The relation between PAI and lesion size on CBCT and periapical status related to the quality of coronal restorations and root fillings

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This certifies that the masters thesis
of Mina Park is approved.

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감사의 글

제가 보존과 대학원에 입학했을 때부터 여러 면으로 부족한 저를 이끌어주시고 논문이 완성되기 까지 세심한 지도와 따뜻한 격려를 해주신 김의성 교수님께 깊은 감사를 드립니다. 그리고 애정 어린 관심으로 조언을 아끼지 않으신 이찬영 교수님과 항상 저에게 보다 나은 방향을 끊임없이 제시해 주신 정일영 교수님께도 깊은 감사를 드립니다. 또한 보존학 공부를 할 기회를 주시고 저를 좋은 의사로 거듭날 수 있도록 많은 가르침을 주신 이승종 교수님, 노병덕 교수님, 박성호 교수님, 박정원 교수님, 신수정 교수님, 신유석 교수님, 송민주 교수님께도 감사의 말씀을 전합니다.

대학원 과정동안 저에게 따뜻한 도움을 주었던 의국 선배님, 후배님들께도 감사의 마음을 전합니다. 또한 바쁜 와중에도 성실히 실험을 도와준 김수연 선생님에게 고마운 마음을 전하며 행운을 기원합니다. 마지막으로 항상 헌신적인 희생과 사랑으로 저를 이 자리에 있게 해주신 부모님, 부족한 며느리에게 넘치는 사랑과 격려를 베풀어주시는 시부모님, 그리고 언제나 큰 힘이 되어주는 남편과 삶의 원동력인 예나에게 고마운 마음은 전하며 함께 기쁨을 나누고 싶습니다.

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저자 씀

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ABSTRACT

The relation between PAI and lesion size on CBCT and periapical status related to the quality of coronal restorations and root fillings

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(Directed by Prof. Euiseong Kim, D.D.S., M.S.D., Ph.D.)

The purpose of this study was (1) to examine efficacy of digital periapical (PA) radiographs for identification of PA lesion compared to cone-beam computed tomography (CBCT) and (2) to evaluate the relationship of the quality of the coronal restoration and of the root canal obturation on the radiographic periapical status of endodontically treated teeth.

1. The relationship between PAI and lesion size on CBCT

The CBCT images and periapical radiograph of the 302 roots of the 290 endodontically treated teeth that had previously been obtained in the Dental Hospital of Yonsei University College of Dentistry were examined. On axial CBCT scans, buccolingually the widest length of PA lesion around root apex was measured and the soundness of buccal and lingual cortical bone was

recorded. Periapical radiographic images were coded with PAI scoring system by two independent examiners. Statistically significant differences between the PAI score and the PA lesion size on CBCT were evaluated by Spearman's rank correlation. The results of this study demonstrated that PAI score was positively correlated with PA lesion size on CBCT and 68.2% of 157 PA lesions within cancellous bone were evaluated more than PAI score 2. PAI score was positively correlated with PA lesion size on CBCT and 68% of PA lesions within cancellous bone were detected on digital PA radiographs.

2. Periapical status related to the quality of coronal restorations and root fillings

Full-mouth radiographs and periapical radiographs from new patients at Dental Hospital of Yonsei University College of Dentistry were examined. A total of 1030 endodontically treated teeth restored with a full veneer crown type restoration were evaluated two independent examiners. The quality of endodontic and the periapical status of endodontically treated teeth were evaluated by radiographic criteria. The quality of coronal restorations of endodontically treated teeth were evaluated by radiographic criteria and by reviewing the intraoral examination records as well. Root fillings were categorized as good(GE) or poor(PE), and coronal restorations were categorized as good(GR) or poor(PR). The periapical status were categorized as "absence of periradicular Inflammation"(API) or "presence of periradicular

inflammation"(PPI). The API rate for all endodontically treated teeth was 59.1%. Both qualities of the endodontic filling and coronal restoration affected significantly the periapical status and there is no significant difference in the odds of API between 2 parameters. The difference of API rate of the group with good endodontic filling (GE, 75.5%) and the group with poor endodontic filling (PE, 50.1%) was statistically significant. The difference of API rate of the group with good restoration (GR, 65.3%) and the group with poor restoration (PR, 45.7%) was statistically significant. API of the GE+GR group (82.3%) was statistically significantly different from other three groups (GE+PR, 56.3%, PE+GR, 54.7%, PE+PR, 41.2%), and API of the PE+PR group was statistically significantly different from GE+PR and PE+GR. Both technical qualities of the endodontic treatment and the coronal restoration are of equal importance for periapical health.

Key words: periapical lesion, CBCT, radiographic evaluation, quality of endodontic treatment, coronal restoration

The relation between PAI and lesion size on CBCT and periapical status related to the quality of coronal restorations and root fillings

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I. Introduction

Radiographic examination is essential in diagnosis and treatment planning in endodontics. However, periapical(PA) radiography has limitation that information is rendered in only 2 dimensions. Interpretation is more difficult when the background pattern is complex (Kundel and Revesz, 1976). Investigations of naturally occurring and experimentally created periapical lesions have led many to conclude that a lesion in cancellous bone cannot be detected on the radiograph until it erodes the junctional area between the

cortical bone and cancellous bone, and even the cortical plate itself (Bender and Seltzer, 1961). In contrast, Lee et al reported that periapical lesions can be identified radiographically while still confined to cancellous bone, at least under experimental conditions (Lee and Messer, 1986).

Previous studies used the periapical index (PAI) as a scoring system for assessment of PA status (Brynolf, 1967). The PAI represents an ordinal scale of 5 scores ranging from normal to severe periodontitis with exacerbating features and is based on reference radiographs with confirmed histologic diagnosis originally published by Brynolf. Orstavik et al. applied the PAI to both clinical trials and epidemiologic surveys (Orstavik et al., 1986).

The introduction of cone-beam computed tomography (CBCT) was an important development in dentomaxillofacial radiology and brought a shift from 2- to 3-dimensional data acquisition, image reconstruction, and visualization. In particular for the diagnosis of endodontic pathology, CBCT has important advantages over conventional intraoral radiographs. Lofthag-Hansen et al compared PA radiographs and CBCT for detection of apical pathology in maxillary molars and in mandibular molars (Lofthag-Hansen et al., 2007). This study found that 38% of the lesions were undetected by PA radiography, despite the fact that an additional PA radiograph was taken from a different angle. In a recent study, 34% of roots with PA lesions were detected only on CBCT images (Low et al., 2008). On the other hand, compared to the PA radiograph, CBCT has several disadvantages. The most important is radiation dose to the patient

(Okano et al., 2009). Imaging with CBCT results in a more absorbed dose ranging from 29.62–101.46 mSv, compared with 0.003 mSv for radiographic PA radiographic view.

It is generally accepted that the outcome of root canal treatment is positively associated with the technical quality of the root filling (Sjogren et al., 1990). Restoration of endodontically treated teeth is also required for them to function and prevent coronal leakage. Ray and Trope in a cross-sectional study examined full mouth radiographs to determine the relative importance of the root filling and coronal restoration in establishing and maintaining periapical health of endodontically treated teeth (Ray and Trope, 1995). They found that the quality of the coronal restoration was significantly more important than the quality of the root filling in periapical health. On the contrary, Tronstad et al in a cross-sectional study performed by examining full mouth radiographs conclude that the technical quality of the endodontic treatment as judged radiographically was significantly more important than the technical quality of the coronal restoration when the periapical status of endodontically treated teeth was evaluated (Tronstad et al., 2000).

The purpose of the present study was (1) to examine efficacy of digital periapical (PA) radiographs for identification of PA lesion compared to cone-beam computed tomography (CBCT) and (2) to evaluate the relationship of the quality of the coronal restoration and of the root canal obturation on the radiographic periapical status of endodontically treated teeth.

II. Materials & Methods

1. The relationship between PAI and lesion size on CBCT

Subjects

CBCT images that had previously been obtained in the Dental Hospital of Yonsei University College of Dentistry, Seoul, Korea from January 2011–June 2011 were screened and examined. The radiographs of the 302 roots of the 290 endodontically treated teeth were evaluated. Subjects were selected according to the following criteria; (1) teeth had been previously endodontically treated, and (2) teeth involved were examined with PA radiography and CBCT.

Radiographic Evaluation

The CBCT machine used (Symphony; Ray, Korea) produced isotropic voxels with a size of 0.4 mm, producing submillimeter resolution(90 kVp, 10 mA). The 3-dimensional images were reconstructed with a X-ray viewer (PiViewSTAR software; INFINITT, Korea).

The sizes of radiolucent images suggestive of periapical lesions were measured by using the working tools of PiViewSTAR software. On axial CBCT scans, buccolingually the widest length of PA lesion around root apex was measured (Figure 1). PA lesion-bone junction was used for the most buccal and lingual point of the PA

lesion. Soundness of buccal and lingual cortical bone was recorded.

Radiographic images were coded and stored by two independent examiners. Before the evaluation of the mages, each examiner graded a series of 20 radiographic images not associated with the study sample for calibration between examiners. Instructions for grading images with the PAI scoring system were adapted from Orstavik et al. and are presented in Table1. The examples corresponding to each PAI score are presented in Figure 2. Digital images were evaluated in a random order on a high-resolution 19-inch TFT-LCD monitor (FLATRON N1715S; LG, Korea). After independent evaluation, inter-examiner agreement was assessed by Kappa test. Any disagreement between 2 examiners was discussed until a consensus was reached.

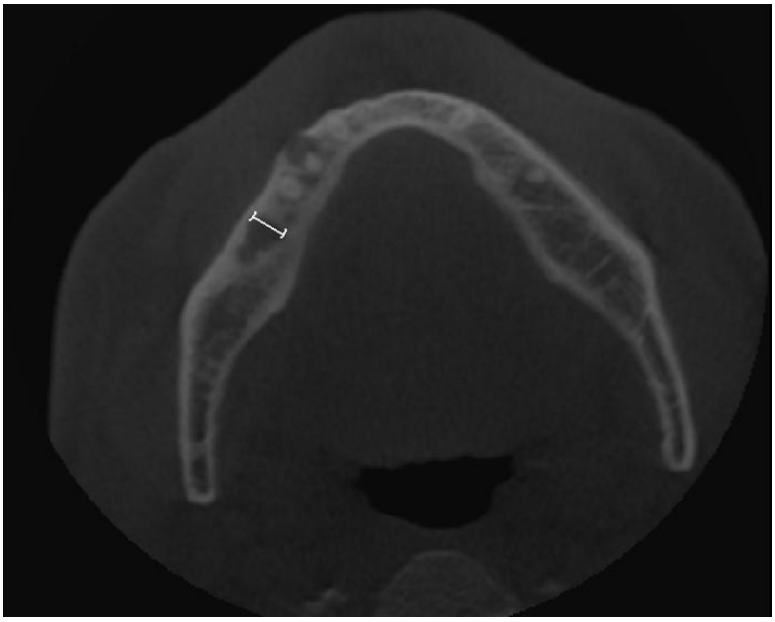

Figure 1. In axial plane buccolingually the widest length of PA lesion around root apex were measured.

Table 1. PAI with verbal descriptors and instructions for scoring

PAI Score		Description of radiographic findings
1	No lesion	Normal periapical structures (a)
2		Small changes in bone structure (b)
3	Lesion	Changes in bone structure with some mineral loss (c)
4		Periodontitis with well-defined radiolucent area (d)
5		Severe periodontitis with exacerbating features (e)

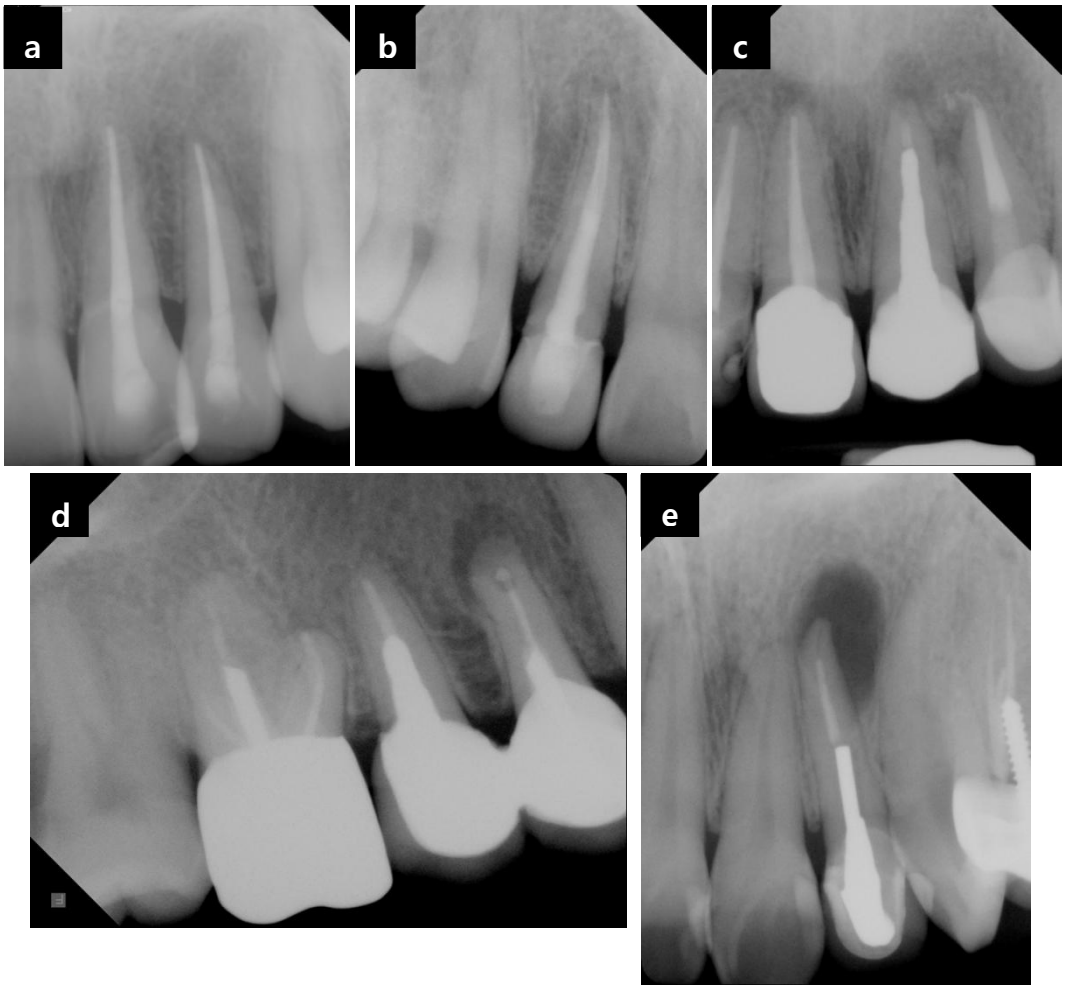

Figure 2. The examples corresponding to each PAI score (a) PAI 1 in the teeth #21, 22, (b) PAI 2 in the tooth #12, (c) PAI 3 in the teeth #11, 21, (d) PAI 4 in the tooth #14, (e) PAI 5 in the tooth #22.

Statistical Analysis

Statistically significant differences were evaluated by Spearman's rank correlation using SAS software(SAS 9.2, SAS Institute Inc., Cary, NC, USA). The level of statistical significance was set at $P<0.05$.

2. Periapical status related to the quality of coronal restorations and root fillings

Subjects

Full-mouth radiographs and periapical radiographs from new patients at Dental Hospital of Yonsei University College of Dentistry, Seoul, Korea from January 2004- February 2012 were examined. The exclusion criteria for subject selection were the following: (1) teeth reported dental treatment for one year previous to the selected radiographs; (2) teeth restorated with post and core type restoration; (3) teeth involved with endo-perio lesion; and (4) teeth with no root canal fillings. The radiographs of the 1030 endodontically treated teeth with a full veneer crown type restoration were selected.

Radiographic evaluation

Two independent observers examined the radiographs using a X-ray viewer (PiViewSTAR software; INFINITT, Korea) on a high-resolution 19-inch TFT-LCD monitor(FLATRON N1715S; LG, Korea). Before the evaluation of the images, each examiner graded a series of 30 radiographic images not associated with the study sample for calibration between examiners. Multirooted teeth were categorized by the root with the most incomplete filling. The teeth were grouped according to the radiographic qualities of the root filling as follows:

1. Good endodontic filling: No voids present. Root filling ending was within 0 to 2mm from the radiographic apex (Figure 3).
2. Poor endodontic filling: Root filling ending more than 2 mm from radiographic apex. Root filling with voids. Root filling poorly dimensioned or poorly condensed (Figure 4).

The coronal restorations were evaluated by the qualitative criteria and by reviewing the intraoral examination records as well.

1. Good restoration: Any permanent restoration that appeared intact radiographically and not reported as having had poor restoration state (Figure 5).
2. Poor restoration: Any permanent restoration with radiographic signs or clinical record of overhangs, recurrent decay or open margins (Figure 6).

The radiographic appearance of the apical one-third of the root and surrounding structures was evaluated and categorized as follows:

1. Absence of periradicular Inflammation (API): if the contours, width and structure of the periodontal ligament were normal or slightly widened (Figure 7).
2. Presence of periradicular inflammation (PPI): if one or more of the criteria of success were not fulfilled (Figure 8).

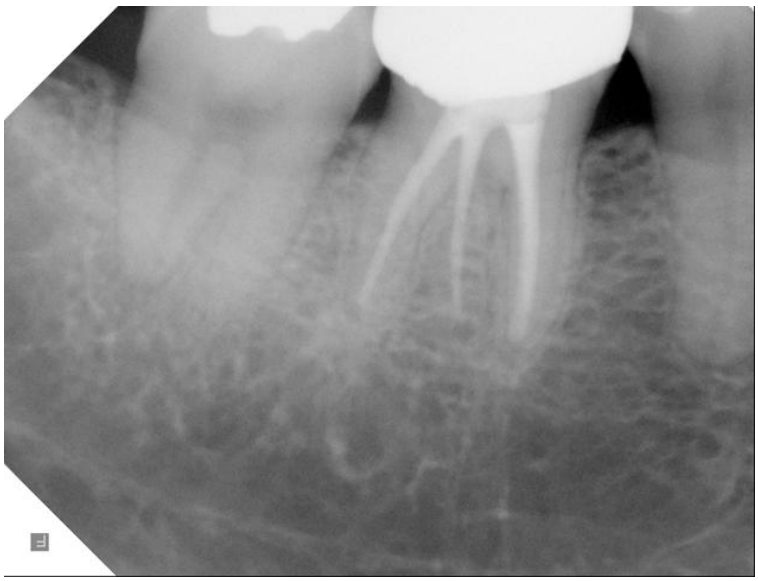

Figure 3. Radiograph of an endodontically treated molar assessed as good endodontic filling (GE). No voids are present and the fill of the main gutta-percha point is 0-2mm from the radiographic apex.

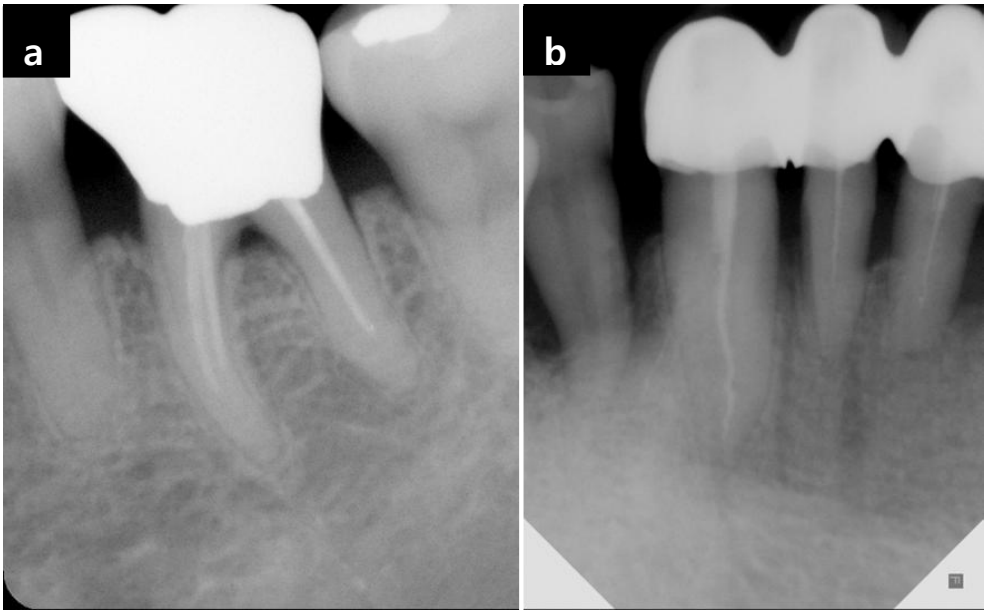

Figure 4. Radiographs of endodontically treated teeth assessed as poor endodontic filling (PE) (a) too short, (b) obvious voids are present.

Figure 5. Radiographs of endodonticaily treated molar with restoration assessed as good restoration (GR).

Figure 6. Radiograph of endodonticaily treated second molar assessed to be restored with poor restoration (PR). Obvious defects in the mesial seal of the crown of tooth #47 are seen.

Figure 7. Radiographic appearance of roots of tooth #36 categorized as successful. The lamina dura can be traced around the entire length of the roots.

Figure 8. Radiographic appearance of root of tooth #12 categorized as unsuccessful. A break in the lamina dura and an obvious apical radiolucency is seen.

Statistical analysis

SAS software (SAS 9.2, SAS Institute Inc., Cary, NC, USA) was used for statistical analysis. Statistically significant differences between groups were detected by $\chi 2$ test and odds ratio. The periapical status was explained by logistic regression using two parameters; endodontic filling and coronal restoration. The level of statistical significance was set at $P<0.05$.

III. Results

1. The relationship between PAI and lesion size on CBCT

The kappa value for the agreement of PAI scoring between the 2 examiners was 0.691, indicating good agreement.

Spearman correlation coefficient between the PAI score and the PA lesion size was 0.8091, indicating that there is a significant correlation between the PAI score and the PA lesion size ($P < 0.0001$) (Figure 9).

The sort by size of periapical lesion and PAI score is shown in Table 2. Of 157 lesions having both intact cortical bones on axial CBCT sections, 107 (68.2%) lesions were evaluated more than PAI score 2. Of 84 lesions having only one intact bone, 82 (97.6%) lesions were evaluated more than PAI score 2. All the lesions eroding both cortical bones were scored PAI 5 (Table 2).

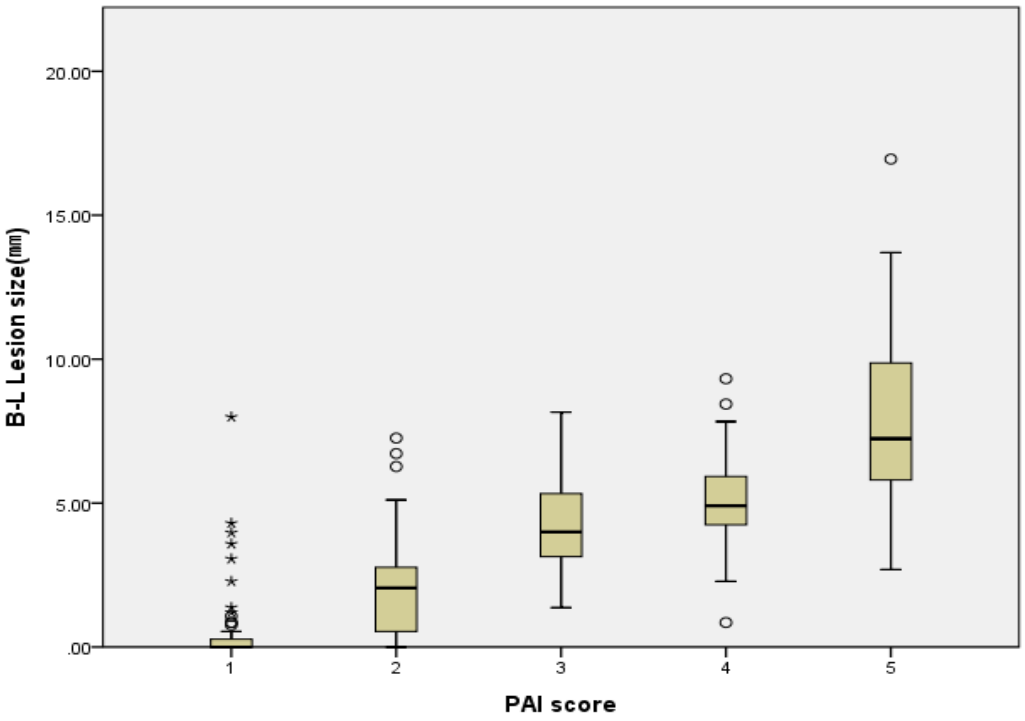

Figure 9. Comparison of bucco-lingual lesion size on CBCT with PAI score derived from periapical radiographs

Table 2. Size of periapical lesion and PAI score in roots with soundness of cortical bone

Intact cortical bone	Lesion size(mm)			
	None	0< <5	5≤ <10	10≤
	PAI score(1/2/3/4/5)			
both	56 (46/10/0/0/0)	104 (14/31/41/15/3)	50 (1/4/12/20/13)	3 (0/0/0/0/3)
one	0	33 (0/2/5/20/6)	42 (0/0/6/13/23)	9 (0/0/0/0/9)
none	0	0	2 (0/0/0/0/2)	3 (0/0/0/0/3)

Lesion size : number of lesions within ranges

PAI score : number of lesions corresponding to PAI score

2. Periapical status related to the quality of coronal restorations and root fillings

The kappa value for the agreement between the 2 examiners was 0.7561, 0.8612, and 0.7700 in the categories of PA lesion, root filling, and coronal restoration respectively.

The periapical condition was analyzed using logistic regression modelling. Table 3 shows the results of this analysis on 1030 teeth. On the comparison between endodontic filling and coronal restoration by using Z-test, there is no significant difference in the odds of API between 2 parameters (P =0.0970). These results indicated that both parameters were of equal importance and are strong independent predictors of periapical status.

Table 3. Regression table of the periapical status by 2 parameters

	Odds ratio	95% CI	P Value
Endodontic filling	2.866	1.151-3.818	<0.0001
Coronal restoration	2.33	1.755-3.093	<0.0001

The overall rate of API for the endodontically treated teeth was 59.1%. The perirapical status for each category of treatment quality is shown in Table 4. The group with good endodontic filling (GE) consisted of 367 teeth (35.6%) and

API rate in this group was 75.5%. The group with poor endodontic filling (PE) had API rate of 50.1%. The difference between the two groups was statistically significant (Figure 10).

The group with good restorations (GR) consisted of 706 teeth and API rate in this group was 65.3%. The group with poor restorations (PR) had API rate of 45.7%. The difference between the two groups was statistically significant (Figure 10).

Table 4. Periapical status of groups of teeth with good endodontic treatment, poor endodontic treatment, good coronal restorations and poor coronal restorations

Group	Endodontic filling	Coronal restoration	No. teeth	PPI	API	%API
1	Good(GE)	Any	367	90	277	75.5
2	Poor(PE)	Any	663	331	332	50.1
3	Any	Good(GR)	706	245	461	65.3
4	Any	Poor(PR)	324	176	148	45.7

PPI: number of teeth with presence of periradicular inflammation

API: number of teeth with absence of periradicular Inflammation

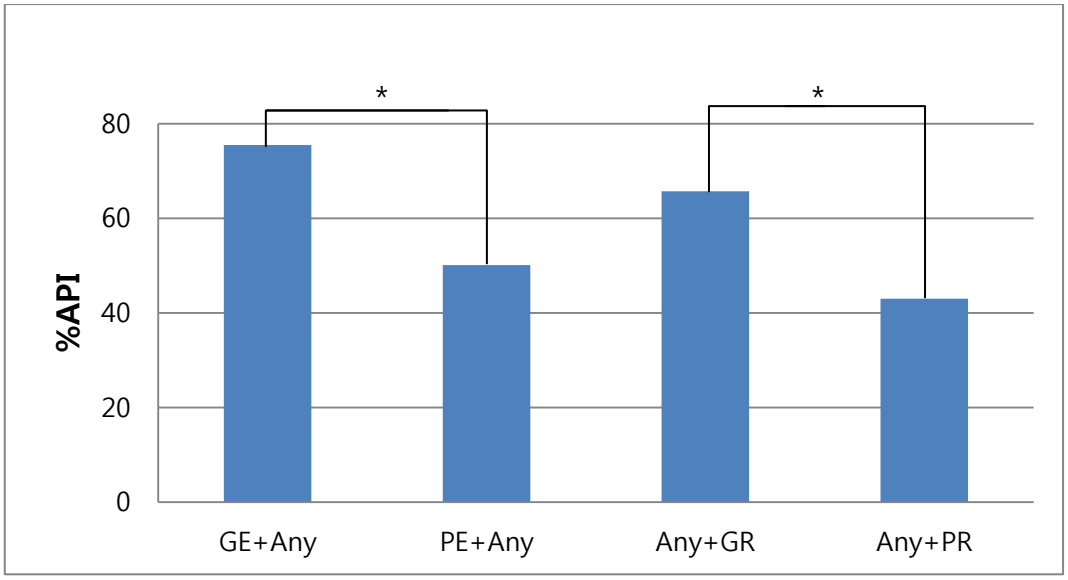

Figure 10. API rate or groups of teeth with good endodontic treatment, poor endodontic treatment, good coronal restorations and poor coronal restorations

API: number of teeth with absence of periradicular Inflammation

* statistically significant difference ($P < 0.05$)

Table 5. Periapical status of endodontic treatment of good or poor quality in teeth with good or poor coronal restorations

Group	Endodontic filling	Coronal restoration	No. teeth	PPI	API	%API
1	Good(GE)	Good(GR)	271	48	223	82.3
2	Good(GE)	Poor(PR)	96	42	54	56.3
3	Poor(PE)	Good(GR)	435	197	238	54.7
4	Poor(PE)	Poor(PR)	228	134	94	41.2

PPI: number of teeth with presence of periradicular inflammation

API: number of teeth with absence of periradicular Inflammation

Statistics: Group1 vs. Group2: $\chi 2=25.9653$, $P < 0.0001$, Odds ratio: 3.613, 95%CI (2.170-6.016); Group1 vs. Group3: $\chi 2=56.0316$, $P < 0.0001$, Odds ratio: 0.510, 95%CI (0.425-0.612); Group1 vs. Group4: $\chi 2=90.0962$, $P < 0.0001$, Odds ratio: 0.151, 95%CI (0.100-0.227); Group2 vs. Group4: $\chi 2=6.1437$, $P=0.0132$, Odds ratio: 0.739, 95%CI (0.581-0.940); Group3 vs. Group4: $\chi 2=10.8804$, $P=0.0010$, Odds ratio: 1.722, 95%CI (1.245-2.382)

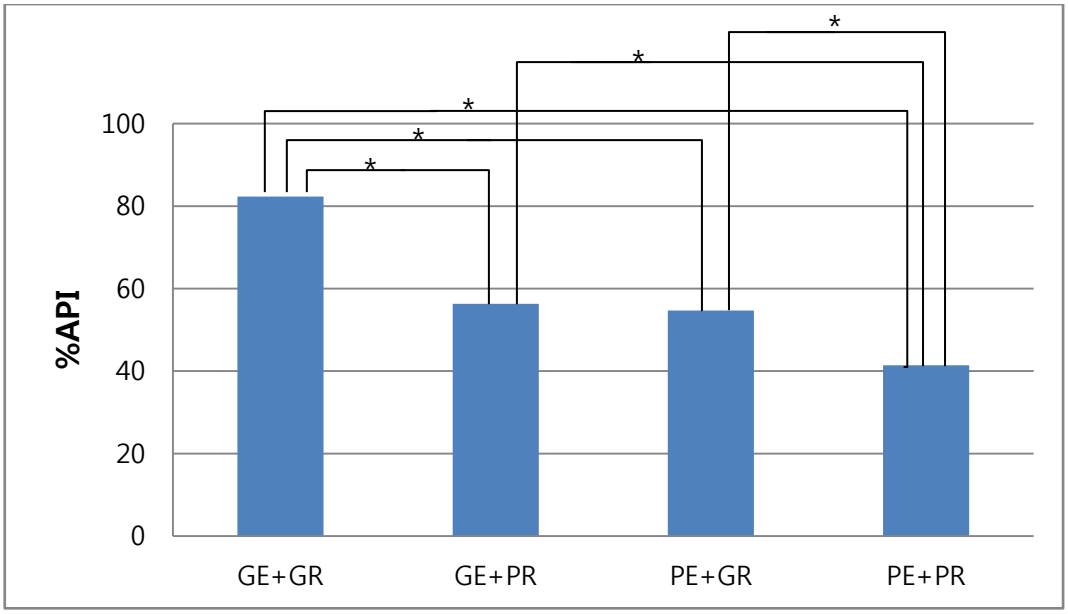

Figure 11. API rate of endodontic treatment of good or poor quality in teeth with good or poor coronal restorations

API: number of teeth with absence of periradicular Inflammation

* statistically significant difference ($P < 0.05$)

Table 5 and Figure 11 present the results of the combination of the criteria poor and good for coronal restorations and endodontic root fillings. When both qualities were good (GE+GR, group 1), API rate was 82.3%. When the groups with good endodontic filling and poor restorations (GE+PR, Group 2) were combined, the API rate was 56.3%. The difference between these two groups was statistically significant (Group1 vs. Group2: $\chi 2=25.9653$, $P < 0.0001$, Odds ratio: 3.613, 95%CI (2.170−6.016)). The teeth with poor endodontic filling combined with the teeth with good restoration (PE+GR, Group 3) resulted in API rate of 54.7%. This group was statistically significantly different from Group

1 (GE+GR)(Group1 vs. Group3: $\chi 2$=56.0316, P < 0.0001, Odds ratio: 0.510, 95%CI (0.425−0.612)). When both qualities were poor (PE+PR, Group 4), API rate was 41.2%. This group was statistically significantly different from Group 2(GE+PR) (Group2 vs. Group4: $\chi 2$=6.1437, P=0.0132, Odds ratio: 0.739, 95%CI (0.581−0.940). The difference between the Group 3 and Group 4 was statistically significant (Group3 vs. Group4: $\chi 2$=10.8804, P=0.0010, Odds ratio: 1.722, 95%CI (1.245−2.382)).

IV. Disccusion

1. The relationship between PAI and lesion size on CBCT

The present study examined efficacy of digital PA radiographs for identification of PA lesion by comparison of the PAI score on PA radiographs and the PA lesion size on CBCT. The result demonstrated that a significant correlation was found between the PAI score on PA view and the PA lesion size on CBCT (Spearman correlation coefficient = 0.8091). Although variance is slightly high, Figure 9 shows that PAI score was positively correlated with PA lesion size on CBCT.

Of 157 lesions having both intact cortical bones on axial CBCT sections, 107(68.2%) lesions were evaluated more than PAI score 2. These results indicate that naturally occurring periapical lesions can be identified radiographically while they are still confined to cancellous bone. Bender demonstrated that periapical lesion in cancellous bone cannot be detected on the radiograph until it erodes the junctional area between the cortex and cancellous bone. (Bender and Seltzer, 1961) On the other hand, the present results are in agreement with Lee et al. and suggest that PA lesions can be identified radiographically while they are still confined to cancellous bone. (Lee and

Messer, 1986) In the present study, 68% of PA lesions within cancellous bone were detected on digital PA radiographs. Although the rest (32%) were not detected on PA radiograph, they still remained within cancellous bone.

Of 246 total lesions detected on axial CBCT sections regardless of whether their cortical bones were intact or not, 52 (21.1%) were not detected with PA radiographs. Of course, these results are subject to changes according to the thickness or quality of cortical bones. In a recent study, comparing PA radiography and CBCT for assessment of PA bone defects after apical surgery, the authors reported that the evaluation of PA radiographs resulted in the diagnosis of statistically significantly smaller PA lesions compared with sagittal and coronal CBCT section (Christiansen et al., 2009). These findings show that CBCT image provide exact dimensions of PA lesions and could be helpful in early diagnosis when PA radiography is inconclusive as a result of a complex anatomical background pattern.

However, PA radiographs have clear advantages over CBCT; the most important is less radiation administered to the patient than CBCT. In assessment of PA status, digital PA radiographs may be useful tool to make a decision to prescribe an additional CBCT. Imaging with CBCT results in a more absorbed dose ranging from 29.62–101.46 mSv, compared with 0.003 mSv for radiographic PA view.

Although PA radiographs are somewhat inaccurate compared to CBCT, the present study shows that PAI score was positively correlated with PA lesion

size on CBCT and 68% of PA lesions within cancellous bone were detected on digital PA radiographs. Hence, it is necessary to selectively use CBCT. Clinicians should refrain from irrational CBCT photography. However, still 32% of PA lesions within the cancellous bones were not detected on the PA radiographs. Therefore, clinicians should be aware of the limitations of the PA radiographs as well.

2. Periapical status related to the quality of coronal restorations and root fillings

The overall API rate was 59.1%. This was a similar result to other previous studies. Not unexpectedly in the Group 1 (Table 4) diagnosed with good endodontic filling and good restoration (GE+GR), the highest API rate (82.3%) was found. In Group 2, diagnosed with good endodontic filling and poor restoration (GE+PR), the API rate dropped 82.3% to 56.3%. This difference was statistically significant. Thus, the importance of a well sealing coronal restoration for lasting success of endodontic treatment was identified by this study. This was previously stressed by the findings of Ray & Trope (Ray and Trope, 1995).

In previous studies there has been a consistent association between periapical lesion and poor quality of root canal fillings. This was also confirmed by the

present results. In the teeth diagnosed with poor endodontic filling and good restoration the API rate dropped from the group diagnosed with good both qualities (GE+GR, 82.3% and PE+GR, 54.7%).

The technical standard of root canal fillings examined in present study was poor. Of the 663 teeth with poor filling, 331 were associated with periapical periodontitis. This means that 32.1% of the endodontically treated teeth need to be retreated.

In the present study, 64.4% of the root fillings were classified as poor. This poor filling rate was relatively high compared with other studies with root filling evaluation methods similar to the present study. The other studies are ranged from 43.1% (Siqueira et al., 2005) to 49.5% (Tronstad et al., 2000).

Previous studies evaluated the quality of root canal filling combined with quality of coronal restoration to assess the impact on periapical health. The distribution of teeth in different categories as revealed in different studies is presented in Table 6 (Dugas et al., 2003; Hommez et al., 2002; Kirkevang et al., 2000). In the present study, Group 3 (PE+GR) had the greatest number of teeth. This was the case in the Hommez et al study, as well (Hommez et al., 2002). On the contrary, Ray and Trope and Tronstad et al assessed most teeth with Group 1 (GE+GR), while Dugas et al found that most teeth had both parameters poor (Group4: PE+PR).

Table 6. Distribution of teeth in combined categories of quality of root filling with quality of coronal restoration in different countries

Country	Author	Total teeth	Combined categories (%)			
			Group1	Group2	Group3	Group4
Korea	Park et al, 2012	1030	26.3	9.3	42.2	22.1
Canada	Dugas et al, 2003	383	18.3	20.6	24.0	37.1
Belgium	Hommez et al, 2002	745	28.4	5.9	49.7	16.0
Norway	Tronstad et al, 2000	1001	36.3	14.2	29.9	19.6
USA	Ray and Trope, 1995	985.5	33.5	16.7	30.7	19.1
Denmark	Kirkevang et al, 2000	773	19.9	–	–	8.9

Group 1: GE+GR; Group 2: GE+PR; Group 3: PE+GR; Group 4: PE+PR

Ray and Trope suggested that quality of coronal restoration is significantly more important than the technical quality of root filling for periapical health when the periapical status of endodontically treated teeth was evaluated. On the other hand, Tronstad et al and Dugas et al concluded that the technical quality of the endodontic treatment as judged radiographically was significantly more important than the technical quality of the coronal restoration. Segara-Egea et al found that quality of root filling affected significantly the periapical status, but quality of coronal restoration had no effect (Segura-Egea et al., 2004). However, the present results are in agreement with Hommez et al and suggest that both technical qualities of the root filling and the coronal restoration are of equal importance. According to the present results, there is no significant difference in the outcome of preiapical status between 2 parameters.

The present study is a cross-sectional study based on evaluation of radiographs. This type of study design has certain limitations. There was no knowledge of pre-existing conditions prior to treatment and although it was known that only new patients were subjected, the exact length of time between treatment and radiographic evaluation is unknown. However, misinterpretations and misdiagnoses in cross-sectional studies are known to be fairly equally distributed so that the results still remain meaningful (Altman, 1991). It has also been assumed that cross sectional studies are less prone to be biased by the opinion of the researchers in comparison with longitudinal studies (Torabinejad et al., 1988). The reliability of the present results was strengthened by a large study sample.

Another limitation lies in the method of the evaluation of the coronal restorations. As many other authors have mentioned before (Camps, 2012), it is also acknowledged that there are limitations in using only the radiographic examination when assessing quality of coronal restorations. Although the ideal method for the evaluation of coronal restoration is clinical examination, this is an available method only in prospective study. The present study was a retrospective study and tried to overcome at least some of the limitation of the evaluation of restoration with reference to the dental records as well as radiographs.

Despite those limitations, results from the present study indicate that the periapical health of endodontically treated teeth depends on both the quality of the endodontic treatment and of the coronal restoration.

V. Conclusion

1. The present study evaluated efficacy of digital PA radiographs for identification of PA lesion by comparison of the PAI score on PA radiographs and the PA lesion size on axial CBCT section. The results of this study demonstrated that PAI score was positively correlated with PA lesion size on CBCT and 68% of PA lesions within cancellous bone were detected on digital PA radiographs. Hence, it is necessary to selectively use CBCT and clinicians should refrain from irrational CBCT photography. However, still 32% of PA lesions within the cancellous bones were not detected on the PA radiographs. Therefore, clinicians should be aware of the limitations of the PA radiographs as well.
2. The results, in 1030 endodontically treated teeth examined radiographically are as follows.
   A. Absence of periradicular pathology was present in 59.1% of the teeth examined.
   B. Both technical qualities of the endodontic treatment and the coronal restoration are of equal importance for periapical health.

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국 문 요 약

CBCT상의 병소 크기와 PAI의 관계 및 보철물과 근관치료 상태에 따른 치근단 건강상태에 대한 평가

본 연구의 목적은 (1) PAI score와 CBCT의 비교를 통해서 치근단 병소를 식별하는데 치근단 방사선 사진의 효용성을 평가하고, (2) 근관치료된 치아의 방사선학적인 치근단 건강상태에 대한 보철물과 근관 충전의 quality의 관계를 평가하는 것이다.

1. PAI와 CBCT 사이의 관계를 통해서 치근단 방사선 사진의 효용성을 평가

연세대학교 치과병원에서 촬영된 방사선 사진 중에서 근관치료가 되어 있고 치근단 방사선 사진과 CBCT가 촬영된 치아 290개의 302개 root가 선택되었다. CBCT의 axial면에서 병소의 가장 넓은 부위의 길이를 측정하였고 buccal, lingual cortical bone의 건전성을 기록하였다. 치근단 방사선 사진은 두 명의 조사자에 의해 PAI score로 평가되었다. 두 PAI score와 병소 크기의 관계를 알아보기 위하여 스피어만 랭크 코릴레이션 분석이 사용되었고 유의수준은 0.05 이하로 평가하였다. 실험 결과, 치근단 방사선 사진상에서 평가한 PAI score와 CBCT상에서 측정한 병소 크기 사이에 유의적인 상관관계를 보였고, 양쪽 cortical bone이 건전한 cancellous bone내에 있었던 병소 157개중에서 68.2%가 PAI score 3 이상이었다.

2. 보철물과 근관치료 충전의 quality에 관련된 치근단 건강상태

연세대학교 치과병원에 내원한 신환의 근관치료되고 full veneer crown된 1030개 치아의 full-mouth 방사선 사진과 치근단 방사선 사진이 선택되어 두명의 조사자에 의해 평가되었다. 최근 1년 이내에 치과치료를 받은 치아, post한 치아,

endo-perio 병소 있는 치아, root canal filling이 안된 치아는 제외하였다. 치근단 건강상태는 치근단 방사선 검사를 통해서 치근단 염증의 없음(API) 또는 있음(PPI)으로 분류하였고, 근관 충전에 대한 평가는 치근단 방사선 검사를 통해서 좋음(GE) 또는 불량함(PE)으로 분류하였다. 보철물에 대한 평가는 치근단 방사선 검사와 임상검사 기록을 조사하여 좋음(GR) 또는 불량함(PE)으로 분류하였다. 실험 결과, 치근단 병소가 없는 치아는 59.1%였고, 근관 충전과 보철물의 두 quality 모두가 치근단 건강 상태에 유의한 영향을 주는 것으로 나왔으며 두 파라미터의 odds ratio 사이에는 유의한 차이가 없었다. API rate에 있어서 GE그룹(75.5%)과 PE그룹(50.1%)사이와 GR그룹(65.3%)과 PR그룹(45.7%)사이에 통계적으로 유의한 차이를 보였고, GE+GR그룹(82.3%)은 나머지 세 그룹들(GE+PR, 56.3%, PE+GR, 54.7%, PE+PR, 41.2%)과 유의한 차이가 있었고, PE+PR그룹은 GE+PR그룹, PE+GR그룹과 유의한 차이가 있었다.

결론적으로, 치근단 방사선 사진상에서의 PAI score와 CBCT상에서 측정한 치근단 병소 크기를 비교함으로써 병소를 식별하는데 치근단 방사선 사진의 유효성을 조사한 연구 결과, 치근단 방사선 사진상의 PAI score와 CBCT의 치근단 병소 크기 사이에 유의한 상관관계가 있었고 cancellous bone 내에 있었던 68%의 병소가 치근단 방사선 사진에서 관찰될 수 있었다. 또한 1030개의 근관치료된 치아를 방사선학적으로 검사한 결과, 치근단 병소가 없는 치아는 59.1%였고, 치근단 건강 상태에 있어서 근관치료와 보철물의 두 technical quality는 똑같이 중요하였다.

핵심되는 말 : periapical lesion, CBCT, radiographic evaluation, quality of endodontic treatment, coronal restoration