ORIGINAL ARTICLE

Assessment of the periapical health of abutment teeth: A retrospective radiological study

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Abstract

Aim: The aim was to examine the technical quality of root fillings and periapical status of root-filled and nonroot-filled teeth restored with crowns and bridge retainers through a retrospective analysis of orthopantomographs (OPTGs) in an adult Turkish subpopulation.

Materials and Methods: In this study, the digital OPTGs of adult patients between the ages of 20 and 70 who appealed to the Endodontics Endodontics Department of the Dentistry Faculty at Marmara University (Istanbul, Turkey) for the first time to have their endodontic treatment needs met were used. The periapical health of all teeth restored with crowns and bridge retainers, and the technical quality of the root fillings on abutment teeth were evaluated by radiographic criteria.

Results: The survey was carried out using the OPTGs of 1000 adult patients composed of 590 (59.0%) women and 410 (41.0%) men. 4656 (20.9%) of the totally examined 22280 teeth were with crowns and bridge retainers. 986 of the total abutment teeth were root-filled and 458 (46.5%) of them had apical periodontitis (AP) while 3670 of the total abutment teeth were nonroot-filled and 930 (25.3%) of them were with AP. The most commonly treated teeth were premolars (33.8%), followed by molars (26.2%), incisors (23.3%) and canines (16.7%). Technical quality was proved to be adequate in 27.5% of the root fillings. A higher frequency of AP was related to inadequate root fillings ($P < 0.01$).

Conclusion: The frequency of root-filled abutment teeth with AP, nonroot-filled abutment teeth with AP, and technically inadequate root-fillings among teeth with crowns and bridge retainers was high in the selected adult population.

Key words: Abutment teeth, apical periodontitis, endodontics, epidemiology, radiology

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Introduction

Extensive removal of enamel and dentin is required during the preparation of teeth for fixed partial dentures. This procedure may lead to irreversible damage of the dental pulp if not carried out carefully.[1] Besides, various operative procedures and dental materials applied on the prepared tooth may cause significant biological consequences on the dental pulp.[2,3] In addition, several studies revealed that common luting cements introduced to the oral environment dissolve, and the degree of dissolution depends on material properties and fit of the fixed partial dentures.[4] Therefore, pulpal damage in a proportion of the restored teeth is inevitable, and it may occur either during the preparation of the tooth, while operative procedures are performed on the prepared tooth, or throughout the lifetime of the fixed partial denture.

Vital teeth are often crowned due to the failure of a previous extensive intracoronal restoration which was performed on teeth that suffered from caries lesion, periodontal disease, or traumatic injury (either physical or as a result of restorative procedures). Subsequent preparation of these teeth for a fixed partial denture could precipitate pulpal problems, and induce irreversible pulpal damage in the future.[5]

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Along with carious lesions and periodontal diseases, diseases of endodontic origin which affect the abutment teeth are the biological reasons for failures of the fixed partial dentures.[6,7] Fixed partial dentures may also fail mechanically; the mechanical failures may occur due to retention loss, porcelain fracture, metal framework failure, wear, and abutment tooth fracture.[7] The remaining failures are defective margins, poor contour and esthetics. As these failures may have unfavorable effects on the health of the pulp tissue, it is expected that the pulps of a certain proportion of crowned teeth will be damaged.[8]

Valderhaug *et al*.[9] have reviewed the studies on the frequency of radiographic periapical changes in teeth restored with crowns and bridges, and reported that the rate varied from 3% to 22% in follow-up studies over 11 years[10] and 6 years,[11] respectively. A further study suggested that the rate of pulpal necrosis was 1% per year.[12]

In cross-sectional studies of risk factors in the development of apical periodontitis (AP), the presence of AP was obviously associated with coronal fillings, crowns, and root fillings particularly those that are radiographically inadequate.[13,14]

To our knowledge, no epidemiological studies on the frequency of AP in teeth restored with fixed partial dentures have been carried out in Turkey. The aim of this study was to radiographically examine the periapical status of root-filled and nonroot-filled abutment teeth restored with crowns or bridge retainers, and the technical quality of root fillings on the abutment teeth in an adult Turkish subpopulation.

Materials and Methods

The digital orthopantomographs (OPTGs) of randomly selected 1000 adult patients (aged between 20 and 70) having fixed partial dentures who appealed to the Endodontics Department of the Dentistry Faculty at Marmara University (Istanbul, Turkey) for the first time to have their endodontic treatment needs met were used in this study. The study protocol was approved by the Ethics Committee of Marmara University Institute of Health Sciences and patient anonymity was strictly respected.

Information regarding age and gender, number of present teeth, number of units of fixed partial denture, number of abutment teeth, number and location of root-filled abutment teeth with and without AP, number of nonroot-filled abutment teeth with AP, and number of crowns, fixed-fixed bridges, and cantilever bridges was recorded on a customized form for each patient. Impacted teeth were excluded.

Abutment teeth filled with a radiopaque material in the pulp chamber and/or in the root canal (s) were regarded as root-filled. The parameters listed in Table 1 were assessed in all root-filled abutment teeth.

The "periapical index" (PAI) was used in the assessment and categorization of the periapical health status of root-filled abutment teeth. PAI is a visual five-point index which has an ordinal scale of five scores ranging from healthy periapical bone to severe AP and is proposed by Orstavik *et al*.[15] In order to reduce the chance of false positive scores for AP, the PAI scores were dichotomized so that 1 and 2 represented healthy periapical status, and 3, 4, and 5 represented AP. For multi-rooted teeth, the root given the highest PAI score and the quality of the corresponding root-filling were taken into consideration. The technical quality of the root fillings was classified as either adequate or inadequate according to the guidelines of the European Society of Endodontology.[16]

An endodontist calibrated before beginning of the study examined the OPTGs and categorized the periapical status of abutment teeth. Intra-observer agreement on the radiographic assessment was determined by calculating Cohen's Kappa value. For this purpose, the radiographs of randomly selected 50 individuals were double scored at 3-month intervals. All Kappa values were calculated to be higher than 0.80.

Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) 15.0 for Windows (SPSS Inc., Chicago, IL, USA). The Chi-squared test was used in the assessment of the association between the root filling quality, periapical health status, and tooth type. A $P < 0.05$ was considered statistically significant.

Results

The survey was carried out using the OPTGs of 1000 adult patients composed of 590 (59.0%) women and 410 (41.0%) men aged between 20 and 70 years (mean 47.04 ± 11.31 years). Totally, 22280 teeth were examined, the average number of teeth per subject was 22.28 ± 6.21, and 4656 teeth (20.9%) served as abutments of crowns and bridges. The fixed dentures were either single crowns (n = 1488), fixed-fixed bridges (n = 983), or cantilever bridges (n = 274).

Among 1000 patients, 489 (48.9%) had at least one root-filled abutment tooth (ranging from 1 to 15) and 490 (49.0%) had at least one nonroot-filled abutment tooth with AP (ranging from 1 to 9). 986 of the total 4656 abutment teeth were root-filled and 458 (46.5%) of them presented signs of AP radiologically, while 3670 of the total abutment teeth were nonroot-filled and 930 (25.3%) of them were with AP [Table 2]. The most commonly root-filled abutment teeth were premolars (33.8%),

Table 1: The parameters assessed in all root-filled abutment teeth

Parameters	Criteria	
Technical quality of root-filling[16]	Adequate: No voids or defects along the walls of the canal, the filling terminated between 0 and 2 mm from the radiographic apex	
	Inadequate: Voids or defects along the walls of the canal, filling ending more than 2 mm short of the radiographic apex or overfilled	
Apical periodontitis (PAI scores)[15]	Normal periapical structures	absent
	Small changes in bone structure	absent
	Changes in bone structure with some mineral loss	Present
	Periodontitis with well-defined radiolucent area	Present
	Severe periodontitis with exacerbating features	Present

PAI=Periapical index

Table 2: Distribution of the radiographically examined abutment teeth according to periapical status

Periapical status	*n* (%)		
	Root-filled abutment teeth	Non root-filled abutment teeth	Total
With apical periodontitis	458 (46.5)	930 (25.3)	1388 (29.8)
Without apical periodontitis	528 (53.5)	2740 (74.7)	3268 (70.2)
Total	986 (100)	3670 (100)	4656 (100)

Table 3: The association between the parameters registered for root-filled abutment teeth and the radiological sign of apical periodontitis

	Apical periodontitis *n* (%)		*P*
	Absent	Present	
Type of restoration			
Crown	253 (47.9)	221 (48.3)	0.796
Fixed-fixed bridge	229 (43.4)	192 (41.9)	
Cantilever bridge	46 (8.7)	45 (9.8)	
Technical quality of root filling			
Adequate	247 (46.8)	24 (5.2)	0.001*
Inadequate	281 (53.2)	434 (94.8)	

Chi-squared test. *$P \leq 0.01$

followed by molars (26.2%), incisors (23.3%), and canines (16.7%).

In Table 3, the association between the parameters registered for root-filled abutment teeth, and the radiological sign of AP is presented. Technical quality was proved to be adequate in only 271 (27.5%) of the root fillings and radiological signs of AP were observed in 24 (5.2%) of them. Periapical pathosis was detected in 94.8% of the teeth with inadequate root-fillings. A higher frequency of AP was related to inadequate root-fillings ($P < 0.01$).

In Table 4, the association between the parameters registered for root-filled abutment teeth and the tooth type is presented. Statistically significant difference was found in the frequency of inadequate technical quality between different types of teeth. Significantly more inadequate root fillings were detected in molars in comparison to incisors, canines and premolars ($P < 0.01$). Among the root-filled abutment teeth, the AP frequency for molars was higher (55.4%) than for incisors and premolars (37.0% and 44.7%, respectively) ($P < 0.01$).

Discussion

As for all cross-sectional retrospective studies, there are a number of shortcomings of the present study. The digital OPTGs of 20–70-year-old patients who appealed to the Endodontics Department of the Dentistry Faculty at Marmara University (Istanbul, Turkey) for the first time for their endodontic treatment needs were used in this study. Although, a patient population from various regions of the city and its neighborhoods apply to the clinics of the dental faculty, the selected population used in this study may not be representative of a random sample of the Turkish population because some patients seek care at the dental faculty due to lower treatment costs or governmental social security while others did so due to the reputation of the faculty. Therefore, extrapolation of the results to the general population cannot be carried out.

In the evaluation of the periapical health, as the absence of clinical symptoms may be misleading, histological

Table 4: The association between the parameters registered for root-filled abutment teeth and the tooth type

	n (%)				*P*
	Incisor	Canine	Premolar	Molar	
Technical quality of root filling					
Adequate	94 (40.9)	56 (33.9)	86 (25.8)	35 (13.6)	0.001*
Inadequate	136 (59.1)	109 (66.1)	247 (74.2)	223 (86.4)	
Apical periodontitis					
Absent	145 (63.0)	84 (50.9)	184 (55.3)	115 (44.6)	0.001*
Present	85 (37.0)	81 (49.1)	149 (44.7)	143 (55.4)	

Chi-squared test. *$P \leq 0.01$

examination is the ideal approach but is not clinically applicable. Therefore, radiographic examination is the main method in the determination of the periapical health of root-filled teeth. The use of OPTGs, taken as general screening radiographs, was preferred in this study because of their availability. The accuracy of OPTGs and periapical radiographs has been compared and found to be similar in some previous studies. Since OPTGs enable the visualization of all teeth on one radiograph and provide lower patient radiation doses, their use in epidemiological studies is supported.[17-20] On the other hand, it is also commonly argued that this imaging technique does not allow the precise analysis of periapical health. De Cleen *et al*.[21] conducted their study on the prevalence of periradicular disease using OPTGs and pointed out that the periapical status of a considerable number of teeth could not be classified due to difficulties in interpretation.

Panoramic and periapical radiographs are extensively used for diagnosis, treatment, and follow-up of AP. AP might be underestimated since panoramic or periapical radiographs are two-dimensional representations of three-dimensional structures.[22] On the other hand, advanced imaging methods like cone beam computed tomography (CBCT) may provide promising results with a more accurate detection of AP.[22,23] However, a CBCT scan is not a simple and routine examination since it exposes the patient to higher radiation dose equivalent to that needed for 4–15 panoramic radiographs.[24] This should be considered in order to respect the as low as reasonably achievable principle and avoid unnecessary radiation exposure without clinical need or benefit.[25] Currently, CBCT should only be considered when conventional radiographic techniques are unsatisfactory in providing enough information for the diagnosis of AP.

Three different indices have been proposed for evaluation of periapical health.[15,26,27] The main reason for choosing the PAI scoring system was that it had been increasingly used to evaluate periapical health conditions in recent years. Furthermore, PAI presents good accuracy and reproducibility (intra- and inter-observer agreement). In this study, the dividing line between healthy and diseased periapical status has been set between scores 2 and 3 as in most of the epidemiological studies using the PAI. However, it is questionable whether this dichotomization represents a real borderline between healthy and pathologic periapical status.

A comparison of the results of this study with previous studies seems controversial due to variations in study design, population selection, evaluation criteria, and length of the observation period. In the present study, it was not possible to establish the age of each restoration and also the time it has taken for AP to develop. For the root-filled abutment teeth, it could be argued that the percentage of the radiolucencies recorded were lesions in a healing process. In addition, some of the root-filled abutment teeth might have presented clinical symptoms requiring endodontic treatment, but remained undetected due to lack of radiographic changes. The present investigation was based on data obtained from available dental radiographs. Clinical examination might be contributive in providing further detailed information however this was not possible due to the nature of the study.

In a similar cross-sectional radiographic study, examining full-mouth set of periapical radiographs, Saunders and Saunders[28] reported the frequency of AP to be 19% for nonroot-filled and 51% for root-filled crowned teeth. In this study, these values were found to be 19.9% and 46.5%, respectively.

The significant higher frequency of AP recorded in root-filled abutment molar teeth in comparison to other tooth types may be related to a number of factors such as increased occlusal stresses and failures in endodontic treatment due to complex root canal anatomy and limited visibility. Similar to the findings of this study, the mortality rate for molars was reported to be higher compared to other teeth in other endodontic and epidemiologic studies.[29] The abutment tooth groups with the greatest number of nonroot-filled teeth with AP were the incisors and premolars. This may be explained by the fact that these teeth are most commonly crowned to improve esthetics, meaning at least 1.3 mm removal of labial tooth tissue to ensure a satisfactory esthetic result.[28] Such amount of tooth removal may compromise pulpal health, especially if there is a history of previous restorations.

Within the limitations of this study, the frequency of root-filled and nonroot-filled abutment teeth with AP, and the frequency of technically inadequate root-fillings among abutment teeth were found to be high in the selected population. It is, therefore, very important that radiographic examination prior to preparation for fixed partial dentures, and long-term radiographic follow-up of teeth restored with fixed partial dentures should be undertaken routinely in order to assess the periapical status.

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