

Examiner Agreement in the Replacement Decision of Class I Amalgam Restorations

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Abstract

The aim of this study was to investigate interexaminer and intraexaminer agreement in the replacement decision for Class I amalgam restorations. Three examiners evaluated the restorations clinically and with bitewing radiographs. One hundred and twelve restorations were evaluated for secondary caries, body fracture, deficient anatomic form (contour), ditched margins, and marginal overhangs. After one month, the assessments were repeated by the same examiners under the same conditions. Cohen's Kappa analysis was used to analyze the data. The number of replacement decisions varied from 12 to 27 and from 6 to 14 at the first and second evaluations, respectively. The Kappa statistics indicated "moderate" to "substantial" consistency for interexaminer and intraexaminer agreement in the replacement decisions based on clinical and radiographical examinations. Restorations with deficient anatomic form and marginal overhangs presented the most frequent diagnostic difficulties and lead to disagreement among examiners. The most frequently mentioned reasons for replacement were the restorations had ditched margins at both clinical evaluation periods and secondary caries was detected during radiographical evaluations. In the absence of agreement among examiners, clinical and radiographic guidelines are necessary for replacing Class I amalgam restorations.

Keywords: Amalgam, dental, decision making, diagnosis, examiner variation, radiography, secondary caries, ditched margins, marginal overhangs, amalgam body fractures

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Introduction

An accurate assessment of the quality of a restoration is an essential part of dental practice and epidemiological research.¹ Studies have shown replacement of existing restorations accounts for a significant portion of treatment in operative dentistry.^{2,3} Decisions to replace restorations also have a significant impact on the cost of restorative care.⁴ Although dentists have placed dental amalgam restorations for over 150 years, there is widespread variability in the criteria used for assessing restoration quality and recommending replacement.^{2,3} Dentists may be influenced by several factors when deciding upon the replacement of existing amalgam restorations; consequently, significant variations among clinicians are common.^{3,5,6}



The aim of this study was to investigate inter-examiner and intraexaminer agreement in the replacement decision of Class I amalgam restorations based on clinical and radiographic assessments.

Materials and Methods

One hundred and sixty-seven students of Süleyman Demirel University School of Dentistry served as subjects in this study. There were 89 female and 78 male students ranging from 18 to 27 years of age. No student declined to take part in the study, and verbal consent was obtained from each participant.

A total of 112 occlusal amalgam restorations were evaluated including 3 premolars and 109 permanent molars {maxillary (n=38) and mandibular (n=74)}. Three examiners (A, B, and C) evaluated the occlusal amalgam restorations clinically and radiographically. These examiners had eight to 13 years of experience in restoration assessment. No attempt was made to calibrate them.

Clinical Examination

Each of the three evaluators examined the teeth independently using the naked eye. They then performed clinical evaluations using a sharp explorer and a mouth mirror. The teeth were

dried with compressed air from an air-water syringe. Illumination was provided by the dental unit light.⁷ Care was taken to provide consistency in examination process and patient positioning.

Radiographic Examination

Bitewing radiographs (E-speed, Agfa, Belgium) were taken for each tooth with an occlusal amalgam restoration using a dental X-ray unit (Anthos, Italy) at 65 kVp, 12 mA, 0.4 s and a film holder (Test set, Hawe x-ray Film holders, Switzerland). The films were processed in an automatic processor (Velopex, X/51853, England) with fresh processing solutions (Kodak RP X-Omat LO, France) mixed according to the manufacturer's instructions. The bitewing radiographs were assessed without magnification on a standard view box masked to cover all but the radiograph in a room with subdued lighting.⁸

The restorations were evaluated for secondary caries, body fracture, deficient anatomic form (contour), ditched margins, and marginal overhangs clinically and radiographically.⁹ Other causes of failure were also recorded, if present. No examiner knew the identity of the patient in the radiographic films. The examiners recorded their findings and made one of two recommendations: "no replacement" or "replacement of filling." After one month, the assessments of the teeth were repeated by the same examiners under identical conditions. The examiners were not informed about previous decisions.

Interexaminer and intraexaminer agreement were expressed as Cohen's Kappa. The Kappa statistics were calculated using SPSS statistical program package (SPSS 11.0 for Windows). The results were then interpreted according to guidelines suggested by Landis and Koch (Table 1).¹⁰

Kappa Statistic	Strength of Agreement
<0.00	Poor
0.00-0.20	Slight
0.21-0.40	Fair
0.41-0.60	Moderate
0.61-0.80	Substantial
0.81-1.00	Almost perfect

Table 1. Kappa values and corresponding strength of agreement.

Results

At the second evaluation, 110 of the original 112 occlusal amalgam restorations were examined clinically. Two restorations were excluded in the second evaluation because they had been replaced. On radiographic examination, two additional teeth with orthodontic brackets were excluded from the study resulting in a sample size (n) for the second evaluation to 108.

Clinical Examination

At the first clinical evaluation, the decisions to replace the restorations were 24% (n=27), 22% (n=25), and 11% (n=12), respectively for examiners A, B, and C. Following the second clinical evaluation, the recommendations to replace the restorations were 13% (n=14), 13% (n=14), and 5% (n=6) of the restorations for examiners A, B, and C, respectively. Three examiners were in agreement in their decisions in 71.43% and 84.55% of the restorations at the first and second evaluations, respectively.

Radiographic Examination

Kappa values for interexaminer agreement in the replacement decisions based on clinical and radiographical examination of Class I amalgam restorations are shown in Table 2. The Kappa



Figure 1. The recommendation for this occlusal amalgam restoration with a body fracture was “replacement of filling.”

statistics indicated “moderate” consistency among the three examiners in the decision to replace amalgam restorations based on the clinical examination. On radiographic examination, the Kappa statistics indicated “moderate” and “substantial” consistency among the three examiners in the replacement decision of amalgam restorations.

Kappa values for intraexaminer agreement in the replacement decisions based on clinical and radiographic examination of Class I amalgam restorations are also shown in Table 2. Intraexaminer agreement showed “moderate” agreement with clinical examination and “moderate” and “substantial” consistency in the replacement decision for amalgam restorations based on the radiographic examination.

Table 2. Interexaminer and intraexaminer agreement in the replacement decision of occlusal amalgam restorations clinically and radiographically (1 = first evaluation and 2 = second evaluation).

Interexaminer Agreement					Intraexaminer Agreement		
Examiners	Clinical		Radiographical		Examiners	Clinical	Radiographical
	1	2	1	2			
A-B	0.50	0.59	0.59	0.65	A	0.42	0.58
A-C	0.43	0.46	0.65	0.58	B	0.45	0.64
B-C	0.46	0.35	0.65	0.65	C	0.46	0.65

Table 3. Values of Kappa for interexaminer and intraexaminer agreement (1 = first evaluation and 2 = second evaluation).

Examiners	Secondary Caries		Body Fracture		Anatomic Form		Ditched Margin		Marginal Overhangs	
	1	2	1	2	1	2	1	2	1	2
Interexaminer Agreement										
A-B	0.52	0.65	0.37	0.49	0.19	- 0.01	0.18	0.54	0.32	-
A-C	0.37	0.85	0.27	-*	0.48	-	0.40	0.18	-0.01	-
B-C	0.33	0.74	0.56	-	-0.03	-	0.17	-0.03	-0.01	-
Intraexaminer agreement										
A	0.26		0.32		0.32		0.42		-0.02	
B	0.19		0.66		0.26		0.22		-	
C	0.32		-		-		-0.03		-	

*- indicates the Kappa value can not be determined because of limited data.

Table 4. Distribution of the examiners' reasons to replace the restorations clinically.

	Examiner A		Examiner B		Examiner C		Total	
	n	%	n	%	n	%	n	%
First Evaluation								
Secondary caries	5	4.46	6	5.36	5	4.46	16	14
Body fracture	5	4.46	5	4.46	2	1.79	12	10.71
Deficient anatomic form	5	4.46	4	3.57	3	2.68	12	10.71
Ditched margin	14	12.50	9	8.04	8	7.14	31	28
Marginal overhangs	4	3.57	2	1.79	1	0.89	7	6.25
Second Evaluation								
Secondary caries	4	3.64	5	4.55	3	2.73	12	11
Body fracture	2	1.82	2	1.82	2	1.82	6	5.45
Deficient anatomic form	1	0.91	3	2.73	2	1.82	6	5.45
Ditched margin	8	7.27	6	5.45	2	1.82	16	15
Marginal overhangs	1	0.91	2	1.82	2	1.82	5	4.55

Kappa values for interexaminer and intraexaminer agreement in the decisions of secondary caries, body fracture (Figure 1), anatomic form, ditched margin, and marginal overhangs are shown in Table 3.

Distribution of the examiners' reasons to replace the restorations on clinical evaluation are presented in Table 4. On radiographic evaluations, secondary caries was found to be the only reason for the recommendation to replace a restoration. The examiners were in agreement in their decisions in 94.55% and 96.36% of the cases in the first and second radiographic evaluations, respectively.

The number of secondary caries lesions detected clinically but not radiographically were in the range of 2 to 5 (1.9% to 4.5%) for all evaluations (Figures 2a and 2b).

In total, 3 to 7 (2.8% to 6.4%) secondary caries lesions were detected radiographically but not clinically (Figure 3a and 3b).

Discussion

It is well known all dentists do not make the same decisions in the same clinical situations regarding the need for treatment and the choice of treatment. Three sources of disagreement have been described: the clinician (examiner), the patient (examined), and the procedure (examination).¹¹

The procedure (examination) has been shown to be associated with decisions to treat.^{11,12} Examinations should be performed in a consistent fashion using standardized techniques to minimize patient and procedure variability.¹¹ The method used in the study for the assessment of restorations is one that is simple, practical, and familiar to all dental practitioners. It requires only a sharp explorer and visual inspection, aided by a mouth



Figure 2a. It was recommended in clinical evaluation by all of the examiners this occlusal amalgam restoration with secondary caries be "replaced."



Figure 2b. The bitewing radiograph of the same occlusal amalgam restoration received a "no replacement" recommendation by all of the examiners.



Figure 3a. This occlusal amalgam restoration received the "no replacement" recommendation in clinical evaluation by all of the examiners.



Figure 3b. The bitewing radiograph of the same occlusal amalgam restoration revealing secondary caries.

mirror. Considerable attention was also given to the patient positioning and the examination process to reduce measurement variability.



One of the sources of disagreement is examiner variability.¹¹ Clinician variability arises from the process by which information is observed and interpreted. The data are then converted into categories. Disagreement can occur

when the findings are observed or when they are organized into the arbitrary categories used in classification systems. It has been reported an examiner may make measurements that do not meet all of the criteria of a category. One examiner will then choose the closest matching category, while another examiner may choose another category.¹¹ One study found criteria used to decide whether or not to replace Class I and Class II amalgam restorations are poorly defined for examiners.⁹

In this study we attempted to evaluate the examiner agreement during routine clinical and radiographic examinations, and our results indicated calibration would be useful to improve examiner agreement. However, some investigators have shown training to improve examiner reliability is equivocal or unsuccessful, while others have reported success with examiner training programs.^{13,14} Further, there is no universally accepted calibration methodology in the literature, therefore, it may be misleading to use a single calibration method to evaluate the benefits of a training program. The authors suggest further studies should focus on the comparison of different calibration methods.

Today, the most accepted method of measuring examiner agreement is the Kappa value.¹¹ To assess the strength of agreement obtained with a given Kappa value, the criteria of Landis and Koch¹⁰ have gained widespread acceptance. In this study the Kappa values were interpreted according to these criteria. Kappa values for replacement decision of amalgam restorations clinically have been reported to be as low as -0.09, 0.44, or 0.54 without any training pro-

gram.^{1,3} Because of the methods used to examine and report the extent of variation varied widely in different studies, comparisons among studies are not possible, especially the numerical data.³ Education level and clinical experience have been shown to positively affect interexaminer agreement.^{3,11} In this study three experienced dentists, all faculty members, reached moderate interexaminer agreement in the recommendation to replace restorations at the first (0.46) and the second evaluation (0.47), and also reached moderate intraexaminer agreement (0.45) without examiner training.

Agreement for identification of caries requiring treatment (Kappa value of 0.58) was more consistent than agreement for restorations needing replacement for body fracture, deficient anatomic form, ditched margin, marginal overhangs, and other reasons at both evaluation periods in this study (Table 4).¹²

Restorations with deficient anatomic form and marginal overhangs presented the most frequent diagnostic difficulties leading to disagreement among examiners (Kappa value of 0.10) (Table 4). Therefore, it is important to improve the criteria for evaluating anatomic form and detecting marginal overhangs to reduce this high level of disagreement.

Although the frequently reported reason for replacing the restorations in several studies^{9,15,16,17} was secondary caries, we found secondary caries in only 14% (n=16) and 11% (n=12) of the restorations at the first and second evaluations, respectively. This finding may be due to the fact secondary caries is rarely noted on occlusal surfaces compared to approximal areas.⁹ Bader and Shaugars¹² reported the most frequently mentioned reasons for restoration replacement, other than caries, are breakdown of the margin and fracture of the restoration. In the present study the principal reason for replacement was ditched margins at both evaluation periods (Figure 4).

Tveit and Espelid² reported there are different opinions among dentists where crevices or marginal defects are concerned. They also mentioned the size of the crevice and the amount of marginal degradation that is acceptable or



Figure 4. An occlusal amalgam restoration with ditched margins received the “replacement of filling” recommendation by two of the examiners.

non-threatening for the tooth is still unknown. Cardoso et al.⁹ has found many marginal defects can be resolved satisfactorily with a finishing and polishing procedure. All examiners in their study recommended replacing fewer restorations with ditched margins after the procedure.

When measuring the level of examiner agreement, information can be obtained from a number of different sources such as the patient history, clinical examination, and radiographic examination. Replacement decisions for Class I amalgam restorations were made and compared both clinically and radiographically in the present study. Pooterman et al.¹⁸ found about 2.5 to 6 times as many assumed dentin lesions were diagnosed using radiographs. In the present study more secondary caries lesions were detected on radiographic assessments in both examinations. These results are in line with the findings of Pooterman et al. Some researchers have mentioned bitewing radiographs do not truly correspond to the actual state of disease. Some carious lesions are not detected (false-negative), while a number of sound tooth surfaces are deemed carious (false-positive).¹ Wenzel et al.¹⁹ found when occlusal caries is assessed clinically and radiographically,

more false-negative than false-positive diagnoses may be expected. They noted some teeth were radiographically scored as caries free when in fact a carious lesion actually extended deep into the dentin.¹⁹ However, Espelid et al.²⁰ have indicated most dentists tend to “overscore” lesions (false-positive diagnoses) in the outermost part of dentin. These authors mentioned some dentists also hold the opinion radiographs are less valuable for detecting occlusal caries than approximal lesions because the examiners are more accustomed to radiographic diagnoses on the approximal surface.²⁰ The results of this study demonstrated interexaminer and intraexaminer variations were greater for the clinical than for the radiographic assessment. Because secondary caries found under the restorations were in the inner part of the dentin and proximal surface of the teeth, lower examiner variation may have been observed for the radiographic examination.

Conclusions

1. The decision whether or not to replace a Class I amalgam restoration varies among dentists.
2. Class 1 restorations with deficient anatomic form and marginal overhangs may present diagnostic difficulties in replacement decision.
3. The presence of clinically detectable ditched margins is one of the principal reasons dentists cited for recommending the replacement of Class 1 amalgam restorations.
4. Bitewing radiographs provide more information on the diagnosis of secondary caries compared to visual inspection alone.
5. The degree of agreement among examiners was influenced by the method of assessing the Class 1 restorations (clinically or bitewing radiography).



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