2% L1, 43,4% L2, 5,4% L3, 5,4% L4, 3,6% L5;
- ETTI H: 36,7% H1, 63,3% H2;
- ETTI CS: 10,8% CS1, 89,2% CS2;
- ETTI CF: 3,6% CF1, 9% CF2, 5,4% CF3, 81,9% CF5.

Tables 4.1-4.3 expose the distribution of ETTI components related to COPI D, R, S.

Most frequent ETTI components associated with COPI D3 (destruction of cortical bone) in root canals were L5 (apical radiolucency) and L4 (non-treated root canal) (100%) as well as CF1 (root perforation) and CF3 (root resorption) (100%) (Table 4.1). Most frequent ETTI components associated with COPI R2 (apical lesion more than one root) were L5 (apical radiolucency) and L3 (overfilled root canal) (100%) as well as CF3 (root resorption) (100%) (Table 4.2). Most frequent ETTI components associated with COPI S3 (AP diameter > 5mm) were L5 (apical radiolucency) and L4 (non-treated root canal) (100%) as well as CF1 (root perforation) and CF3 (root resorption) (100%) (Table 4.3).

Table 3. Distribution of COPI and ETTI components in study group (root canals)

		n	%
COPI_D	D1	51	30.7
	D3	115	69.3
COPI_R	R1	45	27.1
	R2	117	70.5
	R3	4	2.4
COPI_S	S1	27	16.3
	S2	36	21.7
	S3	103	62.0
ETTI_L	L1	70	42.2
	L2	72	43.4
	L3	9	5.4
	L4	9	5.4
	L5	6	3.6
ETTI_H	H1	61	36.7
	H2	105	63.3
ETTI_CS	CS1	18	10.8
	CS2	148	89.2
ETTI_CF	CF1	6	3.6

	CF2	15	9.0
	CF3	9	5.4
	CF5	136	81.9
Total		166	100.0

Table 4.1. Distribution of COPI D related to ETTI components in study group (root canals)

		COPI_D				Total		p-value†
		D1		D3		n	%	
		n	%	n	%			
ETTI_L	L1	27	38.6%	43	61.4%	70	100.0%	0.004**
	L2	18	25.0%	54	75.0%	72	100.0%	
	L3	6	66.7%	3	33.3%	9	100.0%	
	L4	-	-	9	100.0%	9	100.0%	
	L5	-	-	6	100.0%	6	100.0%	
ETTI_H	H1	18	29.5%	43	70.5%	61	100.0%	0.796
	H2	33	31.4%	72	68.6%	105	100.0%	
ETTI_CS	CS1	-	-	18	100.0%	18	100.0%	0.003**
	CS2	51	34.5%	97	65.5%	148	100.0%	
ETTI_CF	CF1	-	-	6	100.0%	6	100.0%	0.032*
	CF2	3	20.0%	12	80.0%	15	100.0%	
	CF3	-	-	9	100.0%	9	100.0%	
	CF5	48	35.3%	88	64.7%	136	100.0%	
Total		51	30.7%	115	69.3%	166	100.0%	

†Pearson Chi-squared test; p < 0.05 statistically significant; p < 0.01 statistically highly significant

Table 4.2. Distribution of COPI R related to ETTI components in study group (root canals)

		COPI_R						Total		p-value†
		R1		R2		R3		n	%	
		n	%	n	%	n	%			
ETTI_L	L1	12	17.1%	54	77.1%	4	5.7%	70	100.0%	0.006**
	L2	30	41.7%	42	58.3%	-	-	72	100.0%	
	L3	-	-	9	100.0%	-	-	9	100.0%	
	L4	3	33.3%	6	66.7%	-	-	9	100.0%	
	L5	-	-	6	100.0%	-	-	6	100.0%	
ETTI_H	H1	12	19.7%	45	73.8%	4	6.6%	61	100.0%	0.011*
	H2	33	31.4%	72	68.6%	-	-	105	100.0%	
ETTI_CS	CS1	6	33.3%	12	66.7%	-	-	18	100.0%	0.665
	CS2	39	26.4%	105	70.9%	4	2.7%	148	100.0%	
ETTI_CF	CF1	6	100.0%	-	-	-	-	6	100.0%	0.001**
	CF2	6	40.0%	9	60.0%	-	-	15	100.0%	
	CF3	-	-	9	100.0%	-	-	9	100.0%	
	CF5	33	24.3%	99	72.8%	4	2.9%	136	100.0%	
Total		45	27.1%	117	70.5%	4	2.4%	166	100.0%	

†Pearson Chi-squared test; p < 0.05 statistically significant; p < 0.01 statistically highly significant

Table 4.3. Distribution of COPI S related to ETTI components in study group (root canals)

		COPI_S						Total		p-value†
		S1		S2		S3		n	%	
		n	%	n	%	n	%			
ETTI_L	L1	21	30.0%	10	14.3%	39	55.7%	70	100.0%	<0.001**
	L2	-	-	26	36.1%	46	63.9%	72	100.0%	
	L3	6	66.7%	-	-	3	33.3%	9	100.0%	
	L4	-	-	-	-	9	100.0%	9	100.0%	
	L5	-	-	-	-	6	100.0%	6	100.0%	
ETTI_H	H1	12	19.7%	6	9.8%	43	70.5%	61	100.0%	0.018*
	H2	15	14.3%	30	28.6%	60	57.1%	105	100.0%	
ETTI_CS	CS1	-	-	-	-	18	100.0%	18	100.0%	0.002**
	CS2	27	18.2%	36	24.3%	85	57.4%	148	100.0%	
ETTI_CF	CF1	-	-	-	-	6	100.0%	6	100.0%	0.022*
	CF2	-	-	3	20.0%	12	80.0%	15	100.0%	
	CF3	-	-	-	-	9	100.0%	9	100.0%	
	CF5	27	19.9%	33	24.3%	76	55.9%	136	100.0%	
Total		27	16.3%	36	21.7%	103	62.0%	166	100.0%	

†Pearson Chi-squared test; p < 0.05 statistically significant; p < 0.01 statistically highly significant

DISCUSSIONS

PESS is a recent index that was proposed to be used in clinical practice and epidemiological studies to allow research groups worldwide to calibrate and build combined data [12, 13].

In our study, the use of COPI index proved that most cases of bone destruction were extended to bone destruction (69,3%), while only 30,7% were limited around root; also, regarding the relation apical periodontitis and root, most cases of apical lesions were extended more than one root (70,5%), confirmed by predominance of periapical lesions with diameter over 5 mm (62%). The characterization of the periapical lesions in the pre-operative stage may influence the outcome of root canal treatment. COPI peri-apical index has prognostic value due to its suggested periapical lesions treatment risk degrees.

Thus, COPI index parameter was grouped into three different treatment risks: mild (green color), moderate (yellow color), and high (red color) [12, 13]. When apical periodontitis is extended on several roots in a multi-rooted tooth, the treatment outcome might be different when compared to periapical lesion limited to one root canal [19]. The location and severity of the lesions, such as destruction of cortical bone or contact with the sinus or the mandibular canal, can be more easily missed using periapical radiography when compared to CBCT [20, 21].

Regarding ETTI components, while 42,2% of root canals were properly filled, 43,4% had short root canals fillings. Also, 63,3% of root canals had non-homogenous root canal fillings. Both, under-filling and non-homogenous root canals fillings were found to be correlated to the presence of

periapical lesions in root-filled teeth [24]. One research group reported, regarding the quality of endodontic treatments, that 59% of teeth with poor root canal fillings were diagnosed with apical periodontitis versus 15,2% of teeth with adequate root canal fillings [25]. Moreover, 89,2% of the assessed root canals were associated to teeth with poor coronal sealing (gap, recurrent caries). Low quality of marginal coronal sealing in teeth with improper root canals fillings was significantly related to the presence of apical periodontitis [26-31]. Regarding the fourth component of ETTI index (complications/failures), most root canals (81,9%) had radiolucent periapical areas, while 9% were not treated or missed root canals, and 3,6% had root perforations. Teeth with missed root canals were found to be 3.658 times more likely to be associated with apical periodontitis [32]. Missed canals were found in 12.0% of root-filled teeth while teeth with untreated canals had periapical pathology in 82.6% of the cases [33]. ETTI index is useful to understand the possible risk factors (short or over filling

length, poor homogeneity, poor marginal coronal sealing) of the apical periodontitis as well as number of roots involved.

Our results prove the possibility of using newly developed PESS index to evaluate both the status of periapical tissues, and endodontic treatment quality.

CONCLUSIONS.

In endodontically treated teeth with apical periodontitis, PEES indices allowed to detect 62% of root canals with periapical lesions with diameter over 5 mm, while more than two thirds of teeth roots had periapical lesions extended in cortical bone (69,3%) affecting more than one root (70,2%). All teeth roots with apical radiolucency and non-treated root canals as well as roots with perforations or resorptions had apical lesions with diameter over 5 mm extended in cortical bone. The presence of apical radiolucency more than one root was associated to overfilling or root resorption.

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