Original Article

An In Vivo Comparison of Two Diagnostic Methods in Secondary Caries Detection

Kazem Saber Hamishaki[1], Nasim Chiniforush[1✉], Abbas Monzavi[2], Mohammad Javad Khazarazifard[3]

[1]PhD Candidate, Laser Research Center of Dentistry, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran
[2]Associate Professor, Prosthodontic Department, Laser Research Center of Dentistry, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran
[3]PhD Candidate of Epidemiology, Dental Research Center Dentistry Research Institute, Tehran University of Medical Sciences, Tehran, Iran

Abstract

Objective: The aim of this study was to compare the level of agreement between four operators with different levels of experience for two methods of detecting secondary enamel and dentin carious lesions in composite restored teeth.

Materials and Methods: Sixty teeth of 40 patients with with secondary carious lesions in the composite resin were selected. The teeth were examined by two methods; visual inspection and a laser fluorescence device (DIAGNO dent pen 2190) by four operators including an undergraduate student, a dentist with 5 years of clinical experience, a general dentist with 12 years of clinical experience and an oral and maxillofacial radiologist. Cohen's kappa statistic was applied in order to assess the agreement between the diagnoses performed by the four operators with each diagnostic method.

Results: The diagnosis performed by different operators achieved an excellent agreement with high ICC.

Conclusion: DIAGNOdent can be a useful device for secondary caries detection in posterior teeth as an adjunct to visual examination.

Key Words: DIAGNOdent; Visual Examination; Secondary Caries

✉ Corresponding author:
N. Chiniforush, Department of Laser Research Center of Dentistry, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran

n-chiniforush@farabi.tums.ac.ir

INTRODUCTION

Despite the considerable decrease in the global incidence of dental caries in the last decades, dental caries mainly carious lesions occurring as secondary caries around amalgam and composite restoration is still a problem of great importance [1,2]. Diagnosis of secondary caries has always been challenging for the dentists, although various methods have been used to detect caries for more than half a century [3]. These methods have provided varied sensitivities for detecting secondary caries lesions. Many methods such as visual inspection (VI) have been claimed as the best diagnostic method in a population with low caries prevalence, but they are unable to correctly detect caries lesions because of their low sensitivity [4,5]. On the other hand, probing using the visual method does not appear to improve the diagnostic accuracy [2,3].

It may contaminate other sound sites, may damage the fissure as well as facilitate the lesion progression [6].

Bitewing radiography is the most common method used to diagnose secondary caries. In the recent years, the traditional clinical examination for detection of secondary caries by visual inspection, examination by probing and bitewing radiographic have been the subject of critical treatment. Despite the improvement in the quality of restorative material and the orientation of dental health care towards prevention, secondary caries remains an unresolved problem in dentistry that has become an important issue in daily dental practice [7,8].

Color change around a restoration is difficult to interpret, and it is not a reliable indicator for secondary caries. In recent times, a laser device named KaVo DIAGNOdent (KaVo, Biberach, Germany) has been introduced to clinical practice [9]. This device generates a laser light that is absorbed by both inorganic and organic tooth substances and also by metabolites from oral bacteria [10]. Each diagnostic method is characterized by sensitivity and specificity that represent the ability to identify diseased and sound teeth, respectively [11].

The aim of this study was to compare the level of agreement between four operators with different levels of experience for two methods of enamel and dentin secondary carious lesion detection in composite restored teeth.

MATERIALS AND METHODS

This study was carried out on 60 permanent premolars and molars of 40 patients aged from 19 to 60 years, (29 female and 11 male). The inclusion criteria were to have at least one posterior composite filling accompanied by inconspicuous caries. Therefore, patients with teeth showing frank cavitation, obvious sign of enamel hypomineralization, or hypoplasia in the occlusal and proximal surfaces were excluded from the study. The diagnosis of each suspicious lesion was performed separately by four operators with different levels of clinical experience.

The protocol was approved by the Ethics committee of the Laser Research Center of Dentistry, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran.

A total of 40 patients (60 teeth) were examined with two different methods (visual inspection, DIAGNOdent) by four operators with different levels of experience.

Operator 1 was an undergraduate student attending the final year of dentistry. Operator 2 was a young dentist with 5 years of clinical experience. Operator 3 was a general dentist with 12 years of clinical experience and finally, operator 4 was an oral and maxillofacial radiologist.

After drying with compressed air and prior to examination, calculus deposits were removed with a hand instrument. Then, the soft rubber prophylaxis cup was used to eliminate discoloration and plaque from the tooth surface.

Visual examination was done by mirror without probing.

The visual diagnostic criteria proposed by Ekstrand et al. [12] are as follow:

Score 0: No or slight change in enamel translucency after prolonged air drying (>5sec)

Score 1: Opacity or discoloration hardly visible on the wet surface, but distinctly visible after air drying

Score 2: Opacity or discoloration distinctly visible without air drying.

Score 3: Localized enamel break down in opaque or discolored enamel and/or grayish discoloration from the underlying dentin

Score 4: Cavitation in opaque or discolored enamel exposing the dentin beneath

The recording of a score 0 was assumed to predict the absence of caries. Recordings of scores from 1 to 4 were deemed to predict the presence of caries either in the enamel (score 1 or 2) or the dentin (scores 3 or 4).

Four examiners were also trained on how to use the DIAGNOdent device, according to the manufacturer's directions.

The measurements with the DIAGNOdent (KaVo, Biberach, Germany) device were made after calibration of the device with the ceramic standard.

The laser tip was positioned on a sound enamel region to provide a baseline measurement. After that, the laser tip was positioned on the target site and rotated around along the margin of the restoration under clinical condition, and then the highest value was then recorded The DIAGNOdent pen was used following the indications of Lussi and Hellwig regarding the cut-off value for enamel and dentin caries:

0-13 $\rightarrow$ Healthy tooth substance
14-20 $\rightarrow$ Beginning demineralization
21-29 $\rightarrow$ Strong demineralization
> 30 $\rightarrow$ Dentin caries

Each operator was unaware of the diagnostic evaluation performed by the other three.

Statistical Analysis

The scores of each examiner were collected. To assess reproducibility (intra examiner) for the visual inspection, the kappa statistics and for DIAGNOdent method, intraclass correlation coefficients (ICC) were used.

RESULTS

The range and mean of inter examiner reproducibility of DIAGNOdent (ICC) is summarized in Table 1. All operators showed an ICC near 1 indicating the perfect strength of agreement. The reproducibility for visual examination between different operators (Kappa value) is shown in Table 2. The Kappa value between different operators was more than 0.930 that showed the best agreement among different operators according to Landis and Koch classification (Table 3).

Table 1. The Reproducibility of DIAGNOdent Data between Different Operators

Reproducibility	ICC	Range
Dentist (12 years)/Dentist (5 years)	0.948	0.915-0.969
Dentist (12years)/Radiologist	0.946	0.912-0.967
Dentist (12 years)/Student	0.930	0.888-0.958
Dentist (5 years)/Radiologist	0.989	0.982-0.993
Dentist (5 years)/Student	0.973	0.955-0.984
Radiologist/Student	0.970	0.951-0.982
All Operators	0.959	0.941-0.974

Table 2. The Reproducibility of Visual Examination Data Between Different Operators

Reproducibility	Kappa
Dentist (12 years)/Dentist (5 years)	0.965
Dentist (12 years)/Radiologist	0.965
Dentist (12 years)/Student	0.930
Dentist (5 years)/Radiologist	1
Dentist (5 years)/Student	0.965
Radiologist/Student	0.956

Table 3. Kappa Scores and Strength of Agreement (Landis and Koch)

Kappa Score	Strength of Agreement
0.00	Poor
0.01-0.20	Slight
0.21-0.40	Fair
0.41-0.60	Moderate
0.61-0.80	Substantial
0.81-1.00	Almost perfect

DISCUSSION

The diagnosis of secondary caries is still a challenging topic due to the increase in application of resin composite materials. Early detection of these kinds of caries can be helpful to use preventive procedures [13, 14]. DIAGNOdent showed the potential for early diagnosis of carious lesions in different studies. On the other hand, DIAGNOdent can provide the ability for practitioners to monitor the progression of lesions [15, 16].

The aim of this study was to evaluate the reproducibility of visual examination and DIAGNOdent technique for secondary caries detection by four different operators with different degrees of clinical experience

As interexaminer reproducibility is considered as an important index in diagnostic studies, it was used for evaluation of the data obtained by different operators in this study.

Since DIAGNOdent showed mineral loss by numerical scale, the ICC analysis was used. Comparison of reproducibility between all operators showed an ICC of approximately 1.00 indicating high reproducibility.

Furthermore, there was a small deviation between upper and lower limits that strengthened the results.

In agreement with our results, Kuhnisch et al. in the evaluation of intra or inter examiner reproducibility of DIAGNOdent for occlusal caries detection showed excellent ICC and no difference was found between dentists and students [17]. In addition, Rodrigues et al. reported the excellent values of ICC for DIAGNOdent in caries detection [18].

To evaluate the reproducibility of visual examination among different operators, Kappa coefficient was used. Comparing all operators, Kappa coefficient was near 1 indicating good repeatability.

Although reproducibility alone is considered as an important factor, it is not enough; therefore, sensitivity and specificity are necessary to evaluate the diagnostic tests.

In most studies DIAGNOdent showed the best reproducibility [19-22], but there was no study evaluating whether this technique depends on the operators' clinical experience.

Dentists with long-term clinical experience may be more familiar with certain techniques compared to young dentists at the beginning of their clinical career and students with limited clinical training. The results of this study showed that DIAGNOdent provided promising results for secondary caries detection by various operators regardless of the clinical experience level.

CONCLUSION

According to the results, DIAGNOdent is a reproducible device that may be useful for secondary caries detection in posterior teeth as an adjunct to visual examination. More studies are needed in larger sample sizes to extend the level of confidence for using results in clinical practice.

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