ORIGINAL ARTICLE

Assessment of periapical health, quality of root canal filling, and coronal restoration by using cone-beam computed tomography

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Abstract

Aim: The purpose of this study is to use cone-beam computed tomography (CBCT) to describe the prevalence of apical health, the quality of root canal filling, and coronal restorations of endodontically treated teeth in the east Anatolian subpopulation of Turkey.

Materials and Methods: CBCT scans were taken from 748 patients attending for the 1st time to the clinic at the Oral Diagnosis and Radiology Department at Ataturk University's Faculty of Dentistry in Erzurum, Turkey. All images were analyzed by two research assistants who were trained using examples of CBCT images with and without the presence of periapical radiolucency. The two examiners assessed images from the experiment independently, and the readings were then compared. All data were entered on an MS Excel 2007 spreadsheet and SPSS software 15.0 which was used for statistical analysis. The Chi-square test was used to determine if a patient's periapical status was associated with the technical quality of root filling, coronal status, and to evaluate differences between tooth subgroups.

Results: In total, 147 teeth from 748 patients were found to have been treated endodontically. Sixty three teeth were found to have short root canal fillings, whereas 74 teeth had adequate root canal fillings, and the remaining 10 teeth had over extended root canal filling. A significant correlation was observed between the length of root filling and apical periodontitis (P = 0,023). Inadequately dense root canal filling was observed in 141 teeth, whereas adequately dense filling was found in only six teeth. There was a significant correlation between the density of root filling and apical periodontitis (P = 0.044). Coronal restoration was found in 90 teeth, but was not observed in all the three teeth. A crown was present in 54 teeth. There was a significant correlation between coronal restoration and apical periodontitis (P = 0.028).

Conclusion: The results indicate that the quality of both the root filling and restoration were found to have impact on the periapical health of root-filled teeth.

Key words: Cone-beam computer tomography, coronal restoration, periapical health, root canal treatment

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Introduction

Apical periodontitis is a common public health problem with medical, economic, and ethical repercussions

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throughout the world, especially in Japan, North America, and in many European countries.[1] Apical periodontitis is more prevalent in patients who have undergone root canal treatment, a rate of 35.9%, which is a stark contrast to those who have not had a root canal, 2.1%.[2] Contemporary research has uncovered a relation between a patient's periapical situation, the quality of his or her root canal treatment, and the quality of his or her coronal restoration.[3-7] There is a positive correlation between the density and apical extent of root canal filling and a patient's periapical health.[8] Inadequate root filling and coronal restoration quality are two pivotal causes for apical periodontitis of endodontic origin.[9]

Radiography is the most generally accepted imaging method in this issue. Intraoral periapical radiographs have been used for a long time to evaluate the results of root canal treatment.[2,6,7,10] The presence of cortical perforation and sort of erosion and/or demineralization on the inner surface of the cortical bone on a radiograph is generally accepted as a sign of apical periodontitis.[11] However, these changes in the periapical tissues cannot be always determined by the radiographs.[12] Cone-beam computed tomography (CBCT) has recently been reported to be more sensitive to density changes, better reflects periapical lesions, and gives an improved depiction of periapical lesions in three-dimensional (3D) when compared to intraoral radiographs.[13,14] Thus, CBCT gives an easier and more accurate diagnosis of periapical lesions.[13,15]

Many of the studies in Turkey to determine the prevalence of apical periodontitis have used intraoral radiographs. The purpose of this cross-sectional study is to use CBCT to describe the prevalence of apical health, the quality of root canal filling, and coronal restorations of endodontically treated teeth in the east Anatolian subpopulation of Turkey.

Materials and Methods

CBCT scans were taken from 748 patients (412 women and 336 men) attending for the 1st time to the clinic at the Oral Diagnosis and Radiology Department at Ataturk University's Faculty of Dentistry in Erzurum, Turkey, from September 1st 2008 to March 1st 2009. The patients were seeking implant applications and oral pathology diagnoses. Clinic patients who were younger than 15 and older than 65 at the time of the examination were excluded from the study. All images were recorded by the same dental radiologist using CBCT (NewTom FP QR-DVT 9000, 110 kVp, 15 mA, 36 s scan time, 5.4 s typical X-ray emission time, 17 cm diameter–13 cm height scan volume, Verona, Italy). Axial, cross-sectional, and sagittal views were examined. The images were simultaneously scanned on a digital imaging workstation. The image slices were 1 mm thick and the distance between slices was 1 mm.

All images were analyzed by two research assistants who were trained using examples of CBCT images with and without the presence of periapical radiolucency. Before assessing the experimental material, the two examiners were assessed by asking them to grade 25 CBCT images. Inter-examiner agreement was detected by Cohen's kappa (kappa – 0.88). These images were not from the experimental sample of the present study. The two examiners assessed images from the experiment independently, and the readings were then compared. In the event of disagreement, the case was discussed until a consensus was reached. All images are evaluated according to the following parameters.

Length was measured in millimeters. Short: Ending more than 2 mm from radiographic apex. Adequate: Ending 0–2 mm from radiographic apex. Over extended: Root filling material was extruded beyond the radiographic apex into the periapical region.

The density of the root filling was assessed qualitatively according to the visual judgment of the examiners. Adequate: Uniform radio-density, without voids or spaces between filling materials; the filling has successfully adapted to the root canal walls. Inadequate: Visible canal space appears laterally along the filling, or as voids within the filling mass, or there is identifiably untreated canal.

The quality of the coronal restoration was also assessed according to the judgment of the examiners. Adequate: Any permanent restoration that appeared radiographically intact. Inadequate: Any permanent restoration with detectable radiographic signs of overhangs, open margins, or recurrent caries, or presence of temporary coronal restoration. Teeth with no coronal restorations were also included in this group. Crown: Coronal restoration of the tooth with a metal or porcelain-fused-to-metal crown. Post: The presence or absence of a post in the root canal was recorded.

Apical condition was assessed by the periapical index (PAI) according to Orstavik[16] for each one of the root-filled roots and scored as follows:

- Normal periapical structures
- Small changes in bone structure
- Changes in the bone structure with little mineral loss
- Periodontitis with well-defined radiolucent area
- Severe periodontitis with exacerbating features.

The scores were then dichotomized as follows: PAI 1 was defined as healthy periapex. All other PAI scores (PAI 2–5) were considered periodontitis.

All data were entered on an MS Excel 2007 spreadsheet (Microsoft, Washington, USA) and SPSS sofware 15.0 (Inc., Chicago, IL, USA. which was used for statistical analysis. The Chi-square test was used to determine if a patient's periapical status was associated with the technical quality of root filling (the apical limit of filling), coronal status,

and to evaluate differences between tooth subgroups for the following parameters: The number of missing teeth, the number of teeth with apical periodontitis, and the number of root-filled teeth with apical periodontitis.

Results

Patients aged between 15 and 65 years (mean = 35.34) were evaluated. There was no significant correlation between patients' age and apical periodontitis.

Table 1: A significant correlation was observed between the length of root filling and apical periodontitis (*P*=0.023)

	PAI					Total
	1	2	3	4	5	
Short root canal filling	3	17	25	10	8	63
Adequate root canal filling	4	29	19	11	11	74
Over extended root canal filling	0	1	1	7	1	10
Total	7	47	45	28	20	147

PAI 1 was defined as healthy periapex. All other PAI scores (PAI 2-5) were considered periodontitis. PAI=Periapical index

Table 2: There was a significant correlation between the density of root filling and apical periodontitis (*P*=0.044)

	PAI					Total
	1	2	3	4	5	
Inadequately dense root canal filling	5	45	44	28	19	141
Adequately dense root canal filling	2	2	1	0	1	6
Total	7	47	45	28	20	147

PAI 1 was defined as healthy periapex. All other PAI scores (PAI 2-5) were considered periodontitis. PAI=Periapical index

Table 3: Density and length of root canal filling is evaluated together

	Density of root canal filling		Total
	Inadequately dense root canal filling	Adequately dense root canal filling	
Short root canal filling	62	1	63
Adequate root canal filling	69	5	74
Over extended root canal filling	10	0	10
Total	141	6	147

Table 4: There was a significant correlation between coronal restoration and apical periodontitis (*P*=0.028)

	PAI					Total
	1	2	3	4	5	
Absence of filling	0	0	3	0	0	3
Coronal restoration	7	33	24	18	8	90
Crown	0	14	18	10	12	54
Total	7	47	45	28	20	147

PAI 1 was defined as healthy periapex. All other PAI scores (PAI 2-5) were considered periodontitis. PAI=Periapical index

In total, 147 teeth from 748 patients (55.1% female and 44.9% male) were found to have been treated endodontically. Out of these 147 teeth, 107 (72.8%) were in the maxilla and the remaining 40 (27.2%) were in the mandible. Sixty three (42.9%) teeth were found to have short root canal fillings, whereas 74 (50.3%) teeth had adequate root canal filling, and the remaining 10 (6.8%) teeth had over extended root canal filling. A significant correlation was observed between the length of root filling and apical periodontitis (P = 0,023) [Table 1].

Inadequately dense root canal filling was observed in 141 teeth, whereas adequately dense filling was found in only six teeth. There was a significant correlation between the density of root filling and apical periodontitis (P = 0,044) [Table 2].

When density and length are evaluated together, only one out of 63 teeth with short root canal filling was found to have inadequate density. On the other hand, only five out of 74 teeth with adequately long root canal filling length were found to have adequate densities. Meanwhile, all 10 teeth with over extended root canal filling were discovered to have inadequate density [Table 3].

Coronal restoration was found in 90 teeth (61.2%), but was not observed in all the three teeth (2.04%). A crown was present in 54 teeth (36.7%). There was a significant correlation between coronal restoration and apical periodontitis (P = 0.028) [Table 4].

A post had been applied in seven teeth, but there was no significant correlation discovered between this form of restoration and apical periodontitis (P = 0.199).

Discussion

CBCT scans of patients, between 15 and 65 ages, attending for the 1st time to the Oral Diagnosis and Radiology Department of Faculty of Dentistry, Ataturk University in Erzurum, Turkey, was used for this study. The dental faculty attracts patients from numerous parts of the city and its surroundings. However, the sample does not represent a random sample of the entire Turkish population; it would therefore be inappropriate to extrapolate the results of this study to the general population.

This is a cross-sectional study based on retrospective radiographic data. The main disadvantage of a cross-sectional study is that it is impossible to determine whether a periapical lesion is a sign of persistent apical periodontitis or an incompletely healed lesion after root canal treatment.[17] An additional disadvantage of a cross-sectional study is that a radiograph provides limited information. For example, there is no information about any of the patients, preexisting conditions, when treatment or restoration took place, how much time had elapsed since a patient's initial endodontic

treatment, and their clinician's level of training.[18] However, the key advantage of a cross-sectional study was having obtained an extensive sample size and random patient selection.[18] Petersson *et al*.[19] demonstrated the reliability of cross-sectional studies for apical periodontitis, who showed that the number of healed periapical lesions after a 10 years period was equal to the number of new occurring lesions.

One widespread method for research in apical periodontitis is two-dimensional radiography. These radiography techniques offer some disadvantages such as image distortion, image superposition, and the simple fact that the images are two-dimensional. Radiography has poor image quality particularly in the upper and lower anterior regions.[20] Given these problems, the accuracy of two-dimensional radiographs in detecting apical periodontitis has been called into question.[21] However, CBCT overcomes many of these problems. For example, CBCT images do not superimpose anatomical structures, and are more useful in identifying processes occurring within the cancellous bone.[22] CBCT can provide 3D, multi-slice imaging information, none of which is possible using other radiography techniques.[23] CBCT images permit the accurate diagnosis of apical extent and density, the quality of root canal fillings, and periapical tissue condition. CBCT imaging also has advantages over traditional computed tomography scans such as greater accuracy, higher resolution, shorter scan times, and fewer actual radiation doses to patients.[24] CBCT's disadvantages, however, include its greater cost and higher overall radiation exposure to the patient.[25]

Many epidemiological studies that use two-dimensional radiographs employ the periapical scoring system to evaluate the condition of periapical tissue and detect periapical pathologies.[26-28] The main disadvantage of using the periapical scoring system in conjunction with two-dimensional radiographs is that it may not be suitable for all tooth positions. The thickness of the cortical bone and the position of the root tip relative to the cortex may vary with tooth position. However, CBCT can be used because it produces a 3D and more sensitive image.[13,14]

Many studies have been conducted to determine the prevalence of apical periodontitis in the Turkish population. For example, Gündüz *et al*.[18] discovered a prevalence of apical periodontitis of 67.9% in endodontically treated teeth. Gumru *et al*.[6] found a 42% prevalence of apical periodontitis in endodontically treated teeth. However, all previous studies used two-dimensional radiographs to examine patients. Our study using more accurate 3D CBCT imaging, found apical periodontitis prevalence of 95.2% in endodontically treated teeth.

Previous studies have used different indicators than our work to evaluate the quality of root canal filling and periapical tissue condition in Turkish patients. Some researchers considered the length of the root canal fillings as signs of apical periodontitis.[29-31] Meanwhile, others accept both length and homogeneity of root canal filling individually for their evaluations,[32] and still others evaluated length and homogeneity in tandem.[33-35] Our study found that length and density have important statistical effects on apical periodontitis, which other authors support.[6,18,28]

Another important element that affects periapical health is coronal restoration.[36] Torabinejad *et al*.[37] reported that the direct exposure of root canal filling to microorganisms and their products may facilitate the reinfection of a patient's root canal system in a relatively short time. Our study uncovered an important statistical correlation between coronal restoration and apical periodontitis, which has also been supported by other scientists.[18,36]

Conclusion

The results indicate that the quality of both the root filling and coronal restoration were found to have an impact on the periapical health of root-filled teeth.

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Conflicts of interest

There are no conflicts of interest.

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