Use of Preexisting Radiographs for Assessing Periodontal Disease in Epidemiologic Studies

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Abstract

Objectives: *This study evaluates the feasibility of obtaining preexisting dental radiographs by mail, the validity of assessing alveolar bone loss from posterior radiographs compared to full mouth, and the validity of alveolar bone loss assessed from radiographs taken at different times.* ***Methods:*** *This investigation uses data obtained for a study evaluating associations between oral conditions, blood biomarkers, and coronary heart disease within two large cohorts: the Nurses' Health Study and the Health Professionals Follow-up Study. If consenting participants had dental radiographs, we requested these radiographs from their dentists. Some dentists returned multiple sets of radiographs, which enabled us to conduct this study. A calibrated periodontist read all radiographs with good intraexaminer reliability (r=0.91). We compared posterior radiographs to full mouth (n=121 sets), as well as radiographs taken at different times (mean difference of 5 years) (n=102 pairs).* ***Results:*** *Of the 812 participants, 81 percent consented and 66 percent provided radiographs. Posterior radiographs underestimated periodontitis (≥1 site with ≥5 mm alveolar bone loss) prevalence by 6 percent (53.7% vs 57.0%) compared to full mouth, with sensitivity of 0.94 (95% confidence interval [CI]=0.86, 0.98) and specificity of 1. Spearman correlation coefficients comparing mean alveolar bone loss were 0.70 for anterior versus posterior teeth (mean difference=0.48), 0.92 for posterior teeth versus full mouth (mean difference=0.25), and 0.78 for pairs of radiographs taken at different times (mean difference=0.01). The kappa statistic was 0.70 comparing radiographs taken within 5 years and 0.29 when the period extended beyond 5 years.* ***Conclusion:*** *Preexisting radiographs are feasible for use in epidemiologic studies and provide valid assessments of periodontal disease. [J Public Health Dent 2004;64(4):223-30]*

Key Words: validity, dental radiography, alveolar bone loss, periodontitis, epidemiologic methods.

Assessment of alveolar bone loss from dental radiographs is considered the standard method for diagnosis of periodontal disease in clinical practice. The use of patients' preexisting radiographs in periodontal epidemiologic studies has several compelling benefits. First, radiographs are readily available, as they are an essential component of routine dental examinations. The US Food and Drug Administration's and American Dental Association's guidelines prescribe posterior bitewing or full mouth radiographs for every new dental patient, and repeat posterior bitewing radiographs every three to 36 months depending upon disease risk (1,2). Second, use of preexisting radiographs avoids ethical concerns about unnecessary exposure of individuals to radiation for research purposes. Third, it is possible to obtain preexisting radiographs for a pertinent time period thus enabling establishment of the temporal sequence of periodontal exposures prior to the outcomes. Fourth, alveolar bone loss assessed from radiographs correlates highly with other quantitative clinical measures of periodontitis such as pocket depth and attachment loss (3). Fifth, evaluation of preexisting radiographs does not require the physical presence of the participant. In summary, it is inexpensive, noninvasive, and provides a viable option for the study of periodontal disease in population-based epidemiologic studies.

Since posterior bitewings are the most commonly prescribed dental radiographs, it seems likely that we could obtain them for studies of preexisting radiographs. However, we were concerned that participants could be falsely classified as negative if they only had bone loss in the anterior teeth. In addition, since radiographs for the exact period of interest may not be available, another concern was how well radiographs taken several years before or after the period of interest could represent periodontal bone loss status at the time of interest.

A search of the literature found that many epidemiologic studies have utilized preexisting radiographs to determine alveolar bone loss. The radiographs in these studies were taken from dental clinics or medical centers (4-8), recruitment screenings (9), or annual examinations in the community (10). To our knowledge, there is no report of using the postal system to collect preexisting radiographs. Accordingly, the present study had three goals: (1) to evaluate the feasibility of obtaining preexisting dental radiographs by mail, (2) to evaluate the validity of partial mouth posterior radiographs compared to full mouth in al-

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veolar bone loss assessment, and (3) to compare alveolar bone loss assessments from radiographs taken at different time points.

Methods

Study Populations. This investigation is part of a case-control study to evaluate the associations between chronic oral conditions, blood biomarkers, and coronary heart disease, nested in two large ongoing cohorts: the Nurses' Health Study (NHS) and the Health Professionals Follow-up Study (HPFS). The NHS was established in 1976, when 121,700 female registered nurses aged 30–55 years responded to detailed questionnaires about their medical history and health behavior. The HPFS was started in 1986, when 51,529 US male health professionals (58% dentists) completed similar mailed questionnaires.

The sampling frame for the present study consisted of incident coronary heart disease cases and matched controls from the two cohorts, among a subset of participants who had provided blood samples. Cases include all participants with confirmed incident nonfatal coronary heart disease that occurred from 1989–90 through 1996 in the NHS and from 1993–94 through 1998 in the HPFS. Controls were selected randomly from the respective cohorts from those who remained free of coronary heart disease, matched for age (within five years), smoking status (current, former, and never) and date of blood collection. The case-control ratio in this report was 1:1 in the HPFS and 1:2 in the NHS. The study was approved by the Human Subjects' Committee of the Harvard School of Public Health and the Brigham and Women's Hospital.

Data Collection. In May 1999, we mailed invitation letters and questionnaires to all eligible cases and controls who were still participating in the main studies. If participants had dental radiographs taken within five years of the time they provided a blood sample, we asked them to provide these radiographs or the address of the dentist who might have them. Up to three mailings were sent to each participant. In the HPFS, if a participant was deceased, we attempted to contact next of kin with individually written letters for authorization to obtain radiographs and information of the dentist. Due to a low response rate from next of kin and other ethical concerns, we did not pursue this method in cases (and their matched controls) occurring after 1996 or in the NHS.

Upon obtaining permission and the dentist's contact information, we wrote to the dentist requesting the radiographs. We telephoned the dentists if they did not respond after the third mailing. Although we requested only one set of posterior bitewing radiographs, many dentists provided us with full mouth or multiple sets of radiographs. We used these additional radiographs to compare posterior radiographs to full mouth and to evaluate the correlation of alveolar bone loss between radiographs taken at different time points. We included radiographs that were collected up to November 2002 for the present report.

Radiographic Assessment. The examiner in this study (CC) is a periodontist who was trained and calibrated by a gold standard examiner (CWD) with experience reading radiographs and training examiners since 1982, and with a high documented inter- and intraexaminer reliability for reading radiographs (11). The calibrated periodontist read all radiographs using 2.5x magnifying loupes and a viewing box to aid in the detailed assessment of the landmarks. Radiographic alveolar bone loss was measured in millimeters between the cementoenamel junction and the alveolar bone crest using a standard Williams-marking periodontal probe (Hu-Friedy, Chicago, IL, USA). Measurements of alveolar bone loss were done at the mesial and distal sites of the teeth. If the same site was seen in more than one radiograph, then the most severe reading was recorded. Multiple sets of radiographs from the same individual were read on separate days; the examiner was blinded to the results of the previous assessment. To assess the reliability of the assessment, 10 percent of the radiographs were randomly chosen to be read twice with an interval of at least one week. The Spearman correlation coefficient for intraexaminer reliability for mean bone loss was 0.91.

Statistical Methods. We compared characteristics of participants who provided radiographs with all the eligible participants using descriptive statistics. To evaluate the validity of posterior radiographs in alveolar bone loss assessment, we examined 121 sets of full mouth radiographs provided by HPFS and NHS dentate participants. For each individual, the posterior mean alveolar bone loss was calculated from mesial and distal sites on all posterior teeth except third molars (a maximum of 32 measurements per subject), the anterior mean alveolar bone loss from all anterior teeth (a maximum of 24 measurements per subject), and full mouth mean alveolar bone loss excluding third molars (a maximum of 56 measurements per subject).

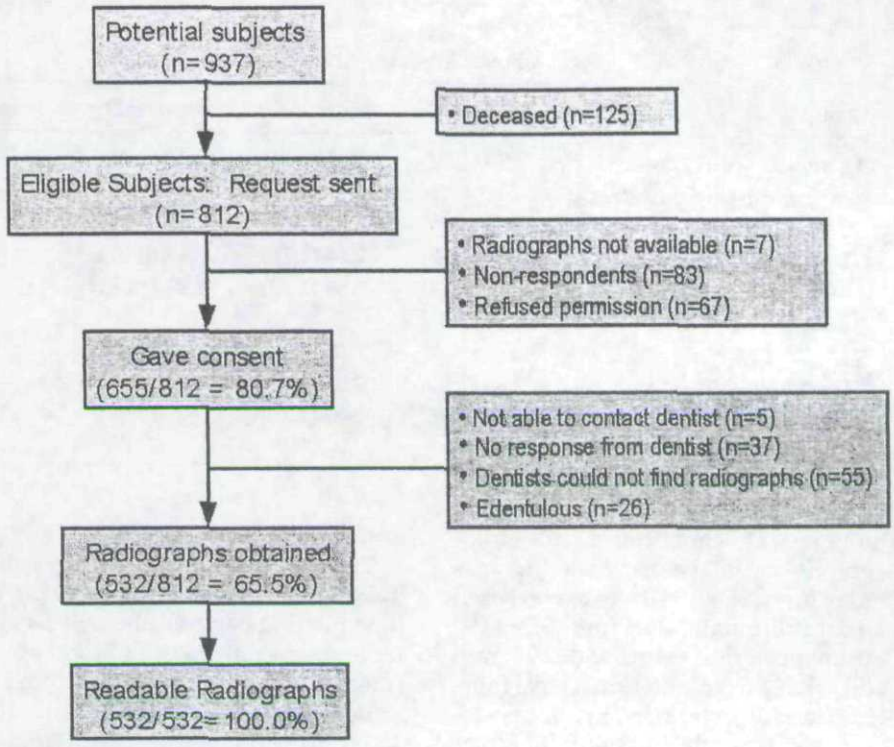
We compared posterior teeth to the full mouth in estimating disease severity (mean alveolar bone loss) and prevalence of periodontitis. Spearman correlation coefficients were calculated between the means for posterior teeth and anterior teeth. We also show the correlation between posterior teeth and full mouth; this correlation is expected to be higher due to the fact that posterior teeth are part of the full mouth. The Wilcoxon signed-rank test was used to compare the difference in the posterior teeth and full mouth estimates, and posterior teeth and anterior teeth estimates.

There is no universal consensus on classifying an individual's periodontal status based on alveolar bone loss. We arbitrarily defined periodontitis using two thresholds: (1) having at least one site with alveolar bone loss ≥4 mm, and (2) having at least one site with alveolar bone loss ≥5 mm as in our previous study (12). Similar cutoffs have been used to define periodontitis using attachment loss in a national survey (13). We calculated the underestimation of prevalence from posterior radiographs compared with full mouth radiographs as the difference in absolute ($P_{FM} - P_P$) and relative proportions ($[P_{FM} - P_P] \times 100/P_{FM}$), where P_{FM}=prevalence as determined by full mouth assessment and P_P=prevalence as determine by posterior assessment. Sensitivity measures of posterior radiographs versus full mouth radiographs are also presented with the corresponding 95 percent confidence intervals (95% CIs) computed with the Wilson Score Method (14). Since posterior radiographs are a subset of full mouth radiographs, they always underestimate full mouth radiographs. For example, if an individual does not have any site with alveolar bone loss ≥4 mm in full mouth radiographs, they cannot have a site

with alveolar bone loss ≥4 mm in posterior radiographs. Hence, the specificity of posterior bitewings must always equal 1.

To compare radiographs taken at different time points, we examined data of 102 participants who provided two sets of posterior radiographs. If more than two sets of radiographs were available, we selected the two sets taken with the longest time interval. We evaluated the difference in the mean alveolar bone loss scores measured over time using the Wilcoxon signed-rank test. We computed Spearman correlation coefficients to determine the correlation between mean alveolar bone loss, and kappa statistics to describe agreement between the prevalence measured at the two time points. We also conducted subgroup analyses for the time intervals of 1–5 years versus 6 years or more, 1–6 years versus 7 years or more, and 1–7 years versus 8 years or more. This manuscript was prepared manuscript following the Standards for Reporting Diagnostic Accuracy (STARD) checklist (15).

FIGURE 1
Responses among Participants in the Health Professionals Follow-up Study and the Nurses' Health Study



Results

Response Rates. Of the 812 participants contacted by mail, 729 (89.8%) responded and 655 (80.7%) gave permission to review radiographs (Figure 1). The nonresponse rate was 11.2 percent (41/367) among the HPFS, and 9.4 percent (42/445) among the NHS.

We were able to obtain radiographs for 532/812 participants (65.5%), or 81.2 percent of the 655 who gave permission. The radiographs were all of good quality and readable. We attempted to contact next of kin of 29 HPFS deceased participants and were able to get permission for radiographs and dentist's contact information for 15 participants (51.7%), and subsequently obtained radiographs for seven participants (24.1%). One next of kin refused permission, five could not provide information on dentist's address or availability of radiographs, and eight did not respond to the request.

Participants who provided radiographs appeared to be similar to all the eligible subjects with respect to age, race, body mass index, and physical activity (Table 1). We obtained more radiographs from coronary heart disease cases compared to controls among the NHS, as well as from nonsmokers (i.e., not current smokers) in both study cohorts.

Comparison of Posterior Radiographs to Full Mouth Radiographs.

TABLE 1
Characteristics of Study Participants

	Health Professionals Follow-up Study		Nurses' Health Study	
Characteristics	Eligible Subjects (Mean±SD) (*n*=367)	X-rays Obtained (Mean±SD) (*n*=252)	Eligible Subjects (Mean±SD) (*n*=445)	X-rays Obtained (Mean±SD) (*n*=280)
Age (years)	69.3±8.4	69.0±8.3	68.5±6.1	67.7±6.3
Body mass index (kg/m2)	25.7±3.5	25.8±3.6	26.2±5.1	26.0±4.9
Physical activity (METS/wk)	35.0±35.5	35.6±34.8	15.9±18.3	15.9±16.8
Caucasian (%)	94.6	96.0	85.9	85.5
Current smoker (%)	6.9	4.9	14.9	11.8
Dentist (%)	55.6	53.6	—	—
Having coronary heart disease (%)	40.9	40.1	28.8	31.4

TABLE 2
Relation of Alveolar Bone Loss Measured from Partial Mouth and Full Mouth Radiographs *[cont. p 227]*

	Continuous Bone Loss Score				
	Posterior	Anterior	Full Mouth	Spearman Correlation Coefficient	
Group	Mean (SD)	Mean (SD)	Mean (SD)	Posterior to Anterior	Posterior to Full Mouth
All subjects (n=121)	2.70 (1.02)	2.22 (1.06)	2.46 (0.94)	0.70	0.92
Number missing post. teeth					
0 (n=42)	2.20 (0.65)	1.86 (0.62)	2.06 (0.59)	0.66	0.93
1–3 (n=35)	2.70 (0.90)	2.24 (1.16)	2.49 (0.94)	0.71	0.93
4+ (n=44)	3.19 (1.17)	2.56 (1.22)	2.81 (1.08)	0.69	0.87
Sex					
Female (n=49)	2.84 (1.09)	2.25 (0.93)	2.50 (0.88)	0.77	0.92
Male (n=72)	2.62 (0.96)	2.21 (1.15)	2.42 (0.99)	0.66	0.92

Among 121 sets of full mouth radiographs, mean alveolar bone loss was 2.46 mm (SD=0.94) when measured from full mouth, 2.70 mm (SD=1.02) from posterior teeth, and 2.22 mm (SD=1.06) from anterior teeth (Table 2). Mean alveolar bone loss for posterior teeth correlated well with either the mean for anterior teeth (Spearman r=0.70) or the mean for full mouth (Spearman r=0.92) (Figure 2). Mean alveolar bone loss measured from posterior teeth was significantly higher than from anterior teeth (mean difference=0.48; SD=0.78; P<.001) and full mouth (mean difference=0.25; SD=0.42; P<.001). The results were not appreciably different when stratified by number of missing posterior teeth or sex.

Based on a 4 mm threshold, 80.2 percent of our adult subjects were classified with periodontitis using posterior teeth and 81 percent using full mouth; thus, use of posterior radiographs only led to an absolute underestimation of 0.8 percent and 1.0 percent relative underestimation in prevalence of periodontitis. Similarly, based on a 5 mm threshold, the prevalence was 53.7 percent using posterior teeth and 57.0 percent using the full mouth, leading to 3.3 percent absolute underestimation and 5.8 percent relative underestimation of periodontitis prevalence. The sensitivity was 0.99 (95% CI=0.94, 1.00) for a 4 mm threshold and 0.94 (95% CI=0.86, 0.98) for a 5 mm threshold. The validity of posterior radiographs reduced slightly among the subjects who lost four posterior teeth or more.

Comparison of Radiographs Taken at Different Time Points. The time interval between the two sets of radiographs ranged from 1 to 20 years (median=5 years). The Wilcoxon signed rank test showed no significant difference between mean alveolar bone loss scores measured over time (mean difference=0.01, SD=0.54; P=.47). Figure 3 illustrated a good correlation between radiographs taken at different time points (Spearman r=0.78). The results did not materially change in subgroup analyses of radiographs taken at different time intervals (Table 3). The Spearman correlation coefficients ranged from 0.75 for radiographs taken beyond 8 years to 0.80 for radiographs taken within 5 years.

In categorical analysis, there was moderate agreement in the prevalence measures across the two assessment times (kappa=0.45 for a threshold of ≥1 site with ≥4 mm, and kappa=0.54 for a threshold of ≥1 site with ≥5 mm). Kappa statistics were relatively high when comparing radiographs taken

FIGURE 2
Scatter Plot of Mean Alveolar Bone Loss (ABL) for Posterior Teeth and Mean Bone Loss for Full Mouth (n=121) (Points along straight line indicate perfect agreement between posterior and full mouth radiographs)

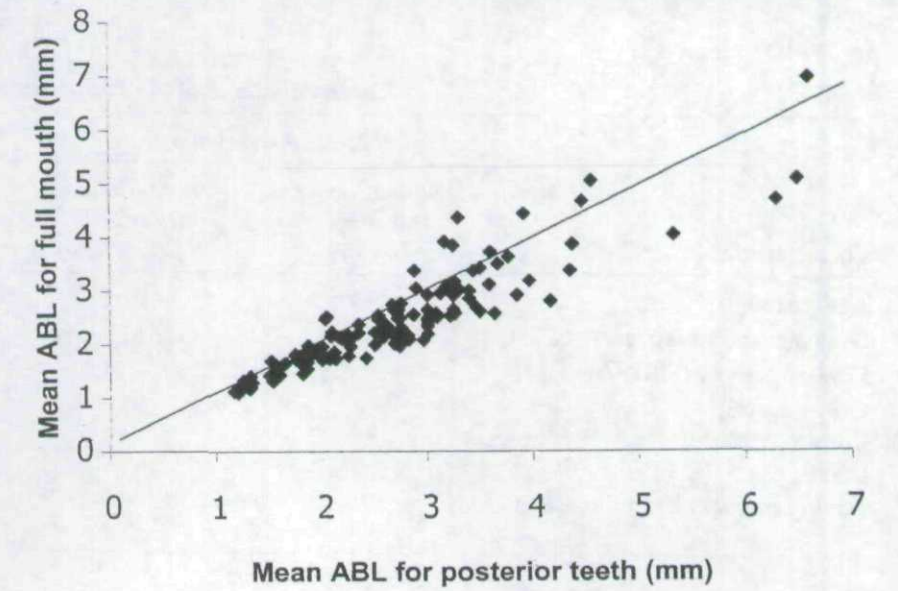
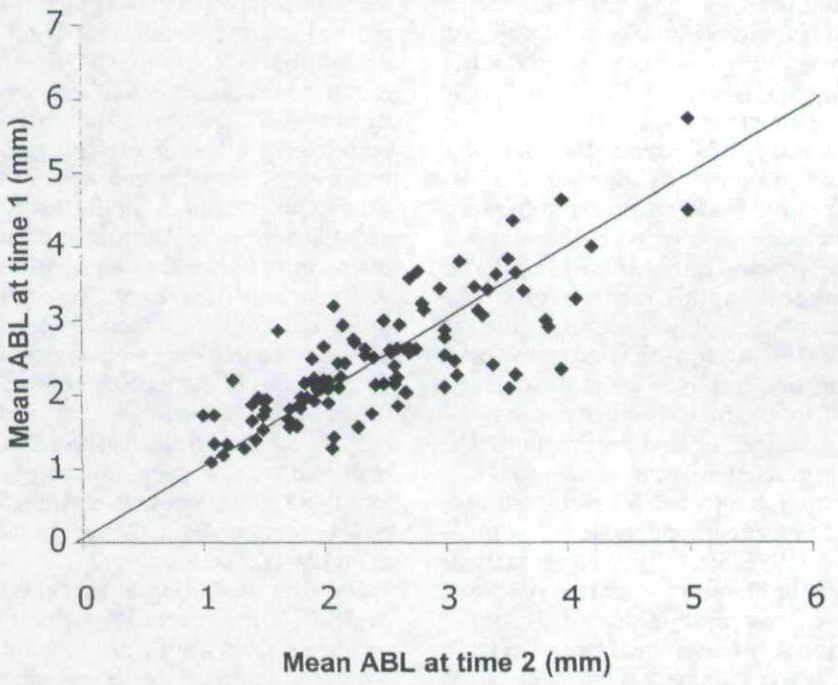


TABLE 2 *[cont. from p 227]*
Relation of Alveolar Bone Loss Measured from Partial Mouth and Full Mouth Radiographs

	Binary Bone Loss Measures					
	≥1 Site with Bone Loss ≥4 mm Prevalence (%)			≥1 Site with Bone Loss ≥5 mm Prevalence (%)		
Group	Posterior	Full Mouth	Sensitivity(95% CI)	Posterior	Full Mouth	Sensitivity(95% CI)
All subjects (*n*=121)	80.2	81.0	0.99 (0.94, 1.00)	53.7	57.0	0.94 (0.86, 0.98)
Number missing post. teeth						
0 (*n*=42)	73.8	73.8	1.00 (0.89, 1.00)	35.7	38.1	0.94 (0.72, 0.99)
1–3 (*n*=35)	77.1	77.1	1.00 (0.88, 1.00)	65.7	65.7	1.00 (0.86, 1.00)
4+ (*n*=44)	88.6	90.9	0.98 (0.87, 1.00)	61.4	68.2	0.90 (0.74, 0.97)
Sex						
Female (*n*=49)	79.6	79.6	1.00 (0.91, 1.00)	49.0	53.1	0.92 (0.76, 0.98)
Male (*n*=72)	80.6	81.9	0.98 (0.91, 1.00)	56.9	59.7	0.95 (0.85, 0.99)

within 5 years (0.53 for the 4 mm threshold and 0.70 for the 5 mm threshold) and decreased slightly when comparing radiographs taken within 6 years (0.49 for the 4 mm threshold and 0.65 for the 5 mm threshold), or radiographs taken within 7 years (0.48 for the 4 mm threshold and 0.54 for the 5 mm threshold). The agreement reduced especially for the 5 mm cutoff when the time interval between assessments extended longer.

FIGURE 3
Scatter Plot of Mean Alveolar Bone Loss (ABL) Measured from Radiographs Taken from the Same Individuals at Different Time Period (*n*=102 pairs) (The Median Time Interval between 2 sets of radiographs was 5 years (range=1–20 years). The points along the straight line indicate perfect agreement across the two time points.)



Discussion

Feasibility in Obtaining Preexisting Radiographs. We were able to obtain radiographs for 66 percent of living participants, or 81 percent of those who consented. The characteristics of the participants who provided radiographs were similar to those of all the eligible subjects with respect to age, race, body mass index, and physical activity. Nonrespondents were slightly more likely to be current smokers. It has been noted in the literature that women, older age groups, those with higher education level or in professional groups, and those with lower body mass index are more likely to respond to mail surveys (16,17). Nonrespondents tend to have worse health status (18) and less favorable health-related behaviors such as cigarette smoking (16).

Our study populations consisted of health professionals who had actively participated in a mail-based longitudinal study for more than a decade. They were highly motivated, health-conscious, more likely to have dental visits and radiographs, and more likely to respond to mail surveys than the general population. The multiple and full mouth radiographs used in this validation study are not a random sample of people with preexisting radiographs. Dentists might have tended to send the full mouth or multiple sets of radiographs for more diseased individuals. For example, in this study the prevalence of ≥5 mm alveolar bone loss was lower among participants who provided only posterior radiographs (37.0%) than those with the full mouth (53.7%). Nonetheless, other

TABLE 3
Relation of Radiographic Alveolar Bone Loss of the Same Individual, Taken at Different Time Points

	Continuous Bone Loss Measure			Binary Bone Loss Measure					
	Mean Bone Loss Score (SD)		Spearman Correlat.	Having at Least 1 Site with Bone Loss ≥4 mm (%)		Kappa	Having at Least 1 Site with Bone Loss ≥5 mm (%)		Kappa
Group	Time 1	Time 2	Coefficient	Time 1	Time 2	(95% CI)	Time 1	Time 2	(95% CI)
All radiographs (*n*= 102 pairs)	2.45 (0.86)	2.46 (0.82)	0.78	68.6	68.6	0.45 (0.27, 0.64)	44.1	41.2	0.54 (0.37, 0.70)
Time interval between 2 sets of radiographs (years)									
1–5 (*n*= 62 pairs)	2.49 (0.88)	2.50 (0.85)	0.80	67.7	66.1	0.53 (0.30, 0.75)	43.6	38.7	0.70 (0.52, 0.88)
6+ (*n*= 40 pairs)	2.39 (0.82)	2.40 (0.78)	0.78	70.0	72.5	0.33 (0.01, 0.65)	45.0	45.0	0.29 (0.00, 0.59)

characteristics including age, race, smoking, body mass index, physical activity, and coronary heart disease status were similar comparing participants who provided posterior radiographs to those who provided full mouth radiographs, and participants who provided multiple radiographs to those with a single set (data not shown). Hence, we expect the results to be generalizable.

Validity of Posterior Radiographs. In the present study, alveolar bone loss measured from posterior radiographs correlated highly with the alveolar bone loss measurements from anterior and full mouth radiographs. The prevalence of periodontal disease could be validly estimated from posterior radiographs as seen from the high sensitivity, high specificity, and minimal degree of underestimation. The 1–6 percent relative estimation was comparable to our previous estimate of 5 percent among the HPFS population (19). Our results are consistent with the literature summarized below.

A study of adult dry skulls sought to identify the optimal subset of teeth for alveolar bone loss surveys based on bitewing radiographs (20). Full mouth alveolar bone loss could be sufficiently represented by mandibular second premolars, accounting for 84 percent of the variation. When one or two additional posterior teeth were included, the variation accounted for increased to 87–92 percent. These findings supported an early epidemiologic survey by Bjorn et al. of 2,900 adults that alveolar bone loss measurements from the mandibular posterior areas satisfactorily represent full mouth measurements (21).

A study of 531 dental school patients aged 25–75 years were evaluated for partial mouth using 18 ad hoc tooth sites depicted in one anterior periapical and one posterior bitewing radiographs in comparison with full mouth based on the Extent and Severity Index (22). The partial mouth index correlated well with the full mouth index with a correlation of 0.92 for the extent (proportion of tooth sites with alveolar bone loss >2 mm), and 0.88 for the severity (mean alveolar bone loss). A similar study conducted among 192 industrial employees aged 30–65 years also showed that the Extent and Severity estimates of the partial mouth and full mouth values were comparable (23). Partial mouth has also been found to provide reasonable estimates of full mouth for clinical measures of gingivitis (24), probing depth (25), and attachment level (26).

Validity of Radiographs Taken at Multiple Time Points. Previous studies have shown a slow progression of bone loss associated with periodontal disease as measured in radiographs. In a follow-up study of 415 adults aged 27–67 years, mean alveolar crestal height of subjects at baseline was 2.05±0.85 mm with an annual loss of 0.04 mm (27). A retrospective longitudinal study of preexisting radiographs over a 10-year period showed a similar annual rate of alveolar bone loss of 0.04 mm (8). Likewise, alveolar bone loss assessed from intraoral radiographs obtained from 416 subjects aged 15–94 years suggested an overall rate of alveolar bone loss of 0.02 mm per year (28). These results suggest the progression of periodontitis is slow enough that radiographs taken at one point may be used to characterize alveolar bone loss of the individuals at other points in time.

In our study, we found no appreciable difference between mean alveolar bone loss measured in the same individual at different time points. The overall results (r=0.78) and results including different time periods (r=0.75–0.80) are quite similar and show high correlation between different timings. Even radiographs beyond 8 years (r=0.75) are reasonably correlated and not substantially different from the results for 1–7 years (r=0.78). Hence, we feel that, based on our data, radiographs within seven years could be used when the measure of interest is mean bone loss. However, the number of x-rays beyond eight years in our study are small, the results may be unstable, and it is not possible to do further subdivisions to see at what point the correlations become substantially weaker.

Radiographs taken within five years had similar patterns of alveolar bone loss when characterized by prevalence measures. Concordance in the prevalence assessing from radiographs taken after five years was lower especially when using a more stringent cutoff.

Periodontal attachment level and radiographic alveolar bone loss are the

most widely accepted measures for the assessment of periodontitis. Both methods measure the cumulative destruction of periodontal structure, are correlated well (29-31), and are usually considered the gold standard for validation studies of new periodontal diagnostic methods (32). Clinical examination of periodontal attachment loss is time consuming, expensive, and impractical to use in large studies. In contrast, radiograph assessment is relatively inexpensive, less time consuming, and noninvasive. Preexisting radiographs are readily available and thus enable investigators to obtain information from a relevant time period in the past, or at multiple time points in some settings.

Preexisting radiograph assessment of alveolar bone loss indeed has limitations. First, these radiographs are nonstandardized. Variations in x-ray technique, such as projection geometry, exposure time, voltage use, and film processing methods may introduce some nonsystematic measurement error, thereby decreasing the power of the study. We conducted a separate study to compare periodontitis assessment by standardized and nonstandardized radiographs among 37 patients aged 21–66 years. The mean alveolar bone loss was similar in the standardized and nonstandardized groups (1.60±0.72 mm vs 1.64±0.85 mm), and the correlation was high (r=0.95) (12).

Second, radiographs generally underestimate the true amount of alveolar bone loss as determined by direct measurement of bone during surgical procedure (33). However, this will not bias associations, as the underestimation would likely be consistent across all participants. The use of preexisting radiographs to assess periodontitis in epidemiologic studies would be unlikely to alter the results apart from reducing statistical power.

Finally, preexisting radiographs can only be obtained from the population of oral health care utilizers, which may or may not represent the general population, depending on the research questions. However, in the United States 82 percent of the adult population in 1998 reported having visited a dentist in the previous three years (34), and radiographs are taken routinely at dental visits.

Posterior radiographic alveolar bone loss represents the full mouth well. For etiologic studies of chronic periodontal disease, researchers may use radiographs taken within five years to represent alveolar bone loss at the time period of interest when using binary measures, but could use radiographs taken within seven years when using continuous measures of bone loss. In summary, we demonstrated that it is feasible and valid to use preexisting radiographs for epidemiologic studies.

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