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The Use of a Microscope for Restorative Treatment Decision-making on Occlusal Surfaces

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Clinical Relevance

The use of an operating microscope at 16x magnification did not aid in the restorative treatment decision-making on posterior teeth.

SUMMARY

Using an operating microscope, this study assessed the effect of 16x magnification on the restorative treatment of posterior teeth and compared the results against an unaided visual examination *in vitro*. Three dentists examined 300 premolars and molars at different times using an unaided visual examination and an operating microscope at 16x magnification. The observers examined the occlusal surfaces of teeth according to a patient model and selected a treatment protocol based on the following scale: 0: No Active Care (NC); 1: Preventive Care (PC) and 2: Operative Care and Preventive Care (OC+PC) advised. According to the results, there was good intra-observer agreement and moderate inter-observer agreement with both techniques. No significant difference was found between the treatment using an unaided visual examination and that using an operating microscope. The use of a microscope at 16x magnification did not aid in the restorative treatment decision-making on occlusal surfaces.

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INTRODUCTION

Selecting the right treatment for a tooth surface is important, because it is a critical step to achieving a successful outcome.[1-3] The activity, location and surface continuity of carious lesions are primary factors in restorative treatment decision-making.[3] Additionally, factors, such as local environmental conditions, individual patient factors (trigger conditions, risk factors, compliance) and dentist factors (characteristics, preferences and practice variables), are integral to the decision-making process.[4]

The activity of an enamel lesion is defined as the net progression or regression of the lesion.[5] Lesions having chalky, matte and rough enamel features are referred to as active, while lesions with shiny, smooth surfaces are

referred to as inactive.[6] The progression rate of carious lesions differ according to the lesion's activity. Active lesions have a higher progression rate when compared to inactive lesions. In addition to a change in local environmental conditions,[3] when Preventive Care (PC) is applied to a non-cavitated active lesion, the progression rate could be changed.[7] However, if PC is not applied to such a lesion, the progression rate will be greater than that found in a non-active lesion.[3] The location of a carious lesion is another important factor when making a treatment decision, however, it should be considered along with other factors. It is recommended that lesions located in enamel, even when cavitated, be treated with PC and not with operative care (OC).[8] The surface continuity and activity of the lesion should be assessed before making a treatment decision in cases where the lesion is located in dentin. OC + PC is advised in cavitated lesions involving dentin.[3]

Although visual examination is a method routinely used for caries diagnosis and restorative treatment decision-making, research has shown that clinicians may mis-diagnose some teeth that have initial or hidden dentinal caries.[2] Therefore, adjunct methods could be useful for increasing the accuracy of the treatment decision-making.

Magnifying devices provide clear visualization of the treatment site and various levels of magnification during caries detection and restorative treatment decision-making. The operating microscope is a magnification device that offers homogeneous illumination without shadows and a three-dimensional view, providing clear visualization of the examination site.[9] This study assessed the effect of high level magnification provided with an operating microscope on the restorative treatment decision-making for occlusal surfaces of posterior teeth *in vitro*.

METHODS AND MATERIALS

A total of 300 human premolars and molars, including teeth that had clinically sound occlusal surfaces and others with varying degrees of demineralization, were selected out of a stock of extracted teeth kept in a 10% buffered formalin solution. The teeth were cleaned with a toothbrush, rinsed under running water and embedded into plaster of Paris, forming anatomical contacts.

According to a patient model, all the teeth were asymptomatic, in acceptable occlusion, had a DMFT score of 6 and belonged to non-medicated healthy patients with reasonably good oral hygiene.[10] The surface continuity and activity of the lesions were also assessed during examination before selecting a treatment plan. Carious teeth with chalky, matte and rough surfaces were assessed as teeth having active lesions, and those with shiny and smooth surfaces were assessed as having inactive lesions.[6]

Three dentists in academic positions with 17, 8 and 8 years of clinical experience, respectively, participated in the study. All the observers were calibrated for occlusal caries detection in previous studies.

One area on each tooth was selected for examination to ensure that all of the researchers were evaluating the same surface. Unaided visual examination was performed with the help of a dental light unit, compressed air and water from an air-water syringe, and a standard dental mirror without magnification. The observers examined the occlusal surfaces and chose one of the following treatments: 0: NC; 1: PC; 2 :OC+PC. Fifty percent of the teeth were examined by all of the observers two weeks later using the unaided visual examination to assess intra-observer reproducibility.

Approximately two weeks after the unaided visual examination, the same teeth were examined using an operating microscope (Dento 300, Moeller-Wedel GmbH, Wedel, Germany) at 16x magnification. The examiners were allowed to use the dental unit light and compressed air and water from the unit air-water syringe. The same rating scores and procedures used in the first examination process were used. Fifty percent of the teeth were re-examined by all of the observers two weeks later using the operating microscope to assess intra-observer reproducibility. The teeth were randomized during all examination sessions.

As the actual status of an examined surface and the location of a lesion both have an impact on treatment decision-making, histological validation was performed to determine the actual status of the teeth and location of the carious lesions. Upon completion of the examination, the teeth were removed from the models and mesiodistally sectioned through the examination site using a diamond saw. Two experienced observers assessed the actual surfaces of the tooth sections according to the following scale: 0: No signs of demineralization; 1: Demineralization in the enamel; 2: Demineralization in the outer-third of dentin and 3: Demineralization in the middle- and inner-third of dentin. These observations occurred under a stereomicroscope (SZ PT Olympus, Japan) at 10x magnification to determine the actual status of the surfaces. Any discrepancies in the histologic scores were corrected by consensus after reviewing the sections.

Intra- and inter-observer agreements were analyzed with the Kappa test. The selected treatment decisions made with the unaided visual examination and operating microscope were also analyzed using the Kappa test. Pairwise comparisons between the correlated Kappa values of the unaided visual examination and the operating microscope-assisted examination were performed to determine any significant difference. The comparison of Kappa values was done based on the asymptotic normal distribution of correlated Kappa

values by using the SPSS Syntax program based on recently published articles.[11-12] Under this comparison, the strength of agreement was said to be poor when the Kappa value was <0.00; between 0.00-0.20, it was determined to be slight; 0.21-0.40 was considered fair; 0.41-0.60 was moderate; 0.61-0.80 was substantial and 0.81-1.00 was considered almost perfect.

RESULTS

According to histological evaluation of the sections, 70 teeth were found to be caries-free, 83 had lesions located on the enamel, 56 had lesions located in the outer-third of dentin and 91 had lesions located in the middle- and inner-third of the dentin. According to the Kappa values, the intra-observer agreement, with unaided visual examination, was found to be nearly perfect for the first, substantial for the second and third observer and substantial for all observers using the operating microscope (Table 1). Strength of agreement among the observer's (inter-observer agreement) treatment decisions made with unaided visual examination and operating microscope was found to be moderate (Table 2). With use of the operating microscope, the accuracy of the NC and PC scores slightly increased, and the OC+PC scores slightly decreased when compared with the unaided visual examination (Table 3). Paired comparisons between the correlated Kappa values indicated no significant difference between the treatment decisions made with the two techniques (Table 4).

DISCUSSION

According to the results of the current study, high magnification provided with an operating microscope led to some changes in treatment decision-making of the occlusal surfaces of posterior teeth; however, this difference was not found to be significant. Whitehead and Wilson[13] reported an almost three-fold increase in restorative treatment decisions with the use of a loupe at 3.25x magnification when compared with an unaided visual examination in extracted posterior teeth with amalgam restorations and unrestored teeth with staining on the occlusal surfaces. A histological evaluation for the true extension of caries was not performed in that study. On the other hand, Lavonius and others[14] found a 10.6% increase in restorative treatment decision-making with the use of a binocular loupe at 1.25x magnification when compared with an unaided visual examination, but these authors did not report the difference as being significant. A histological evaluation was not made in their study; therefore, one could not estimate the accuracy of the results. Erten and others[15] reported no significant changes in treatment decision-making using an operating microscope at 16x magnification when histological evaluations were made, although there was an increase in true and false diagnosis rates. The current results are similar to the previous two reports.

The actual status of an occlusal surface of a tooth and the location of the lesion both have an impact on treatment decision-making, while also taking into account the activity of the lesion, surface continuity, local environmental conditions and individual patient and dentist factors.[4] As the true status of a surface could be determined with a histological evaluation, this evalua-

Table 1: *Kappa Values for Intra-observer Agreement for Treatment Decisions Made with Visual Examination and Operating Microscope*

Observer	Visual Examination	Operating Microscope
1	0.85	0.79
2	0.80	0.73
3	0.76	0.64

Note: For all values p:*0.001.*

Table 2: *Kappa Values for Inter-observer Agreement for Treatment Decisions Made with Visual Examination and Operating Microscope*

Observer	Visual Examination	Operating Microscope
	Kappa	**Kappa**
1-2	0.480	0.544
1-3	0.451	0.502
2-3	0.459	0.489

Note: For all values p:*0.001.*

Table 3: *Kappa Values of the Treatment Decisions of All Observers Made with Unaided Visual Examination and Operating Microscope*

	NC	PC	OC+PC
Visual Examination	0.378	0.436	0.446
Operating Microscope	0.401	0.441	0.436

Table 4: *Kappa Values and Pairwaise Comparisons Between Correlated Kappa Values According to All Observers Treatment Decisions Made with Unaided Visual Examination and Operating Microscope*

	Microscope NC	Microscope PC	Microscope OC+PC
Visual NC	Z=-0.546	-	-
Visual PC	-	Z=-0.133	-
Visual OC+PC	-	-	Z=-0.310

Note: In all cases p>*0.05.*

tion should be performed in studies wherein a comparison of the accuracy of treatment decision-making with different methods is assessed for more accurate results. Therefore, a histological evaluation was made in the current study, and the status of the evaluated occlusal surfaces and location of the lesions was determined and correlated to the activity and surface continuity, leading to more accurate results.

As treatment decision-making is not solely dependent on the location, activity and surface continuity of the lesion, a patient model was prepared to provide the patient factors used in previous studies.[10,15] According to this model, all the teeth were asymptomatic, in acceptable occlusion with a DMFT score of 6, and they belonged to non-medicated, healthy patients with reasonably good oral hygiene.

According to the Kappa values, there was good intra-observer reproducibility with the recorded treatment decision with unaided visual examination and operating microscope, indicating the same treatment decision was recorded in the first and second examination sessions. Although there was good reproducibility, a slight decrease in reproducibility occurred in the intra-observer agreement level with the operating microscope. This shows that the number of cases where the same treatment decision was recorded in the first and second examination round by the same observer was lower when compared with the unaided visual examination. When the authors of the current study looked from a clinical perspective, they found good intra-observer reproducibility indicated that the observers were consistent in their treatment decisions. This could be related to the clinical experience level of the observers participating in the current study.

Although unaided visual examination is the method routinely used by all observers participating in the current study for regular restorative treatment decision-making, the lower reproducibility of using the operating microscope might be associated with not only the inexperience of the examiners, but also with preferences, members of different departments and years of clinical experience.

There was a moderate inter-observer agreement between the unaided visual examination and operating microscope. This result indicates that there were variations among the three observers' treatment decisions that were recorded with the unaided visual examination and operating microscope. These variations could be related to the observers' clinical experiences, their preferences and practice variables.

CONCLUSIONS

In conclusion, the current study found that 16x magnification obtained from an operating microscope did not aid in restorative treatment decision-making on the occlusal surfaces of posterior teeth.

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