Diagnostic Performance of Different Methods in Detecting Incipient Non-Cavitated Occlusal Caries Lesions in Permanent Teeth

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Aim: *This in vitro study was aimed to investigate the performance of the new caries detection tools on the incipient occlusal caries.* ***Study design:*** *In our study, 100 permanent molar teeth, which were considered to have incipient, enamel caries (D1 and D2 threshold values) according to ICDAS II score. After the visual examination, caries measurements have been applied to all teeth by using DIAGNOdent pen (DP), CarieScan PRO (CP) and SoproLife camera (SC). In addition, in vitro examinations were repeated 2 weeks later. After sectioning and evaluation in stereomicroscope, the lesion depth was determined with histological criteria that are accepted for the gold standard for this research. Sensitivity, specificity, accuracy and area under the ROC curve were calculated at D1 and D2 thresholds. The intra-examiners' reproducibility were analysed using Cohen's kappa statistics and intraclass correlation coefficient (ICC).* ***Results:*** *Intra-examiner repeatability values varied from 0.94 to 0.99 and kappa values ranged from 0.90 to 0.99. While the highest sensitivity and specificity value showed for SC at D1 and D2 thresholds, CP presented the lowest values. The area under ROC curves (Az) varied from 0.70 to 0.99. ICDAS II showed the highest area under ROC curves (Az).* ***Conclusions:*** *ICDAS II, visual diagnostic method by itself is considered to sufficient in order to diagnose incipient occlusal caries. SC may be used as an alternative method for the ICDAS II, since its advantages by displaying caries lesion on the computer monitor, follow-up and motivation of the patients provided.*

Keywords: Incipient Caries Diagnosis, ICDAS II, Soprolife Camera, DIAGNOdent Pen, CarieScan PRO.

INTRODUCTION

The children, especially who are in the pre-school low age group, are the ones who will the most benefit from the early diagnosis of the dental caries. Although the early diagnosed of the enamel caries will be able to be treated with preventive methods or the minimally invazive restorations, the deep dental caries lesions will need the local anesthesia or longer restorative treatment.[1] This creates fear in the children in their dental treatments and causes challenges to cooperate with child in his/her dental treatment. The such conditions further increase the importance of the early diagnosis of the initial enamel caries in the children.[2,3]The accurate and correct diagnosis of occlusal caries will be the first step of successful treatment. However, the caries detection will be challenging because of an anatomical structure of the dental fissures and fossa and diversity seen in this structure.[4,5]

It is possible to make radiographical examination on occlusal surfaces however, the caries lesion should reach certain dimensions in order to diagnose radiographically. For this reason, it is very difficult to diagnose caries lesions that involve only the enamel of tooth.[6] However, since at least 30% of demineralization is required to observe caries in radiography, incipient caries may be able to be overlooked.[7] The radiographical examination in diagnosis of the incipient occlusal fissure caries is quite limited because of its low sensitivity values and destructive radiation waves given in patients.[8]

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International Caries Detection and Assessment System (ICDAS) is a visual system in diagnosis of caries, that describes severity of caries in six stages. This method allows collecting standart data and comparison of existing studies.[9] Studies disclose that this system comes out with an outstanding performance in diagnosis of occlusal caries in both permanent and primary teeth.[9,10]

DIAGNOdent Pen(DP)(Kavo,Biberach, Germany) device is approximately 220 mm in length and 32 mm in diameter and weighs 110 grams.[11] The DP device has the cylindrical and conical sapphire tips. The cylindrical tip which is 1.1 mm in diameter, is used to diagnose occlusal caries, and the conical tip, 0.7 mm in diameter, is used to diagnose interproximal caries.[12] Another example for current diagnostic tools is the CarieScan PRO (Dundee, Scotland) (CP) device. Utilizing a large number of low-voltage frequencies for the diagnosis of dental caries, this system works by means of an alternating current impedance spectroscopy technique.[13,14] CP is a device which works based on the electrical conduction difference between the healthy and caries tissue and is another example of modern diagnostic tools (ACIST). A low electric current sent to the area under examination can reveal the demineralization / remineralization of the tooth by measuring the mineral density of the tooth.[14] It is well designed for the patient and it does not cause any pain and sensitivity, and performs the measurement in short time at the related area. SoproLife camera (SC), based on induced laser fluorescence, is the modern caries detection method, which combines the advantages of visual examination through a high-magnification oral camera with the advantages of a laser fluorescence device.[14] The images obtained with the SC can be viewed on the large LCD screen and saved to the computer using a special software program (Sopro Imaging Software Life Mode). By this way, images can be compared and change in caries lesion over time can be evaluated. Capturing in white light provides a white light image with a magnification of more than fifty times. The other two modes of the SC work on the principle of autofluorescence. In the diagnostic mode (mode I), the camera uses the visible blue light frequency (wavelength 450 nm) to illuminate the surface of the teeth and provides an anatomic image overlay of the green fluorescence image on the "white light" view. This green fluorescence is considered as an indicator of the healthy dental tissues, while caries lesions can be detected by variation in the autofluorescence of the tissues in relation to a healthy area of the same tooth, such as red and black regions on the fluorescence photograph. In the treatment mode (mode II), the camera brightens with increased red wavelengths and decreased the blue areas. The red fluorescence, which is captured, is considered as an mark between infected and affected dentine.[15]

In pediatric dentistry, incipient caries detection is important clinically in terms of preventative and minimal treatment methods. In our study, it is aimed to compare ICDAS II which is a visual diagnosis system of incipient occlusal enamel caries in permanent molar teeth, with CP, SP, DP tools. It is recognized that there are not too many studies available which uses these tool systems on incipient caries in literature. The hypothesis of our study is based on the comparison of ICDAS II visual caries diagnosis method, which is a very simple clinical diagnosis method of incipient caries, with current caries diagnosis tools and points out that the visual method can be as effective as these tools.

MATERIALS AND METHOD

The protocol of this study was reviewed and approved by Clinical Research and Ethics Committee of the Cumhuriyet University. Permanent molar teeth with indications of extraction due to orthodontic or periodontal reasons have been included in this study. Teeth which have caries rather than occlusal surfaces, previous restoration, macroscopic signs of caries extended to dentin, florosis and hypoplasia were excluded.

The teeth which were included to study were cleaned with air-polishing in order to remove plaque and discolorations on surfaces. Then the teeth were washed and dried with air-water spray. Prior to in vitro evaluations, teeth were embeded in acrylic molds and the surfaces to be examined were identified and marked on the teeth. These surfaces determined under the reflector light without probing, were evaluated by two independent observers using ICDAS II criterias.[14-18] ICDAS II criteria were explained as follows: (0) sound tooth surface: no evidence of caries after 5 sec air drying, (1) first visual change in enamel: opacity or discoloration (white or brown) is visible at the entrance to the pit or fissure seen after prolonged air drying, (2) distinct visual change in enamel visible when wet, lesion must be visible when dry, (3) localized enamel breakdown (without clinical visual signs of dentinal involvement) seen when wet and after prolonged drying, (4) underlying dark shadows from dentine, (5) distinct cavity with visible dentin and (6) extensive (more than half the surface) distinct cavity with visible dentine. 100 permanent molar teeth, which have D1 and D2 threshold values according to ICDAS II criterias, have been included in the study. After then, two seperate observers have measured caries respectively with DIAGNOdent pen(DP), CarieScan PRO(CP), SoproLife camera(SC) tools as explained below.

The working principles of the tools, CP, DP and SC methods which we have utilized in our study, are followings; CP is based on the principle of conductivity difference between healthy and caries dental tissues of electrical conductivity, DP; works on the basis of different fluorescence properties of healthy and caries dental tissues and SC works by combining an autofluorescence image with anatomical image of the illuminated teeth by using a light-emitting diode (LED) -based camera.

The cylinder sapphire tip that was designed to use on occlusal surfaces of teeth was placed onto the device during the examinations done with DP device. Calibration was done in accordance with the instructions of the manufacturer prior to all the measurements. The related tooth was washed with air-water spray, and mildly dried for 5 sec. Three measurements were performed consecutively for marked each site, and the highest value (peak value) was obtained and recorded by two examiners. The values obtained were evaluated with the following scale. According to this scale, 0-13(D0): sound, 14-20(D1): lesions detected in the outer half of enamel, 21-29(D2): deep lesions in the inner half of enamel, and D3>30 dentine caries have been accepted (Table 1).[17]

In measurements with CP, the teeth were washed with air-water spray and dried for three seconds. The device was held with no glove and in order to complete the electric current between tooth and the device, the lip clip has been made to touch to the tooth surface. The measurement was carried out on a flat surface and special care has been shown to not to apply pressure to the tooth during application. The measured values obtained from the marked area were recorded

by each observer. The system was checked periodically with a test adapter to see whether the connection cables were damaged or not. Later, all these data were evaluated using the scale D0 (sound), D1:21-50 (outer 1/2 enamel caries), D2: 51-90(inner 1/2 enamel caries), D3: 91-100(dentine caries) (Table 1). [17]

In measurements with SC, the teeth were washed with air-water spray and dried, then images were captured with a SC in the marked area. Then, the images obtained, were recorded with Sopro Imaging program on the computer screen. Each observer evaluated the images independent then each other and saved the appropriate codes in their study forms. The images were recorded to Sopro Imaging program and evaluated according to below the criterias. The codes were explained as follows: (0) sound, no visible change in enamel (rarely a graphite-pencilcolored thin shine/line can be observed) shiny green fissure, (1) tiny, thin red shimmer in the pits and fissure system, can come up the slopes, no red dots visible, (2) in addition to tiny, thin red shimmer in pits and fissures possibly coming up the slopes darker red spots confined to the fissure are visible, (3) dark red extended areas confined to the fissures; slight beginning roughness, (4) dark red or orange areas wider than fissures; surface roughness occurs, possibly grey or rough grey zone visible and (5) obvious wide openings with visible dentin.[17]

The all teeth were given numbers and stored in a glass bottle filled with saline solution at +4 C for 2 weeks. All teeth were re-evaluated, as in vitro examinations, 2 weeks later using all diagnostic methods by two examiners.

Table 1. Optimal cut-off points for DIAGNOdent pen, CarieScan PRO devices

	Histology	ICDASII	SC	DP	CP
Sound	D0	0	0	0-13	0-20
İn the outer half of enamel caries	D1	1	1,2	14-20	21-50
İn the inner half of enamel caries	D2	2	3	21-29	51-90
Dentine caries	D3	3,4,5,6	4,5	≥30	91-100

Histological evaluation

The teeth were cut with a low-speed sectioning machine (Isomet, Buehler,Lake Bluff, IL, USA) under water cooling with the aid of a diamond cut disc. Sections were hemisectioned by marking in a buccolingual direction parallel to the long axis of caries measurement point of the teeth. The obtained sections were examined under X10 magnification using a stereo microscope (Stemi DV4, Zeiss, Jena, Germany). Imaging of the each section was photographed with a camera. The sections that were examined under stereomicroscope were analyzed according to Lussi *et al.*[19] histological scoring criteria. The histological examination criteria were stated as follows: (0) no caries, (1) caries limited to the outer half of the enamel, (2) caries limited to the inner half of the enamel, (3) caries in the outer half of the dentine and (4) caries in the inner half of the dentine.

Statistical Analysis

Data were analysed with SPSS for Windows Release 18.0 Software package program. Intra-observer reproducibility were analysed with Cohen's Kappa (κ) and ICC analysis for the observers who did *in vitro* examinations. Scoring of the methods was joined in accordance with D1 and D2 threshold values based on histopathology results. Sensitivity, specifitiy, accuracy rates, ROC curves, and an area under the curve were calculated in order to compare the methods, and p value <0.05 was accepted as statistically significant.

Diagnostic performance for caries detection was evaluated, assessing the parameters– sensitivity and specificity by calculating the respective receiver operating characteristic (ROC) values. The respective area under the curve (AUC) values were calculated as measure for the probability to assess the histologically apparent caries extensions, by means of ICDAS II, CP, DP and SC examinations.[20] ROC values were used to analyse the histological validation of the ICDAS II, DP, CP and SC results, dividing the histological results into two groups: sound and caries (whether in the enamel). The sensitivity (proportion of positives classified as such) and specificity (proportion of negatives classified as such) of the four systems(ICDAS II, DP, CP and SC) were also analysed separately and in combination. For the combined analysis of sensitivity and specificity, all ICDAS codes other than 0, all DP values greater than 14, CP values over 21 and all SC codes other than 0 were classified as caries. The histological groups utilized were sound(D0), in the outer half of enamel caries(D1), in the inner half of enamel caries(D1) and dentin caries(D3), of the lesions into account.[21]

RESULTS

Under in vitro conditions, the highest inter-observer Kappa value was found for the SoproLife camera (0.92), followed by ICDAS II (0.76), DP (0.72) and CP (0.68). For all methods, intra-observer compliance was found very high and statistically significant (p<0,001).(Table 2)

Table 2. Intra examiner reproducibility of the methods in detecting occlusal caries lesions in permanent molars

Methods	Intra-examiners reproducibility			
	Examiner 1		Examiner 2	
	κ	ICC	κ	ICC
ICDAS II	0.96	0.96	0.90	0.94
DIAGNOdent pen	0.99	0.99	0.99	0.99
CarieScan PRO	0.99	0.97	0.99	0.98
SoproLife camera	0.98	0.99	0.96	0.98

Intraclass correlation coefficients (ICC) were calculated for intra-observer compliance of all methods. These coefficients were shown in the table 2. Also intra-observer ICC values were found statistically significant (0.94-0.99).

Table 3(İmmediately) and table 4(2 weeks later) show the sensitivity, specificity, accuracy and area under the curve(AUC) of the diagnosis acquired with the ICDAS system, with the DP, with the CP and with the SC tools, compared with the histological results as the gold standard.

While SC showed the highest values for sensitivity and specificity at D1 and D2 thresholds, CP showed the lowest values for sensitivity and specificity at D1 and D2 thresholds. (Table 3)

While SC showed the high accuracy values for both D1 and D2 threshold values, DP and CP showed similar performance for accuracy. CP showed lower accuracy values for both D1 and D2 threshold values when compared to the other methods (Table 3).

In general, all methods showed the higher Az (area under ROC curve) values at D1 and D2 thresholds. However, the ICDAS II had the highest Az (area under ROC curve) values at D1 and D2 thresholds.(Tables 3 and 4) When areas under ROC curves have been compared, differences between values have been found statistically significant (p<0,001).

While the ICDAS II had the highest Az (area under ROC curve) values at D1 and D2 thresholds, CP examination had the lowest value. While SoproLife camera had highest Az values at D1 and D2 threshold under *in vitro* conditions, CP had the lowest value. (Tables 3 and 4)

DISCUSSION

One of the most important stage of preventive dentistry applications is the early diagnosis of caries. The phase in which the caries lesion can be visually diagnosed is the period of demineralization on the dentin tissue. When caries reach to dentin, it would not be difficult to identify the dimensions and borders of the these caries. Because of the different morphological structures of the occlusal surfaces of teeth, the visual early detection of non-cavitated caries is very hard. For these reasons, permanent molar teeth which were included in this research had no cavitation and the integrity of its occlusal surface did not deteriorate, and the destruction of the teeth were at an insignificant and the begining level. Conventional radiography diagnostic methods' inclusion of subjective findings and being inadequate in early stage caries have led to development of novel methods and devices, which thereby dental caries were enabled to be evaluated in the early stages using objective criteria. [17]

Table 3. *In vitro* performance of different methods as assessed by examiners in detecting occlusal caries lesions at D1 and D2 thresholds in permanent molars (n=100) immediatly

Methods	Sensitivity		Specificity		Accuracy		Area Under ROC Curve (Az)	
Examiner 1								
	D1	**D2**	**D1**	**D2**	**D1**	**D2**	**D1**	**D2**
ICDAS II	0.82	0.82	0.76	0.75	0.79	0.78	0.99	0. 99
DIAGNOdent Pen	0.85	0.85	0.77	0.77	0.80	0.80	0.84	0.86
CarieScan PRO	0.74	0.74	0.73	0.72	0.73	0.73	0.88	0.71
SoproLife camera	0.84	0.85	0.93	0.93	0.90	0.90	0.91	0.94
Examiner 2								
	D1	**D2**	**D1**	**D2**	**D1**	**D2**	**D1**	**D2**
ICDAS II	0.78	0.77	0.74	0.73	0.77	0.79	0.99	0.98
DIAGNOdent Pen	0.79	0.79	0.86	0.80	0.80	0.80	0.91	0.87
CarieScan PRO	0.72	0.72	0.59	0.59	0.64	0.64	0.86	0.70
SoproLife camera	0.88	0.87	0.94	0.93	0.92	0.91	0.86	0.94

Table 4. *In vitro* performance of different methods as assessed by examiners in detecting occlusal caries lesions at D1 and D2 thresholds in permanent molars (n=100) after 2 weeks later

Methods	Sensitivity		Specificity		Accuracy		Area Under ROC curve (Az)	
Examiner 1								
	D1	**D2**	**D1**	**D2**	**D1**	**D2**	**D1**	**D2**
ICDAS II	0.79	0.77	0.78	0.77	0.82	0.78	0.99	0.99
DIAGNOdent Pen	0.85	0.82	0.77	0.75	0.80	0.82	0.87	0.86
CarieScan PRO	0.74	0.72	0.74	0.74	0.73	0.74	0.91	0.71
SoproLife camera	0.87	0.87	0.93	0.93	0.93	0.91	0.91	0.94
Examiner 2								
	D1	**D2**	**D1**	**D2**	**D1**	**D2**	**D1**	**D2**
ICDAS II	0.79	0.79	0.88	0.77	0.79	0.78	0.98	0.98
DIAGNOdent Pen	0.80	0.79	0.84	0.83	0.82	0.82	0.90	0.85
CarieScan PRO	0.78	0.72	0.60	0.59	0.64	0.62	0.85	0.70
SoproLife camera	0.93	0.92	0.93	0.93	0.93	0.93	0.87	0.94

In the literature, there are a small number of the studies investigating the use of the newly introduced devices, like CP and SC, on incipient enamel caries on permanent teeth. [7,14, 17,18, 22-24]

In our study, the highest kappa values among the observers were observed in SC (0.93) while the lowest kappa values were observed in CP (0.68). The observed kappa values (0.90-0.99) were similar. Rodrigues *et al*. [10] investigated the effectiveness of fluorescence-based methods, ICDAS, and bitewing radiography on occlusal surfaces and they found kappa values as 0.93 and 0.87 for DP; 0.51 and 0.60 for ICDAS II, respectively. Low kappa values for the ICDAS II system may be explained with different clinical experiences of the observers and inadequate calibration for this method. In our study, ICDAS II kappa values presented for examiner 1 and 2; 0.96 and 90.

In our study, intra-examiner reproducibility was found high for all methods as the result of the evaluations done 2 weeks later. Jablonski-Momeni *et al*.[25] evaluated 50 extracted molars at one day, at one week and at 4 weeks later and investigated the influence of evaluations done at different times on the reliability of ICDAS II, and they reported that the time interval did not have a significant effect on intra-examiner reproducibility. Kuhnisch *et al*.[26] found inter-examiner and intra-examiner reliability high in their study evaluating DP device. Rodrigues *et al*.[10] found inter-examiner reliability low for DP. This condition may be explained with decayed lesions being spread to dentin and using different storing solutions.

Weir *et al*.[27] have been reported that it may be objectionable to make a reliable interpretation based on ICC values only by indicating that the intra-class correlation statistic (ICC) is influenced by the sample size and the variability between the measured values of the participants. For this reason, reliability in our study was established by calculating the Kappa coefficients as well as the intra-class correlation (ICC) values. In the study of Teo *et al*.[28] who have investigated performances of ICDAS, DP and CP on occlusal caries of primary teeth, inter-observer compliance was found high ICDAS II (0.88) moderate for DP (0.73) and low for CP (0.46). Mortensen *et al*.[29] have examined occlusal caries with no cavitation with CP and DP. Similar to our study, ICC values for DP intra-observer was found very good, ICC values for CP in intra-observer values were found high.

Sensitivity and specificity are frequently used for statistical evaluation tests to assess the adequacy of the dental caries diagnosis methods. When the results of our study were examined, the highest sensitivity (0.84-0.93) and specificity (0.93-0.94) values were observed with SC, while the lowest sensitivity (0.72-0.74) and specificity (0.59-0.74) values were observed with CP. In their studies evaluating ICDAS II and SC on occlusal caries under in vivo conditions, similar to our findings, Zeitouny *et al*.[30] have found high sensitivity and specificity values for the blue fluorescence mode of SC (SN = 0,93; SP = 0,88) and stated that SC was a reproducible and reliable device. Gomez *et al*.[31] have investigated the efficacy of ICDAS, FOTI, OCT, QLF and SC under in vitro conditions in their study about occlusal caries. Similar to our findings, according to the D1 threshold value, the sensitivity value for SC was 0.97, the specificity value was 0.95, while the sensitivity for ICDAS was 0.99 and the specificity value was 0.87. In conclusion, they emphasized that visual imaging provides a personal approach to determining the condition of the caries lesion and treatment of dental caries, and allowing the clinician to reassess effectiveness of the treatment. Jablonski – Momeni *et al*.[25] have studied the efficacy of ICDAS II and DIAGNOdent in diagnosis of permanent teeth occlusal caries under in vitro conditions. As a result, they expressed that ICDAS II had a sensitivity of 0.91 at D1 histological threshold value and ICDAS II had better diagnostic accuracy than DIAGNOdent. Mortensen *et al*. [29] investigated the efficacy of DP and CP under in vitro conditions in order to diagnose occlusal caries without cavitation. Sensitivity and specificity values for CP according to D1 histological threshold value, are found lower than those of our study.

Another concept to evaluate success of diagnosis methods is the accuracy rate. The accuracy rate is used when a single measurement is desired by combining sensitivity and specificity. In our study, ICDAS II (0.77-0.82) and DP (0.80-0.82) showed the similar results, while CP (0.62-0.74) showed the lowest results and SC (0.90-0.93) showed the highest accuracy rate. Sinanoglu *et al*.[32], in their studies examining DP, ICDAS ve radiographic treatment methods have found values of 0,92 for ICDAS, 0,82 for DP and 0,80 for radiographic examination similar to our findings. Achilleos *et al*.[18] evaluated the ICDAS, DP and fluorescence camera in the identification of the incipient occlusal caries and found the highest accuracy rate for the fluorescence camera (0.95), the lowest accuracy rate for DP (0.71), and the ICDAS accuracy rate was 0.81.

The ROC curve is often used in order to allow the diagnostic test to define its own accuracy and to make a reliable comparison between the tests. The area under the ROC curve determines the accuracy of the test in seperating patients and healthy population. The size of the area under the ROC curve (AROC) shows the statistical significance of the discrimination ability of the diagnostic test being studied. In the absence of any discriminating ability of the diagnostic test being studied, the expected value of the area under the ROC curve is 0.50. In a perfect test, the field value will be 1,00 with zero false positive and zero false negative.[33] ROC curve and area under ROC curve are frequently used, as they enable verification of accuracy of the diagnostic test and make a reliable comparison between tests. In our study, ICDAS and SC are the methods that had the maximum area under ROC curve.

Gomez *et al.*[31] evaluated the performances of ICDAS, FOTI, OCT, QLF, and SC on occlusal surfaces of the permanent teeth and found that the area under ROC curve was 0.98 for ICDAS and SC. They reported that the ICDAS method indicated very good outcomes when the examiners are trained, the teeth are clean and dry, sufficient alone in clinical practice for the examination of the caries depth, SC enabled the clinical to re-evaluate the effect of treatment. Rechmann *et al.*[34] in their study investigating DIAGNOdent, Spectra Caries Detection Aid, SC the daylight and blue fluorescence mode on occlusal caries of permanent molar teeth under in-vivo conditions, have shown that the largest area under the ROC curve is the blue fluorescence mode of SC. Since the new instrument SC`s the daylight and blue fluorescence codes are able to distinguish sound, non-cavitated and cavitated caries lesion, they have stated that it has been allowed to forecast the depth of the lesion histologically and exact topography of the lesion could be seen by magnification. Also that the clinician is guided by imaging the lesion for the success of long-term protective applications.

Teo *et al*.[28] in their studies, evaluated ICDAS, DP, and CP on diagnosis of occlusal caries of primary teeth under in vitro and in

vivo conditions. They have found that the largest area under ROC curves has been recognized by using ICDAS method whereas the smallest area has been recognized by using CP method. According to these results, they point out that the ICDAS method can be successfully used to diagnose occlusal caries of primary teeth and DP should be used with high caution, especially in non-cavitated caries. Besides this, CP device is not a suitable caries diagnostic device for pimary teeth dentition. Regarding to the results of our study, similar to results of Teo *et al.*[28], CP has been determined to be unable to make reliable measurements at an adequate level in the detection of incipient caries in permanent molar teeth.

Along with the ROC analysis, the threshold values, which gives the highest sensitivity and selectivity values, were calculated for all methods. The numerical values obtained by the threshold values are interpreted. In our study, the threshold values determined for methods such as DP and CP which are evaluated on certain codes are similar to some studies.[17,18,28] When we look at the results of our research, the threshold values obtained by ROC analysis for these devices were only 0.5 value higher than the threshold values used for both the DP and CP. These results also proves that the cut-off values used in our study are within fairly safe intervals.

ICDAS II and SC were identified as the most successful methods, when sensitivity, specificity, reliability, areas under the ROC curve and histological criterias are evaluated as a whole. ICDAS II system, which well describes the stages of demineralization progression, is a successful method. The stand-alone use of it seems sufficient for detection of incipient occlusal caries on permanent teeth. We think that SC, which histologically allows the estimation of the depth of the caries lesion and enlarge the actual topography of the caries lesion, could be used successfully in the detection of early incipient occlusal caries.

When the results of our study were evaluated, all the methods except the CP, especially ICDAS II and SC, gave favorable results in the identification of incipient caries.

SC, for the pediatric dentistry; by means of the ability to display visually and record the caries lesion on the screen, informs the clinician about the success of long-term preventive dentistry applications and allows the treatment to be re-evaluated in follow-up appointments This effects pediatric dental patients` motivation in a positive way, while helps favorable results of preventive dentistry treatments.

CONFLICTS OF INTEREST

The authors deny any conflicts of interest related to this study.

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