Prevalence and Quality of Endodontic Treatment in the Northern Manhattan Elderly

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Abstract

Pulpitis results in significant morbidity among the elderly, particularly in underserved communities. We collected panoramic oral radiographs from 244 (mean age 67) participants of the Northern Manhattan Study, a prospective cohort study of stroke risk in a multiethnic urban population. Radiographs were evaluated for missing teeth, caries, restorations, periodontal bone loss, adequacy of endodontic treatment, and periapical radiolucencies. In the study 206 subjects were dentate (mean 17.1 teeth). 5.1% of teeth had periapical radiolucencies, and 4.8% had been endodontically treated; 37.5% of endodontically treated teeth had periapical radiolucencies. Teeth with restorations, periodontal bone loss, pulpotomy, and inadequate root canal filling had a significantly higher occurrence of periapical radiolucency ($p < 0.05$). Among all root filled teeth, only 26% were deemed satisfactory. We conclude that apical periodontitis is widely prevalent and the technical standard of root fillings is poor in this cohort. There is a substantial need for improved dental care among the northern Manhattan elderly. *(J Endod 2007;33: 230–234)*

Key Words

Epidemiology, periapical status, radiographic evaluation, root-canal treatment

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There is growing disparity in access to health care including dental care in the United States (1). The endodontic disease burden in the United States is thought to be particularly high among the elderly in underserved communities. According to the U.S. Census Bureau estimates of 2000, there were 35 million persons aged 65 and older, representing roughly 13% of the U.S. population. Demographic trends indicate that the number of elderly persons in the United States is likely to grow to almost 17% by 2010 (2). Additionally, recent evidence suggests that oral infection is an important risk factor for cardiovascular disease and stroke (3).

Apical periodontitis has a strong, negative influence on the outcome of endodontic therapy. The success rate of endodontic therapy is 10–25% lower in the preoperative presence of apical periodontitis (4). Other factors influencing endodontic treatment outcomes are intracanal presence of bacteria and quality of endodontic therapy. Several epidemiologic studies of northern European populations have investigated the prevalence of teeth with apical periodontitis and/or endodontic treatment (5–11) in elderly populations. A recent review by Torabinejad et al. (12) suggests that there have been relatively few quality studies of endodontic treatment outcomes in the United States. Further, little is known about the prevalence of pulpal and periapical disease in many communities in the United States, particularly among the elderly living in underserved urban areas.

The present study was undertaken to radiographically assess the periapical periodontitis and endodontic treatment status of a sample of elderly individuals living in the northern Manhattan community of New York City, NY.

Materials and Methods

The present study sample constitutes a subsample of participants enrolled in The Oral Infections and Vascular Disease Epidemiology Study (INVEST), a prospective population-based cohort study investigating the relationship between oral infections, carotid atherosclerosis, and stroke (13). INVEST participants are also enrolled in the Northern Manhattan Study (NOMAS) (14), a prospective cohort study of ischemic stroke risk factors in the multiethnic urban population of northern Manhattan, New York City. The methods of subject recruitment for the present study (3) and enrollment into INVEST and NOMAS were described in previous publications (13, 14). Briefly, subjects were eligible for enrollment for the present study if they were: (1) a resident (>3 months) of northern Manhattan; (2) at least 55 years old; (3) without a history of stroke, myocardial infarction, or chronic inflammatory conditions such as systemic lupus erythematosus, Lyme disease, gonococcal arthritis, or bacterial endocarditis; (4) able to come to the clinic; and (5) concurrently enrolled in INVEST and NOMAS. The present study sample was enrolled between July 2000 and August 2002. The panoramic radiograph was offered to all participants in INVEST during that period. This study was approved by the Institutional Review Board at Columbia University Medical Center.

Patients who consented to radiographic examination were transported to the Columbia School of Dental and Oral Surgery clinic located within the Vanderbilt Clinic of Presbyterian Hospital. Panoramic radiographs were obtained by trained Dental School personnel using Gendex Panelipe II (Gendex dental systems, Lake Zurich, IL) operating at 80 kVp/4 mA. Radiographs were placed on a viewing box and interpreted independently by two examiners using Elema-Schönander magnifiers (15) (Solna,

TABLE 1. Criteria for radiographic categorization of teeth

Outcome parameter	Definition
Periapical radiolucency	An interruption in the lamina dura or, a periodontal ligament space more than double the typical width for that root
Periapical radiolucency size classification	0 No radiolucency 1 less than 3 mm 2 3 to 5 mm 3 larger than 5 mm
Endodontically treated tooth	Tooth with radiographic material in the pulp chamber and/or root canal(s)
Quality of root canal filling	0 no root filling 1 adequate root filling 2 short filling (more than 2 mm from radiographic apex) 3 over-filled (beyond apex) 4 nonuniform radiodensity (voids) 5 pulpotomy
Caries	Loss of tooth structure as determined by presence of radiolucency in tooth crown
Caries severity	0 none 1 into dentin 2 into pulp 3 only root tip remaining
Tooth restoration	Tooth with radiographic appearance of a filling, post, core, or crown
Tooth restoration classification	0 none 1 restoration 2 crown
Periodontal bone loss	Percentage of marginal bone loss of each tooth measured from the cemento-enamel junction to the apex of the tooth. The mesial and distal surfaces were averaged.

Stockholm, Sweden). Parameters recorded were: number of remaining teeth, caries, restorations, periodontal bone loss, endodontically treated teeth, periapical radiolucencies, and quality of endodontic treatments. The criteria listed in Table 1 were used to categorize all teeth. If teeth could not be properly categorized because of overprojection of anatomical structures and/or technical defaults of the radiograph, they were excluded from analysis.

Endodontically treated teeth were examined for quality of root canal treatment. The quality of the root fillings were assessed by measuring the distance of the root filling from the radiographic apex of the tooth. The root fillings were then categorized by distance from the radiographic apex: less than 2 mm, more than 2 mm, or beyond the radiographic apex (11, 16, 17). Root filling density was assessed by noting the homogeneity of fill and whether voids were present. The presence and size of periapical radiolucencies were categorized as follows; none, less than 3 mm in diameter, 3 to 5 mm in diameter, and larger than 5 mm. For multirooted teeth, the largest lucency was used.

The statistical analyses were performed using SPSS version 12.0 (SPSS Inc., Chicago, IL). Means and standard deviations were calculated for normally distributed continuous variables; median and range were calculated for nonnormally distributed continuous variables. Proportions were calculated for categorical variables. For the significant differences between groups, the χ^2 test was used with the significance level set at $p < 0.05$.

Results

In all, 277 subjects or 26% of all eligible INVEST subjects were enrolled. Individuals with missing data (n = 33) were excluded from this analysis. Among the final study sample of 244 subjects the mean age was 68.4 years (range 55 to 94 years) and 42.2% (103) were male. Among the 206 dentate subjects the average number of remaining teeth was 17.1. The total number of teeth present in subjects examined was 3,533 (Table 1). Only one participant (0.4%) had all 32 teeth remaining and 16% (38) were edentulous. The distribution of demographic variables is shown in Table 2: 80 (38.8%) of the subjects had one or more endodontically treated teeth (range 1–6 teeth); 94 (45.6%) subjects had at least one tooth (range 1–7 teeth) with a periapical radiolucency.

Among all teeth, the prevalence of periapical radiolucencies was 5.1% (181 teeth). Of teeth with a periapical radiolucency, 33% (60) had been endodontically treated (Table 3). More than half (52%) of the periapical radiolucencies were larger than 3 mm. A detailed distribution of the type of periapical radiolucency and root canal treatments is given in Table 4.

There was evidence of endodontic treatment found in 4.8% (169) of teeth. Of these teeth, 35.5% (60) had a periapical radiolucency. We assessed the quality of root canal fill among teeth that had endodontic treatment. Teeth were deemed adequately treated if there was evidence of root canal fill to within 2 mm of the radiographic apex of the tooth, and if there was no periapical radioluceny present. By these criteria, only 26% of endodontically treated teeth were deemed to have been satisfactorily treated. We also compared the effect of root canal fill distance from the apex. Teeth that were filled to within 2 mm, greater than 2 mm, or beyond the radiographic apex had a periapical radiolu-

TABLE 2. Characteristics of study participants

Total number of subjects	244
Age distribution	median age 67 range 55–97
% female	58%
Total number of teeth	3,533
Mean teeth per subject (edentulous excluded)	17.06
Edentulous subjects	38 (15.6%)

TABLE 3. Summary of findings

Number of individuals with at least one endodontically treated tooth	80 (38.8%)
Number of individuals with apical periodontitis	94 (45.6%)
Total number of teeth with apical periodontitis	181 (5.1%)
Total number of teeth with endodontic treatment	169 (4.8%)
Total number of teeth with endodontic treatment and apical periodontitis	60 (35.5%)
Number of teeth with satisfactory endodontic treatment	44 (26%)

TABLE 4. Periapical radiolucencies associated with endodontically treated teeth and teeth without root canal treatment

Teeth with root canal treatment (RCT)	Teeth with a periapical radiolucency				
	No radiolucency	Less than 3 mm	3–5 mm	Larger than 5 mm	Total
No RCT					
Count	3,243	53	32	36	3,364
% of Total	91.8%	1.5%	.9%	1.0%	95.2%
Satisfactory RCT					
Count	30	10	1	3	44
% of Total	.8%	.3%	.0%	.1%	1.2%
Short filling					
Count	57	18	9	4	88
% of Total	1.6%	.5%	.3%	.1%	2.5%
Overfilled					
Count	7	2	3	0	12
% of Total	.2%	.1%	.1%	.0%	.3%
Nonuniform radiodensity (voids)					
Count	13	4	4	1	22
% of Total	.4%	.1%	.1%	.0%	.6%
Pulpotomy					
Count	2	0	0	1	3
% of Total	.1%	.0%	.0%	.0%	.1%
Total					
Count	3,352	87	49	45	3,533
% of Total	94.9%	2.5%	1.4%	1.3%	100.0%

cency in 31.8, 35.2, and 41.7% of teeth, respectively. Although the short fillings and overfills showed higher occurrence of periapical radiolucency than the adequate fill group, these differences were not statistically significant ($p > 0.05$). Teeth with only pulpotomy were more likely to have a periapical radiolucency than any of the groups of root-filled teeth ($p < 0.05$).

We measured the severity of alveolar bone loss as a percentage of missing bone at the mesial and distal surfaces of each tooth present using a Schei ruler (18, 19). Teeth with ≥50% bone loss had a significantly greater likelihood of having a periapical radiolucency than teeth with bone loss of <50% ($p < 0.005$).

Coronal restorations were also examined: 43.5% of all teeth had a restoration; 31.2% of teeth appeared to be restored with amalgam, composite resin, or glass ionomer cements; and 12.3% of teeth had a crown restoration with or without post/core. Teeth with crown restorations (with or without post/core) were more likely to have a periapical radiolucency ($p < 0.05$) than teeth with other types of restorations or no restoration.

The presence and severity of caries were also recorded for each tooth: 4.9% of teeth had caries that extended into dentin; 2.7% of teeth had caries that extended into pulp; and 0.7% of the teeth had root caries. Teeth with caries extending into the pulp had a higher occurrence of periapical radiolucency ($p < 0.005$).

Discussion

This study used panoramic oral radiographs as a means of investigating the prevalence of some common oral diseases of the hard tissues in a cohort of elderly subjects taking part in an epidemiologic study of stroke and stroke risk in northern Manhattan. The main finding of this study was the comparatively high prevalence of oral disease in this triethnic urban population compared with studies of similar demographics conducted in other countries, notably the Scandinavian countries (Table 5). To our knowledge, this is the first study to document endodontic conditions of the northern Manhattan community.

A major strength of the current study was the ability to recruit subjects who were participants of both the Northern Manhattan Study (14) and the Oral Infections and Vascular Disease Epidemiology Study (13). The NOMAS enrollment method used random telephone number dialing of over 25,000 households in the northern Manhattan area and achieved a high participation rate (91% participated in at least one telephone interview; 75% were eligible to participate). Thus, although the subjects in the present study do not represent a true random sample, they were recruited from a population-based multiethnic urban cohort. In all, panoramic radiographs were obtained from 26% of subjects who were eligible. We compared the demographic and dental data of subjects who did receive the panoramic radiograph with subjects who were enrolled in INVEST but did not receive the panoramic radiograph (3). Subjects who consented to the panoramic radiograph had more extensive periodontal disease and tended to be younger with higher diastolic blood pressure, but were otherwise similar to the remainder of the INVEST cohort (3). A limitation of the present study is that we were not able to collect dental history data for study participants. Therefore the reason for tooth extraction in this sample is unknown. Extraction may be the only available treatment option for many in underserved areas (20).

The utility of panoramic radiographs for the purpose of determining oral disease in communities has again been demonstrated by the present study (21, 22). Panoramic radiographs offer distinct advan-

TABLE 5. Comparison of the prevalence of periapical radiolucencies and endodontically treated teeth between the present study and previous studies

Author(s)	Year	Country	Age	No. of teeth	Teeth with radiolucency (%)	Endodontically treated teeth (%)	Endo. Treated teeth with radiolucency (%)
Allard and Palmqvist (5)	1986	Sweden	65	2,567	9.8	17.6	27
Eriksen and Bjertness (22)	1991	Norway	50	2,940	3.5	6	36.6
Imfeld (29)	1991	Switzerland	66	2,004	8	26	31
Buckley and Spangberg (16)	1995	USA	20–80+	5,272	4.1	5.5	31.3
Present study	2004	USA	67	3,533	5.1	4.8	37.5

tages over other types of examination methods. The panoramic radiograph takes considerably less time to perform than the intraoral full mouth series, involves less need for patient cooperation, and provides a wider scope of diagnostic possibilities. Still, the panoramic radiograph may be less effective for the detection of periapical radiolucencies (21, 22) and failing root canal treatments than a complete intraoral radiographic series. Therefore, our use of the panoramic radiograph may also be seen as a limitation.

To examine a large number of radiographs, for practical reasons usually needs to be done by multiple observers. The reading of dental radiographs involves interobserver and intraobserver variances (23, 24). Investigations have shown that the best agreement is achieved if there are two observers (25–28). In the present study, two examiners were trained and calibrated and strict criteria for positive recordings were set up before the start of the examination.

The prevalence of both periapical radiolucencies and endodontically treated teeth in our study was comparable to that of other investigations (5, 16, 22, 29) of elderly populations mainly from Scandinavia. In these studies, the prevalence of teeth with a periapical radiolucency varied from 4.1 to 9.8%, whereas the prevalence of endodontically treated teeth ranged from 5.5 to 26% (Table 5). The prevalence in the present study of endodontically treated teeth, 4.8%, was slightly lower than that other studies. This may be attributable to poor access to oral health care services or inability to afford endodontic care. It is possible that our data underestimate the true prevalence of dental disease in this population because missing teeth were common in our study sample. Hanson and Persson (20) reported that tooth extraction is often the only dental treatment possible for many in underserved areas of the United States. It is likely that at least some tooth loss could be prevented in this cohort with better access to quality endodontic therapy. Salehrabi and Rotstein (30) showed high long-term rates of tooth survival in a cohort of individuals participating in a dental insurance plan.

It is well documented that the quality of the root filling is important to the long-term success of endodontic treatment (5, 11, 16, 22, 29, 31, 32). A proper seal and a root filling ending less than 2 mm from the apex has been shown to be an important endodontic treatment outcome criterion. Also, root fillings that end more than 2 mm from the apex or root fillings beyond the apex have shown less favorable prognosis. We examined teeth in the present study by these criteria and found that only 26% of endodontically treated teeth had satisfactory root fillings. Surprisingly, we also found that teeth with adequate root fillings had a considerably higher frequency of periapical radiolucencies than that of other populations that have been studied. In our study, more than one third of those endodontically treated had a periapical radiolucency. The high frequency of periapical radiolucencies associated with endodontically untreated teeth in this cohort indicates that the need for treatment is high.

As was previously shown (33, 34), periodontal disease measures appeared to influence endodontic treatment outcomes. Of the 3,533 teeth examined in this study, 11% had severe marginal bone loss. We found that the severity of marginal bone loss was positively correlated with the number and size of periapical radiolucencies. This finding is consistent with those of Jansson et al. (33) and Ehnevid et al. (34).

We examined restorations in this study. Among crowned teeth, nearly 17% had a periapical radiolucency. Furthermore, 36.6% of crowned teeth with a periapical radiolucency did not have root canal treatment. This high number may suggest that root canal treatment is being underutilized in full coverage restorative procedures. We also found that crowned teeth were far more likely to have periapical radiolucencies than teeth without crowns. This was true irrespective of whether a post was present. This finding is somewhat at odds with those of Eckerbom et al. (7), who showed that crowned teeth with posts had significantly more apical periodontitis than endodontically treated crowned teeth without posts. Further investigation is needed to determine the influence of posts on endodontic treatment outcomes.

Dammaschke et al. (32) demonstrated that the quality of endodontic treatment is of great importance for individual tooth prognosis. We found that the quality of root canal treatment in the current study cohort was generally poor. Our findings suggest a substantial need for improvement in the quality and availability of endodontic treatment in the northern Manhattan elderly. Other prevalent prognostic factors for endodontic treatment such as periodontal bone loss and inadequate restorations underscore the need for better comprehensive dental care in this community.

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