Reproducibility and Agreement of Clinical Diagnosis of Occlusal Caries Using Unaided Visual Examination and Operating Microscope

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ABSTRACT

Aim: To assess the reproducibility of clinical diagnosis of occlusal caries using unaided visual examination and examination with an operating microscope (16× magnification) and to determine the agreement between these 2 methods.

Materials and Methods: Three experienced dentists used unaided visual examination and an operating microscope to grade, according to a standard caries rating scale, a total of 299 occlusal surfaces in 112 subjects (mean age 28.3 years, standard deviation 0.5 years), during several examination sessions. Intraobserver and interobserver reproducibility was calculated, and agreement in diagnosis of the same teeth by different methods was also determined.

Results: The level of intraobserver agreement for the 2 modes of clinical diagnosis was substantial, as indicated by kappa values; however, there was substantial interobserver variability with both techniques. Agreement in clinical diagnosis between the 2 techniques was 62.5% for observer 1 (kappa = 0.483), 65.4% for observer 2 (kappa = 0.531) and 63.5% for observer 3 (kappa = 0.508) (p = 0.001).

Conclusions: Intraobserver agreement with the operating microscope and with unaided visual examination was roughly the same, but interobserver agreement was low with both techniques. For some surfaces, the diagnosis made by a particular observer with unaided visual examination differed from that made with microscopic examination. The diagnoses differed most frequently for surfaces that were scored as sound with unaided visual examination.

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The detection of caries on occlusal surfaces may be difficult because of the high prevalence of hidden caries in this location.[1-4]

Unaided visual examination has been widely used in dental clinics to detect carious lesions on the occlusal surfaces of posterior teeth. Previous studies have shown that this method has high specificity, especially for detecting dentinal lesions. Conversely, unaided visual examination is not a quantitative method and has low sensitivity and reproducibility.[3,5]

One promising noninvasive method of detecting caries involves the use of magnifying visual aids. One such aid is the operating

microscope, which offers various high- and low-power magnifications. Operating microscopes offer homogeneous illumination without shadows and a 3-dimensional view, which combine to allow clear visualization of the examination site.[6] Although acceptance of the operating microscope in dental clinics has been slow, their use during dental treatment procedures is now increasing.[7]

In a previous study, the reproducibility of the operating microscope for detecting caries was assessed in vitro.[8] However, a literature review yielded no studies assessing the reproducibility and agreement of clinical diagnosis of occlusal caries using unaided visual examination and an operating microscope. Therefore, the current study was undertaken to assess the reproducibility of in vivo diagnosis of occlusal caries by unaided visual examination and with an operating microscope at 16× magnification and to determine the agreement between these 2 methods.

Methods and Materials

Sample Selection

A total of 299 occlusal surfaces of molar teeth in 112 patients were evaluated during this study. The patient sample consisted of 54 women and 58 men, ranging in age from 20 to 30 years (mean 28.3 years, standard deviation 0.5 years). The study sample was selected from volunteer patients attending the operative dentistry and endodontics department of the authors' institution. The subjects were informed of the purpose of the study and provided written consent before the examination sessions.

Observers

Three dentists — one professor with 15 years of academic experience (HE), one research assistant in the operative dentistry and endodontics department with 7 years of academic experience (ÖU) and one research assistant in the oral diagnosis and radiology department with 6 years of academic experience (ZZA) — examined the patients. All of the observers routinely used unaided visual examination in their respective dental practices and had been trained in the in vivo use of the operating microscope at 16× magnification. They had also participated in an in vitro study assessing the efficiency of the same microscope for diagnosing occlusal caries.[9]

Unaided Visual Examination

The occlusal surfaces of the teeth were brushed and dried before each examination. Unaided visual examination was performed under illumination from a dental unit light; compressed air and water from the unit's air–water syringe and a standard dental mirror without magnification were also available. The observers examined the occlusal surfaces of the molar teeth, which had no hypoplastic defects, amalgam, composite restoration or fissure sealant, and graded them according to the criteria listed in **Table 1**. If there were multiple areas of demineralization on the fissure fossa system or pit, the most demineralized area was examined. Two weeks later, the observers re-examined half of the same teeth by unaided visual examination to allow assessment of intraobserver reproducibility for this method.

Table 1 Scale for assesing occlusal surfaces of teeth[10]

Score	Criteria
D0	No lesion or subclinical initial lesions in a dynamic state of progresion or regression
D1	Clinically detectable enamel lesions with intact surfaces
D2	Clinically detectable cavites limited to enamel
D3	Clinically detectable lesions penetrating into dentin; surface open or closed
D4	Lesions penetrating into pulp

Examination with Operating Microscope

Three weeks after the visual re-examination, the 3 observers examined the same teeth using an operating microscope (Moeller-Wedel, Dento 300, Wedel, Germany) at 16× magnification. They used the same examination steps and grading criteria as for the unaided visual examination. Two weeks later, the observers re-examined half of the same teeth with the operating microscope to allow assessment of intraobserver reproducibility.

Statistical Analysis

Data were analyzed using the SPSS program (version 7.0, SPSS Inc., Chicago, Ill.). Intraobserver and interobserver reproducibility with each examination method was assessed using the kappa test. For each observer, the percentage agreement and kappa values were calculated for clinical diagnosis of individual teeth with unaided visual examination and examination with the operating microscope. Kappa values less than 0.00 indicate poor agreement, values between 0.00 and 0.20 indicate slight agreement, values between 0.21 and 0.40 indicate fair agreement, values between 0.41 and 0.60 indicate moderate agreement, values between 0.61 and 0.80 indicate substantial agreement, and values between 0.81 and 1.00 indicate almost-perfect agreement.[11]

Results

Intraobserver Reproducibility

The kappa value for unaided visual examination was 0.80 for observer 1, 0.71 for observer 2 and 0.76 for observer 3. The kappa value for examination with the operating microscope was 0.75 for observer 1, 0.65 for observer 2 and 0.78 for observer 3. For observers 1

Table 2 Cross-tabulations of scores of all observers with unaided visual examination and operating microscope

Score determined by microscopic examination	Score determined by visual examination				Total
	D0	D1	D2	D3	
Observer 1[a]					
D0	19	5			24
D1	59	87	5	1	152
D2	5	10	40	3	58
D3	1	2	21	41	65
Total	84	104	66	45	299
Observer 2[b]					
D0	29	2	1		32
D1	44	74	4	1	123
D2	8	22	47	1	78
D3			20	45	65
Total	81	98	72	47	298[c]
Observer 3[d]					
D0	49	3			52
D1	50	69	9		128
D2	6	15	38		59
D3	4	3	19	34	60
Total	109	90	66	34	299

[a]*For observer 1, percentage agreement was 62.5% and kappa = 0.483* (p = *0.001).*
[b]*For observer 2, percentage agreement was 65.4% and kappa = 0.531* (p = *0.001).*
[c]*Observer 2 rated one surface as D4, but observers 1 and 3 did not rate any teeth as D4. Therefore, D4 is omitted from this table, and the tooth scored as D4 by observer 2 is excluded from this tabulation, leaving a total of 298 cases for the analysis for observer 2.*
[d]*For observer 3, percentage agreement was 63.5% and kappa = 0.508* (p = *0.001).*

and 2, the kappa values for examination with the operating microscope were lower than for unaided visual examination. Nonetheless, intraobserver reproducibility was substantial for all observers with both techniques.

Interobserver Reproducibility

The level of interobserver agreement was fair for unaided visual examination (kappa values of 0.356 for observers 1 and 2, 0.355 for observers 1 and 3, and 0.318 for observers 2 and 3) and moderate to fair for the operating microscope (0.420 for observers 1 and 2, 0.318 for observers 1 and 3, 0.328 for observers 2 and 3) ($p = 0.001$ for all kappa values).

Agreement Between Methods

Percentage agreement (i.e., cases in which the observer made the same diagnosis by unaided visual examination and operating microscope) was 62.5% (kappa = 0.483) for observer 1, 65.4% (kappa = 0.531) for observer 2 and 63.5% (kappa = 0.508) for observer 3 ($p = 0.001$ for all kappa values).

According to the cross-tabulations (**Table 2**) comparing diagnoses for individual teeth, the number of teeth with a D0 score was about 3 times greater with unaided visual examination than with the use of an operating microscope for both observers 1 and 2 and about 2 times greater for observer 3. For all observers, the number of teeth with D1 and D3 scores was greater with examination by operating microscope than with unaided visual examination. The number of teeth with a D2 score was slightly greater with the operating microscope for observer 2, but slightly lower for observers 1 and 3. Observer 2 scored one occlusal surface as D4, but because neither observer 1 nor observer 3 recorded this score for any teeth, the D4 category was excluded from statistical analyses to allow use of the kappa test.

Discussion

The results of this study indicate that for about 40% of occlusal surfaces examined in vivo, the diagnosis made with unaided visual examination differed from the diagnosis made with the operating microscope at 16× magnification. The greatest discrepancy occurred for surfaces that were diagnosed as sound or as having enamel lesions without cavitation using unaided visual examination. More of these surfaces were scored as carious when the microscope was used.

Relative to unaided visual examination, the number of surfaces scored as sound was lower with the operating microscope and the numbers of lesions located on enamel without cavities and the number of lesions located in dentin was higher. The lower number of sound surfaces could be related to visualization of carious, hypoplastic and fluorotic defects, which could not be detected by the naked eye, or to visualization of initial lesions, which could not be seen macroscopically but which could be seen with magnification. Conversely, the greater numbers of lesions located on enamel without cavities and lesions located in dentin could be associated with the extent of magnification.

The reported specificity of unaided visual examination for detecting occlusal caries is high.[3,5] However, with the use of the operating microscope, more "sound" teeth were scored as carious. This study did not include a gold standard for determining whether the surfaces were or were not carious, so the true diagnosis for each tooth was unknown. Given the possibility that some of the diagnoses with the operating microscope were false positives, it is premature to advocate adoption of this technology for diagnosis of caries on occlusal surfaces. Further research is required to determine the sensitivity and specificity of examination with the operating microscope.

Intraobserver agreement between unaided visual examination and examination with the operating microscope was substantial for all observers. This indicates good reproducibility in the diagnosis of occlusal caries by both techniques. It is noteworthy that although the observers were not routinely using the operating microscope for detection of caries, they were familiar with using this equipment for in vitro examinations and had been trained in its use for in vivo examinations.

The strength of agreement between raters (interobserver agreement) was fair for unaided visual examination and fair to moderate for examination with the operating microscope. These results indicate variations in diagnosis among the 3 observers with both techniques. The occlusal surfaces were graded according to a 5-point scale (sound, having a lesion located on enamel with intact or with cavitated surfaces, having a lesion localized in dentin and penetrating into pulp). The low interobserver agreement could result from disagreement in identification of cavities between observers. In addition, the observers were from different departments and had different degrees of experience in detecting caries. Low interobserver agreement could be related to these factors. Variation in caries detection among dentists is a common phenomenon. Mendes and others[8] reported moderate intra- and interobserver reproducibility for unaided visual examination and for use of an operating microscope at 20× magnification in an in vitro study. The difference in results between that study and the study reported here could be related to experimental design, magnification level and observers' experience in using the microscope.

Unaided visual examination is routinely used for detecting caries in dental clinics and was also used in recent studies[8,9] comparing the efficacy of various visual aids that provide magnification. Our study assessed the reproducibility and agreement of the clinical examination using unaided visual examination and an operating microscope at 16× magnification level.

The operating microscope provides a range of magnification from 2× to 20×. In the current study, only 16× magnification was used. Further research is required to evaluate the suitability of different magnification levels for detecting occlusal caries in vivo. In a previous study, no significant difference was reported between 8× and 16× magnification for detection of occlusal caries with an operating microscope.[12]

Conclusions

Intraobserver reproducibility for examination with the operating microscope, although lower than that achieved with unaided visual examination, was substantial. At the same time, there was high interobserver variability for both techniques. For about 40% of the occlusal surfaces, the in vivo diagnosis differed between unaided visual examination and examination by an operating microscope at 16× magnification. The discrepancies in diagnosis were more apparent for surfaces diagnosed by unaided visual examination as sound or as having initial enamel lesions.

This assessment of the use of an operating microscope in diagnosing occlusal caries in clinical settings is important to establish the utility of this noninvasive technique. Advantages of the operating microscope are homogeneous illumination and a 3-dimensional view, which together provide clear visualization of the examination site. However, further research is required before this technique can be widely adopted for clinical diagnosis of caries on occlusal surfaces.

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