Validation of a specific selection criterion for dental periapical radiography

Sharon L. Brooks, DDS, MS,[a] *and Steven Y. Cho, DDS,*[b] *Ann Arbor, Mich.*

UNIVERSITY OF MICHIGAN

It has been recommended that the prescription of dental radiographic examinations be based on a series of selection criteria. This study evaluated the usefulness of the presence of a large or deep restoration as an indicator for the need for a radiographic examination. Patients in need of routine examinations were questioned regarding pain in restored teeth. The radiographs of 2269 restored teeth in 209 patients were evaluated for depth of restoration and presence or absence of periapical pathosis. Another 1306 nonrestored teeth in 100 patients were evaluated similarly. There was an association between pain and periapical pathosis and between depth of restoration and periapical pathosis ($p < 0.001$ in each case). Radiographic yield for positive apical findings was low in restored teeth, especially when the restoration was shallow. The radiographic yield may be increased if other factors such as pain or integrity of the restoration are used to help make the decision regarding the need for radiographs.

(ORAL SURG ORAL MED ORAL PATHOL 1993;75:383-6)

Although the American Dental Association has recommended for many years that dentists prescribe radiographs for patients only after performing a thorough history and oral examination and take only those radiographs that are necessary for the diagnosis, treatment, or prevention of disease,[1, 2] published surveys suggest that many dentists tend to order radiographs on routine schedules rather than according to individual patient needs.[3-6]

To aid the dentist in deciding when a radiograph is appropriate, the Center for Devices and Radiological Health, Food and Drug Administration, convened a panel of dental experts to review the literature and to develop a set of guidelines for prescribing dental radiographs. The recommendations were published in 1988 in a publication of the Department of Health and Human Services[7] and shortly afterwards in several other journals, including the Journal of the American Dental Association,[2, 8] as well as in a brochure published by the Eastman Kodak Company (Rochester, N.Y.).[9]

For dentate adult patients new to the dental practice, the guidelines recommend that the radiographic examination consist of posterior bite-wing and selected periapical radiographs, which could be expanded to a full-mouth intraoral survey in selected patients with widespread oral disease.[7] To assist the dentist in deciding which periapical radiographs, if any, to order, the guidelines provide a list of selection criteria, that is, positive historical, clinical, and radiographic (on the basis of bite-wing radiographs) findings that may suggest the need for additional radiographs for further evaluation of the oral condition.

Several authors in both medicine and dentistry[10-16] have demonstrated that the use of selection criteria can substantially reduce the number of unproductive radiographs with minimal risk of missing significant findings. It now remains to evaluate specific clinical indicators for their usefulness as selection criteria.

One positive clinical sign included in the dental examination guidelines as a possible indication for radiographic examination is the presence of large or deep restorations. It has been recognized for many years that bacterial penetration into the tooth can lead to significant pulpal inflammation.[17] Likewise it

Supported by Delta Dental Fund. This study was performed while Dr. Cho was a student at the University of Michigan School of Dentistry.

[a]Department of Oral Medicine/Pathology/Surgery, School of Dentistry, and Department of Radiology, School of Medicine.
[b]In private practice.

0030-4220/93/$1.00 + .10 7/16/43570

Table I. Relationship between periapical pathosis and presence or absence of restoration in nonemergency patients

Periapical pathosis	*Restoration*		
	Present	*Absent*	*Totals*
No	2082	1250	3332
Yes	187	56	243
Total	2269	1306	3575

$\chi^2 = 20.452$ $p < 0.001$.
N = 209 subjects with 2269 restored teeth and 100 subjects with 1306 nonrestored teeth.

has been shown that the restorative procedures and materials used to repair carious teeth can also have a deleterious effect on the pulp.[18]

In a long-term follow-up of patients treated for periodontitis, Bergenholtz and Nyman[19] found that 15% of initially vital abutment teeth and 3% of nonabutment teeth developed pulpal necrosis over the 4 to 13 year evaluation period. Reuter and Brose[20] determined that a bridge built on a vital abutment tooth with a history of recent deep decay had a 10% chance of failure within 5 years because of pulpal complications with the abutment.

Marmary and Kutiner[21] found periapical inflammatory lesions in 51% of 889 randomly selected patients who received complete-mouth radiographic examinations. Although most of these lesions were associated with teeth that had either deep caries or previous endodontic treatment, 11% of the lesions were found in filled teeth and 9% in crowned teeth. Cyr et al.[22] concluded that previous restorative treatment was the major etiologic factor leading to root canal therapy in a review of 1518 endodontic cases at their institution.

In a stepwise evaluation of selection criteria for detecting periradicular lesions, Äkerblom et al.[23] found that the sensitivity could be raised from 0.34 for clinical signs and symptoms alone to 0.90 when a history of previous endodontic therapy or deep caries or restoration as determined from bite-wing radiographs was added as a criterion for making periapical radiographs. However, 10% of the periradicular lesions were not found without a complete-mouth set of radiographs.

This study was carried out to determine the frequency of periapical pathosis on teeth with large or deep restorations in an effort to establish whether the presence of an extensive restoration constitutes a valid high-yield or selection criterion for dental periapical radiography.

METHODS

Subjects for this study were selected from patients who came to the University of Michigan School of Dentistry for a routine oral examination and on whom intraoral radiographs were taken as part of the examination procedure. The patients were questioned about pain or sensitivity to cold, hot, sweets, or pressure for all restored teeth. After the patients were dismissed, one of the investigators evaluated the radiographs of all teeth that contained restorations for depth of restoration and integrity of the apical structures, without knowledge of clinical symptoms.

Restorations were categorized as being shallow, less than halfway through the dentin, or deep, halfway or more through the dentin. This classification of restoration depth was chosen because an attempt to measure the remaining dentin to the nearest millimeter proved unreliable in a pilot study. The periapical structures were considered normal if the lamina dura and periodontal ligament space (PDL) were continuous and of uniform width and there was no resorption of the root apex. Alterations in the presence or width of the lamina dura or PDL, up to and including a frank periapical radiolucency, were considered periapical pathosis for this study. Questionable cases were considered normal. To aid in radiographic interpretation, examples of various types of changes in lamina dura or PDL were available for comparison.

To compare the frequency of periapical lesions on restored and nonrestored teeth, a second group of randomly selected patients was chosen to be a control group. In these subjects all nonrestored, noncarious teeth were evaluated for periapical changes in a similar manner.

Before data collection began, we calibrated ourselves by independently interpreting 25 sets of radiographs selected from the teaching files and then discussing the results. At the end of data collection, we randomly selected another 25 sets of radiographs from the study and reinterpreted them. Kappa statistics for interexaminer and intraexaminer reliability were 0.84 and 0.83 for depth of restoration and 0.69 and 0.71 for periapical change. These statistics were interpreted to indicate adequate examiner consistency throughout the study.

RESULTS

The study population consisted of 209 persons with 2269 restored teeth visible on periapical radiographs and another 100 persons with 1306 nonrestored teeth who served as controls. Roughly one third of the restorations were classified as shallow with the remaining two thirds considered deep or extensive. For the

Table II. Relationship between periapical pathosis and depth of restoration in nonemergency patients

Periapical pathosis	*Depth of Restoration*		
	Shallow	*Deep*	*Totals*
No	768	1314	2082
Yes	45	142	187
Total	813	1456	2269

$\chi^2 = 12.272$ $p < 0.001$.
N = 209 subjects, 2269 restored teeth.

Table III. Relationship between periapical pathosis and presence or absence of pain symptoms in restored teeth in nonemergency patients

Periapical pathosis	*Pain symptoms*		
	None, mild	*Moderate, severe*	*Totals*
No	2044	38	2082
Yes	176	11	187
	2220	49	2269

$\chi^2 = 13.368$, $p < 0.001$.
N = 209 subjects, 2269 restored teeth.

study patients only 2% of the restored teeth exhibited moderate or severe pain symptoms.

Although there was no statistically significant difference in frequency of periapical pathosis in teeth with shallow restorations versus those with no restorations ($p = 0.19$), Chi-square tests showed highly significant differences between no restorations and any type of restoration and between shallow and deep restorations ($p < 0.001$ in each case) (Tables I and II). In addition there was also a significant relationship between severity of pain symptoms and presence of periapical pathosis in restored teeth ($p < 0.001$) (Table III).

The number of teeth with radiographic evidence of periapical pathosis varied, depending on the definition used for pathosis. When the criterion was any variation from normal in either the lamina dura or PDL, 8.2% of the restored teeth showed changes compared with 4.3% of the nonrestored teeth. When the criterion was tightened to include both loss of lamina dura and widened PDL, the prevalence of periapical pathosis dropped to 2.8% and 1.0%, respectively. Most of the alterations in PDL in nonrestored teeth appeared to be of periodontal rather than pulpal origin, although there was one patient with periapical involvement of several mandibular anterior teeth as a result of trauma.

As is to be expected, teeth with deep restorations were more likely to have periapical changes than those with no restorations, no matter what radiographic criteria were used, relative risk of 2.27 to 3.24 (95% confidence intervals = 2.17, 2.38 for any radiographic change, 3.01, 3.49 for "tight criteria"). Restored teeth with moderate or severe symptoms were more likely to demonstrate periapical pathosis than those with mild or no symptoms, relative risk of 2.83 (95% confidence intervals = 2.44, 3.28). When symptomatic teeth with deep restorations were compared with asymptomatic teeth with shallow restorations, there was a three- to five-fold increase in likelihood of periapical change.

DISCUSSION

What is an appropriate yield of positive findings that would validate a specific clinical indicator as a useful selection criterion for radiographic examinations? This question does not have an unequivocal answer at this time. For example, in this study if periapical radiographs were made on all restored teeth with either deep restorations as determined by bitewing radiographs or moderate-to-severe symptoms in patients who came for a complete examination, 64.6% of the restored teeth would be radiographed, but only 74.6% of periapical pathosis would be found, and 96.8% of the radiographs would be negative for periapical changes. If the periapical radiographs were restricted to only those teeth with both pain and deep restoration, the percentage of positive radiographs would be increased, but the number of periapical lesions detected would dramatically decrease because most affected teeth were not painful.

The frequency of periapical pathosis in this study was much lower than in the study by Marmary and Kutiner.[21] Although it is possible that some of the differences in prevalence might have been due to variations in radiographic interpretation, the most likely explanation for the majority of the differences lies in the dental disease patterns in general between a midwestern United States population versus a possibly more heterogeneous Israeli population.

It has been shown in previous studies that the use of high yield selection criteria can reduce the number of unproductive radiographic examinations.[12-14] However, negative radiographic examinations are not necessarily unproductive examinations because in some cases confirmation of absence of disease may affect patient care. It is difficult to determine the worth of negative findings in terms of economic, social, and biologic costs. In evaluating the potential usefulness of a specific selection criterion, consideration must be given to the probability of the presence

of the disease with no clinical signs or symptoms, its potential seriousness, and the consequences if the disease is not found at an early stage.

Without scientific evaluation of all of the above factors, it is hard to justify a specific clinical finding as a high yield selection criterion. However, this study suggests that the radiographic yield of positive periapical changes in restored teeth, especially in teeth with shallow restorations, is low in patients who need a complete examination, at least for a population that may have ready access to dental care. Although it may not be useful in all cases to radiograph a tooth simply because it contains a large or deep restoration, the radiographic yield may be increased if other factors such as pain or sensitivity, integrity of the restoration, and use of the restored tooth as an abutment are used to help make the decision about the need for radiographs. The difference in radiographic yield between this study and the one by Marmary and Kutiner[21] suggests that selection criteria might need to be adapted to the overall dental health needs of the population being studied.

REFERENCES

1. Council on Dental Research. Council on Dental Materials and Devices. Radiation hygiene and practice in dentistry. J Am Dent Assoc 1967;74:1032-3.
2. Council on Dental Materials, Instruments, and Equipment. Recommendations in radiographic practices: an update, 1988. J Am Dent Assoc 1989;118:115-7.
3. Matteson SR, Morrison WS, Stanek EJ III, Phillips C. A survey of radiographs obtained at the initial dental examination and patient selection criteria for bite-wings at recall. J Am Dent Assoc 1983;107:586-90.
4. Kaugars GE, Broga DW, Collett WK. Dental radiologic survey of Virginia and Florida. ORAL SURG ORAL MED ORAL PATHOL 1985;60:225-9.
5. Stanek EJ III, Fitzgerald M, Ken RR, Matteson SR, Phillips C. The relationship between the dentist's year of graduation and ordering of bite-wing radiographs. J Am Dent Assoc 1986;113:42-6.
6. Bernick EB, Branch LG. Comparison of utilization of dental bite-wing radiographs to current guidelines in an insured Massachusetts population. J Dent Educ 1989;53:612-8.
7. Joseph LP, Dental Radiographic Patient Selection Criteria Panel. The selection of patients for x-ray examinations: dental radiographic examinations. Rockville, Maryland: DHHS Pub No. (FDA) 88-8273, 1987:1-32.
8. Matteson SR, Joseph LP, Bottomley W, et al. The report of the panel to develop radiographic selection criteria for dental patients. Gen Dent 1991;39:264-9.
9. Guidelines for prescribing dental radiographs. Pub. No. N-80A. Rochester, New York: Eastman Kodak Co., 1988.
10. Bell RS, Loop JW. The utility and futility of radiographic skull examination for trauma. N Engl J Med 1971;284:236-9.
11. Phillips LA. Comparative evaluation of the effect of a high yield criteria list upon skull radiography. J Am Coll Emerg Phys 1979;8:106-9.
12. White SC, Forsythe AB, Joseph LP. Patient-selection criteria for panoramic radiography. ORAL SURG ORAL MED ORAL PATHOL 1984;57:681-90.
13. Kogon SL, Stephens RG. Selective radiography instead of screening pantomography: a risk/benefit evaluation. J Can Dent Assoc 1982;48:271-5.
14. Brooks SL. A study of selection criteria for intraoral dental radiography. ORAL SURG ORAL MED ORAL PATHOL 1986;62:234-9.
15. Douglass CW, Valachovic RW, Berkey CS, Chauncey HH, McNeil BJ. Clinical indicators of radiographically detectable dental diseases in the adult population. ORAL SURG ORAL MED ORAL PATHOL 1988;65:474-82.
16. Kogon SL, Charles DH, Stephens RG. A clinical study of radiographic selection criteria for edentulous patients. J Can Dent Assoc 1991;57:794-8.
17. Reeves R, Stanley HR. The relationship of bacterial penetration and pulpal pathosis in carious teeth. ORAL SURG ORAL MED ORAL PATHOL 1966;22:59-65.
18. Langeland K, Dowden WE, Tronstad L, Langeland LK. Human pulp changes of iatrogenic origin. ORAL SURG ORAL MED ORAL PATHOL 1971;32:943-80.
19. Bergenholtz G, Nyman S. Endodontic complications following periodontal and prosthetic treatment of patients with advanced periodontal disease. J Periodontol 1984;55:63-8.
20. Reuter JE, Brose MO. Failures in full crown retained dental bridges. Br Dent J 1984;157:61-3.
21. Marmary Y, Kutiner G. A radiographic survey of periapical jawbone lesions. ORAL SURG ORAL MED ORAL PATHOL 1986;61:405-8.
22. Cyr G, Arvis L, Safavi K, Langeland K. Major etiologic factors leading to root canal procedure [Abstract 31]. J Endodont 1985;11:145.
23. Åkerblom A, Rohlin M, Hasselgren G. Individualised restricted intraoral radiography versus full-mouth radiography in the detection of periradicular lesions. Swed Dent J 1988;12:151-9.

Reprint requests.
Sharon L. Brooks, DDS, MS
Department of Oral Medicine, Pathology, Surgery
University of Michigan
School of Dentistry
Ann Arbor, MI 48109-1078