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Efficacy of DIAGNOdent versus bitewing radiography and ICDAS for detection of proximal and occlusal caries of primary teeth in presence/absence of dental plaque and moisture

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Abstract

This study aimed to compare the efficacy of DIAGNOdent versus bitewing radiography and the international caries detection and assessment system (ICDAS) for detection of proximal and occlusal caries of primary teeth in presence/absence of dental plaque and moisture. In this diagnostic test study, 72 proximal and 75 occlusal surfaces of primary molars of children were examined for caries by using DIAGNOdent in three different conditions: (I) presence of dental plaque and moisture, (II) absence of dental plaque and presence of moisture, and (III) absence of dental plaque and moisture. The agreement, sensitivity, and specificity of DIAGNOdent were assessed and compared with bitewing radiography for detection of proximal caries and with ICDAS for detection of occlusal caries. Data were analyzed by the Friedman test, kappa coefficient of agreement, and McNemar test (alpha=0.05). DIAGNOdent results showed no significant difference in different conditions ($P>0.05$). The sensitivity of DIAGNOdent was not significantly different from that of bitewing radiography and ICDAS ($P>0.05$). The specificity of DIAGNOdent significantly decreased for detection of occlusal caries in presence of dental plaque ($P<0.05$). The highest agreement of DIAGNOdent with bitewing radiography and ICDAS was recorded in absence of dental plaque and presence of moisture. The DIAGNOdent values significantly decreased only for the occlusal surface after both plaque and moisture removal. Thus, presence of dental plaque and moisture may have no significant effect on clinical efficacy and performance of DIAGNOdent.

Keywords: Dental Caries; Radiography, Bitewing; DIAGNOdent; ICDAS

Introduction

Dental caries is a highly common preventable oral disease. Incipient carious lesions may develop on the occlusal or proximal surfaces. If detected early, carious lesions may be managed by less invasive techniques and yield a more favorable outcome. Non-cavitated carious lesions, also known as hidden caries, may remain undetected in visual examination. Dental carious lesions are conventionally detected by a dental explorer and a dental mirror. However, this method has drawbacks as well. Dental explorer can transfer the cariogenic flora from an infected area to sound areas, or cause irreversible damage in areas with remineralization potential [1].

Visual clinical examination is primarily performed for detection of occlusal caries. This method is simple and low-cost, and has high specificity. However, difference in clinical judgments of clinicians is a drawback of this method, which can be minimized by systematic methods such as the use of the international caries detection and assessment system (ICDAS) [2].

ICDAS is an evidence-based system designed for standardization of caries detection. ICDAS I was introduced in 2002 and modified in 2005, introducing ICDAS II, which offers a classification based on the severity of caries following the examination of clean and dried teeth.

Bitewing radiography is commonly requested as a standard technique for detection of proximal caries, which has a high specificity and low sensitivity. Thus, alternative methods with higher sensitivity should be considered for detection of incipient proximal caries [3]. Carious lesions appear as radiolucent lesions on bitewing radiographs.

Problems of the conventional methods of caries detection such as risks of X-ray exposure, time consuming process of examination, difficult clinical judgment especially for incipient caries, and poor cooperation of children during clinical examination and radiography led to advent of new modalities for caries detection. DIAGNOdent pen (Kavo, Biberach, Germany) or LF pen uses laser fluorescence and produces laser light in the visible spectrum with 655 nm wavelength. Laser light is absorbed by the tooth structure and produces a fluorescent signal in the infrared spectrum, which is received by a receptor at the tip of the device and is converted into a digital value based on the severity of lesion that may range from 0 to 99. Caries changes the tooth structure and results in a larger value displayed by the device [4,5].

Literature is controversial regarding the efficacy of DIAGNOdent for caries detection. Also, studies on the efficacy of DIAGNOdent for caries detection in primary molars in presence of dental plaque and moisture are scarce. Considering the usual presence of dental plaque and moisture on the surface of teeth in the oral environment, it has been hypothesized that presence of dental plaque and moisture may affect the values displayed by DIAGNOdent. A systematic review on this topic concluded that sufficient clinical evidence does not exist on this topic to reach a definite conclusion in this respect [6].

A dry and plaque-free tooth surface is a prerequisite for the application of DIAGNOdent according to the manufacturer's instructions. Considering the poor cooperation of children during clinical and radiographic examinations, difficult management of children and provision of optimal isolation, and the benefits of early detection of incipient caries, this study aimed to compare the efficacy of DIAGNOdent versus bitewing radiography and ICDAS for detection of proximal and occlusal caries of primary teeth in presence/absence of dental plaque and moisture.

Materials and Methods

This diagnostic test study was conducted on first (D) and second (E) molars of children between 6 to 10 years presenting to the Pediatric Dentistry Department of School of Dentistry, Qazvin University of Medical Sciences. The study protocol was approved by the ethics committee of the university (IR.QUMS.RES.1401.008).

Eligibility criteria:

The inclusion criteria were children between 6 to 10 years and presence of Ds and Es in dental arch with no cavitation or calculus, no restoration, no open proximal contact (no visible proximal surface), and no history of caries preventive treatment.

The exclusion criteria were cavitated carious lesions, presence of calculus, and uncooperative children.

Sample size:

The minimum sample size was calculated to be 68 occlusal and 68 proximal surfaces according to a previous study [7] assuming alpha=0.05 (Z=1.96), study power of 0.80, maximum standard deviation of DIAGNOdent value to be 29.1, and mean difference of 10 before and after dental plaque and moisture removal (effect size) using the formula for the comparison of means by paired t-test.

Data collection:

Written informed consent was obtained from the parents of eligible children. Each child then underwent clinical examination by a trained and calibrated senior dental student under unit light using a dental mirror to ensure meeting the eligibility criteria. Due to time consuming nature and difficulty of assessment of tooth surfaces by DIAGNOdent under different conditions in terms of dental plaque and moisture, the children were randomly assigned to two groups for assessment of their proximal and occlusal surfaces. A total of 72 proximal and 75 occlusal surfaces were evaluated. DIAGNOdent pen (Kavi, Biberach, Germany) was used according to the manufacturer's instructions for assessment of caries in proximal and occlusal surfaces [8]. After calibration, each surface was examined by DIAGNOdent and the mean value was recorded as V1 (presence of dental plaque and moisture). Next, the teeth underwent prophylaxis by a low-speed hand-piece without a prophylaxis paste, and the surfaces were examined again by DIAGNOdent. The value was recorded as V2 (absence of dental plaque and presence of moisture). Finally, the respective teeth were dried with cotton rolls and air spray and the respective surface was examined by

DIAGNOdent again. The value was recorded as V3 (absence of dental plaque and moisture). Classification of DIAGNOdent values according to the manufacturer is as follows:

For fissures and smooth surfaces:

0-12: Sound tooth

13-24: Onset of demineralization

>25: Severe demineralization

For proximal surfaces:

0-7: Sound tooth

8-15: Onset of demineralization

>16: Severe demineralization [8].

Under isolation, ICDAS of the occlusal surface was also recorded. This classification system has 7 codes from 0 to 6 as follows (Figure 1):

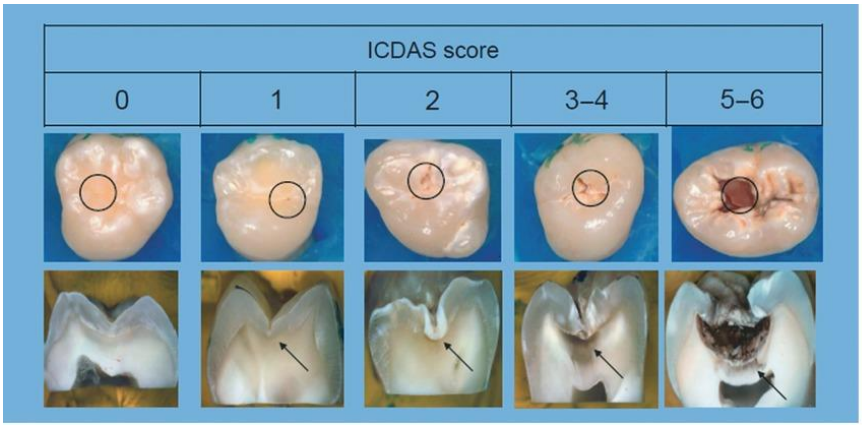

Figure 1. ICDAS scores

0: Sound tooth surface: No evidence of caries after 5 seconds of air drying

1: Primary visual changes in the enamel: Opacity or discoloration (white or brownish) at the opening of pits or fissures after long air drying

2: Distinct visual changes in the enamel: Distinct visual changes are seen in both dry and moist conditions

3: Localized enamel breakdown due to caries with no visible dentin

4: Underlying dark shadow from dentin (with or without enamel breakdown)

5: Distinct cavity with visible dentin

6: Extensive distinct cavity (extending to over half the surface) with visible dentin [9].

Surfaces with codes 5 and 6 were excluded since DIAGNOdent cannot be used for cases with cavitated caries.

Bitewing radiographs of children were then assessed. Classification of caries on bitewing radiographs was as follows [10] (Figure 2):

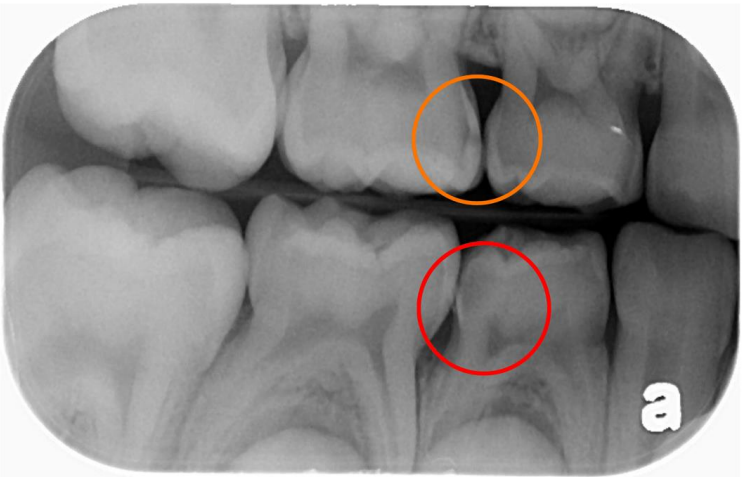

Figure 2. Bitewing radiograph

E1: Caries in the outer half of enamel
E2: Caries in the inner half of enamel
D1: Caries in the outer third of dentin
D2: Caries in the middle third of dentin
D3: Caries in the inner third of dentin

Digital bitewing radiographs were obtained from Ds and Es by the same technician under the supervision of a radiologist by an intraoral X-ray machine (Planmeca, Finland) with photostimulable phosphor plate sensor and processed by a processing machine (Digora Optime; Soredex, Helsinki, Finland). The exposure settings included 60 kVp and 8 mA. The exposure time was adjusted according to the size of patient. The optimal quality of radiographs was confirmed by an oral radiologist and a pediatric dentist.

The agreement between the DIAGNOdent values and the bitewing radiography for proximal surfaces and ICDAS for occlusal surfaces was then evaluated in presence/absence of dental plaque and moisture.

Statistical analysis:

Data were analyzed using SPSS version 25 (Armonk, NY: IBM Corp). The DIAGNOdent values and their classification according to the manufacturer were compared among different testing conditions by the Friedman test. The receiver operating characteristic (ROC) curve was used to determine the cut-off point of DIAGNOdent values for caries. The kappa coefficient was calculated to assess the level of agreement between the DIAGNOdent values and bitewing radiography for proximal surfaces and ICDAS for occlusal surfaces. According to the Cohen's classification [11], kappa values between 0 to 0.20 indicated no agreement, values between 0.21 to 0.39 indicated minimum agreement, values between 0.40 to 0.59 indicated poor agreement, values between 0.60 to 0.79 indicated moderate agreement, values between 0.80 to 0.90 indicated strong agreement, and values > 0.90 indicated almost complete agreement.

Sensitivity was calculated as the ratio of tooth surfaces diagnosed as carious by DIAGNOdent to the total number of surfaces diagnosed as carious by the gold standard (i.e.,

bitewing radiography for proximal surfaces and ICDAS for occlusal surfaces). Specificity was calculated as the ratio of surfaces diagnosed as sound by DIAGNOdent to the entire number of surfaces diagnosed as sound by the gold standard (i.e., bitewing radiography for proximal surfaces and ICDAS for occlusal surfaces). The McNemar test was applied to compare the sensitivity and specificity values among different testing conditions. $P<0.05$ was considered statistically significant.

Results

A total of 72 proximal and 75 occlusal surfaces of 82 primary molars of 6 to 10-year-old children were evaluated in this study.

Results of DIAGNOdent in different testing conditions after classification of values according to the manufacturer:

Table 1 shows the frequency of different stages after classification of DIAGNOdent values according to the manufacturer in the three testing conditions. According to the Friedman test, the difference in DIAGNOdent values was not significant among the three testing conditions neither for proximal ($P=0.280$) nor for occlusal ($P=0.282$) surfaces.

Table 1. Frequency of different stages after classification of DIAGNOdent values according to the manufacturer in the three testing conditions

Testing condition	Class	Proximal surfaces			Occlusal surfaces		
		Number	Percentage	Mean Rank	Number	Percentage	Mean Rank
Presence of dental plaque and moisture (V1)	Sound Onset of demineralization Severe demineralization	53 12 7	73.6 16.7 9.7	2.07	60 7 8	80 9.3 10.7	1.95
Absence of dental plaque and presence of moisture (V2)	Sound Onset of demineralization Severe demineralization	58 8 6	80.6 11.1 8.3	1.97	55 13 7	73.3 17.3 9.3	2.05
Absence of dental plaque and moisture (V3)	Sound Onset of demineralization Severe demineralization	58 8 6	80.6 11.1 8.3	1.97	57 11 7	76 14.7 9.3	1.99
Friedman Test P-value		0.280			0.282		

DIAGNOdent values in different testing conditions:

Table 2 presents the DIAGNOdent values for proximal and occlusal surfaces in different testing conditions. The Friedman test showed a significant difference in

DIAGNOdent values for the occlusal surface among the three testing conditions such that the DIAGNOdent value was significantly lower in V3 (absence of dental plaque and moisture) (P=0.002). However, the difference was not significant fo r proximal surfaces (P=0.052).

Table 2. DIAGNOdent values for proximal and occlusal surfaces in different testing conditions

Testing condition	Proximal surface			Occlusal surface		
	Mean	Std. deviation	Mean rank	Mean	Std. deviation	Mean rank
Presence of dental plaque and moisture (V1)	7.53	15.738	2.17	11.27	16.640	2.17
Absence of dental plaque and presence of moisture (V2)	6.46	15.029	1.97	11.08	16.361	2.12
Absence of dental plaque and moisture (V3)	6.14	14.246	1.85	9.93	15.431	1.71
Friedman Test P-value	0.052			0.002		

Results of bitewing radiographic assessment of proximal surfaces:

Table 3 presents the frequency of different stages of proximal caries according to bitewing radiography. E0 had the highest frequency (43.1%) and E2 and D3 equally had the lowest frequency (5.6%).

Table 3. Frequency of different stages of proximal caries according to bitewing radiography

Stage	Number	Percentage
E0	31	43.1
E1	13	18.1
E2	4	5.6
D1	11	15.3
D2	9	12.5
D3	4	5.6

Results of visual clinical examination of occlusal surfaces using ICDAS:

Table 4 presents the results of visual clinical examination of occlusal surfaces using ICDAS. Code 0 had the highest frequency (48%) while code 3 had the lowest frequency (1.3%).

Table 4. Results of visual clinical examination of occlusal surfaces using ICDAS

ICDAS code	Number	Percentage
0	36	48
1	10	13.3

2	23	30.7
3	1	1.3
4	5	6.7

Assessment of agreement, and comparison of sensitivity and specificity of DIAGNOdent, bitewing radiography, and ICDAS in different testing conditions:

Table 5 shows the agreement and compares the sensitivity and specificity of DIAGNOdent with bitewing radiography for proximal surface caries and ICDAS for occlusal surface caries. Statistical analysis revealed a cut-off point of 5 for caries threshold by using DIAGNOdent. E1 code was also considered as the cut-off point of caries threshold for bitewing radiography and code 1 was considered as the cut-off point of caries threshold for ICDAS. The level of agreement was higher for occlusal surface caries than proximal surface caries. Also, in both occlusal and proximal surfaces, the agreement increased in V2 (after plaque removal) compared with V1 (before plaque and moisture removal). However, the agreement decreased in V3 (after moisture removal) compared with V2.

Table 5. Agreement, sensitivity and specificity of DIAGNOdent (cut-off point of 5) in comparison with bitewing radiography (cut-off point of E1) for proximal surface caries and ICDAS (cut-off point of 1) for occlusal surface caries

Testing condition	Proximal surfaces (bitewing radiography)			Occlusal surfaces (ICDAS)		
	Sensitivity	Specificity	Agreement	Sensitivity	Specificity	Agreement
Presence of dental plaque and moisture (V1)	41.5	80.6	0.206	82.1	66.7	0.490
Absence of dental plaque and presence of moisture (V2)	36.6	87.1	0.218	84.6	86.1	0.707
Absence of dental plaque and moisture (V3)	31.7	74.2	0.055	74.4	77.8	0.520

Pairwise comparisons of sensitivity and specificity (Table 6) showed no significant difference in sensitivity or specificity of proximal caries detection when different testing conditions were compared ($P>0.05$). In the occlusal surface, a significant difference was only detected in specificity of occlusal caries detection when comparing V1 (before plaque and moisture removal) and V2 (after plaque removal) ($P=0.016$).

Table 6. Pairwise comparison of sensitivity and specificity of DIAGNOdent with bitewing radiography for proximal surface caries and ICDAS for occlusal surface caries in different testing conditions

Compared modalities	Comparison of V2 and V3		Comparison of V1 and V3		Comparison of V1 and V2		
	Specificity	Sensitivity	Specificity	Sensitivity	Specificity	Sensitivity	
DIAGNOdent vs. bitewing radiography	P=0.344	P=0.727	P=0.626	P=0.289	P=0.687	P=0.754	P-value
DIAGNOdent vs. ICDAS	P=0.250	P=0.219	P=0.289	P=0.453	P=0.016	P=1.000	P-value

Discussion

This study compared the efficacy of DIAGNOdent versus bitewing radiography and ICDAS for detection of proximal and occlusal caries of primary teeth in presence/absence of dental plaque and moisture. The results showed no significant difference in DIAGNOdent results for occlusal or proximal surfaces among different testing conditions. Thus, it appears that elimination of dental plaque and moisture has no significant effect on the DIAGNOdent result in the clinical setting, especially when DIAGNOdent is used as an adjunct for assessment of demineralization. Search of the literature by the authors yielded no similar study on this particular topic to compare our results with.

The present results also revealed no significant difference in DIAGNOdent values for proximal surfaces when different testing conditions were compared. Bittar et al, [7] in their in vitro study found no significant change in proximal surface DIAGNOdent values after plaque removal compared with before, which was in agreement with the present findings. However, higher DIAGNOdent values were recorded after moisture removal compared with before in their study which was different from the present findings. This difference may be due to clinical design of the present study and difficult moisture removal from the proximal surfaces in the oral environment.

In the present study, the DIAGNOdent values for the occlusal surface were not significantly different after plaque removal but the values significantly decreased after moisture removal. Consistent with the present findings, Bittar et al. [7] indicated that presence of dental plaque did not cause a significant change in DIAGNOdent values but the values significantly increased after moisture removal, which can be due to difference between in vitro and clinical conditions because the moisture in the present study was due to the presence of saliva while the moisture in their study was due to saline, which has a different composition than the saliva.

In assessment of proximal surfaces by the bitewing radiography in the present study, E1 code was considered as the cut-off point for caries. Code 1 was considered as the cut-off point for occlusal caries by ICDAS, and DIAGNOdent value 5 was considered as the cut-off point of caries by DIAGNOdent. The kappa coefficient of agreement was applied to assess the agreement of DIAGNOdent with ICDAS and bitewing radiography. For the agreement of DIAGNOdent and bitewing radiography for detection of proximal caries, the results showed a kappa value of 0.206 in presence of dental plaque and moisture and 0.218 in absence of

dental plaque and presence of moisture, indicating minimum agreement. The value decreased to 0.055 in absence of dental plaque and moisture (no agreement). Assessment of the agreement of DIAGNOdent and ICDAS for the occlusal surface caries revealed a kappa value of 0.490 (poor agreement) in presence of dental plaque and moisture, 0.707 (moderate agreement) in absence of dental plaque and presence of moisture, and 0.520 (poor agreement) in absence of dental plaque and moisture. Thus, DIAGNOdent had the highest agreement with bitewing radiography for proximal surfaces and ICDAS for occlusal surfaces in absence of dental plaque and presence of moisture, which is an advantage considering difficult isolation in children. To the best of the authors' knowledge, no similar study has assessed the agreement of DIAGNOdent results with bitewing radiography and ICDAS to compare our results with.

In the present study, the sensitivity and specificity of DIAGNOdent compared with bitewing radiography for proximal surfaces and ICDAS for occlusal surfaces were also evaluated pairwise in different conditions and the results showed no significant difference in sensitivity or specificity when different conditions were compared, which was similar to the results of Bittar et al [7]. For the occlusal surfaces, sensitivity was not significantly different but specificity significantly increased in absence of dental plaque and presence of moisture compared with presence of both dental plaque and moisture. In other words, specificity increased after plaque removal and before drying. Georgescu et al. [12] showed no significant change in sensitivity or specificity after dental plaque and moisture removal. However, they did not measure sensitivity and specificity before moisture removal. Similarly, the present study revealed no significant change in sensitivity or specificity after plaque and moisture removal. Bitter et al, [7] also revealed a significant reduction in specificity only in presence of dental plaque.

Progression of carious lesions occurs fast in primary teeth due to factors such as thin enamel [13]. Thus, sensitivity is more important than specificity for early detection of incipient caries in primary teeth. Since the sensitivity of DIAGNOdent was not significantly different in proximal and occlusal surfaces under different conditions, dental plaque and moisture may not have a confounding effect on the diagnostic accuracy of DIAGNOdent after all. It should be noted that the level of agreement, sensitivity, and specificity depend on the cut-off point and the threshold value of DIAGNOdent.

Poor cooperation of children and inability to microscopically analyze the lesions due to in vivo study design were among the limitations of this study. Similar clinical studies are recommended on different tooth surfaces of permanent teeth. Also, considering the potential hazards of ionizing radiation, a clinical guideline can be devised for screening of patients by clinical examination with DIAGNOdent to request bitewing radiography only when necessarily required.

Conclusion

The DIAGNOdent values significantly decreased only in the occlusal surface after both plaque and moisture removal. Thus, presence of dental plaque and moisture may have

no significant effect on clinical performance of DIAGNOdent. DIAGNOdent had the highest agreement with bitewing radiography and ICDAS in absence of dental plaque and presence of moisture. Thus, plaque removal may be recommended for higher agreement of DIAGNOdent with bitewing radiography and ICDAS.

ETHICS APPROVAL:

This study was approved by the Ethics Committee of Qazvin University of Medical Sciences under the code IR.QUMS.REC.1401.008. There is no conflict with ethical considerations.

Conflict of Interests:

The authors have no conflicts of interest to declare.

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Funding for this study was not received.

Author Contributions:

Conceptualization: Ali Karimkhani, Helya Alizadeh, Methodology Ali Karimkhani, Maryam Tofangchiha, Formal analysis and investigation: Mehdi Ranjbaran, Writing - original draft preparation: Mohammad Zarabadi, Writing - review and editing: Ali Karimkhani, Maryam Tofangchiha

Data Availability Statement

The data used to support the findings of this study are included in the article and available on request from Author 1 OR the corresponding author.

References

1. Akarsu S, Karademir SA. In vitro comparison of ICDAS and DIAGNOdent pen in the diagnosis and treatment decisions of non-cavitated occlusal caries. Odovtos-International Journal of Dental Sciences. 2019 Mar 4;21(1):67-1.
2. Gimenez T, Piovesan C, Braga MM, Raggio DP, Deery C, Ricketts DN, Ekstrand KR, Mendes FM. Visual Inspection for Caries Detection: A Systematic Review and Meta-analysis. Journal of dental research. 2015 Jul;94(7):895-904.
3. Schwendicke F, Tzschoppe M, Paris S. Radiographic caries detection: A systematic review and meta-analysis. Journal of dentistry. 2015 Aug;43(8):924-33.
4. Abogazalah N, Ando M. Alternative methods to visual and radiographic examinations for approximal caries detection. Journal of oral science. 2017 Sep 14;59(3):315-22.
5. Shukla H, Sajjanar A, Wasnik M, Gahlod N, Rojekar N, Bhattad D. Caries Diagnostic Techniques in Pediatric Dentistry. Annals of the Romanian Society for Cell Biology. 2021 Apr 15:6097-107.

6. Macey R, Walsh T, Riley P, Glenny AM, Worthington HV, Fee PA, Clarkson JE, Ricketts D. Fluorescence devices for the detection of dental caries. The Cochrane database of systematic reviews. 2020 Dec 8;12(12):CD013811.
7. Bittar DG, Gimenez T, Morais CC, De Benedetto MS, Braga MM, Mendes FM. Influence of moisture and plaque on the performance of a laser fluorescence device in detecting caries lesions in primary teeth. Lasers in medical science. 2012 Nov;27(6):1169-74.
8. Instructions for use DIAGNOdent pen 2190. Available from: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://kavo.widen.net/content/bkleiblbt2/pdf/GA_2190_20230815_07_US-EN.pdf?u=pj169z.
9. Gugnani N, Pandit IK, Srivastava N, Gupta M, Sharma M. International Caries Detection and Assessment System (ICDAS): A New Concept. International journal of clinical pediatric dentistry. 2011;4(2):93-100.
10. Schwendicke F, Göstemeyer G. 11 Conventional Bitewing Radiographs. Detection and Assessment of Dental Caries: A Clinical Guide. 2019 Nov 6:109.
11. McHugh ML. Interrater reliability: the kappa statistic. Biochemia medica. 2012;22(3):276-82.
12. Georgescu A, Stoleriu S, Iovan G, Topoliceanu C, Andrian S. Study regarding the influence of different methods used to remoove the organic debris on the diagnostic accuracy of diagnodent. Romanian Journal of Oral Rehabilitation. 2012 Jul 1;4(3):83-9
13. Cho KH, Kang CM, Jung HI, Lee HS, Lee K, Lee TY, Song JS. The diagnostic efficacy of quantitative light-induced fluorescence in detection of dental caries of primary teeth. Journal of dentistry. 2021 Dec;115:103845.