DOI: 10.7860/JCDR/2024/67006.18876

Original Article

Dentistry Section

Detection of Early Smooth Surface Caries in Primary Molars using Conventional Methods in a Low-Resource Setting: A Cross-sectional Study

PN NANMARAN[1], NILANJANA SAHA[2], SHILADITYA SIL[3], SUBHANKAR GHOSH[4]

ABSTRACT

Introduction: Dental caries is a widespread chronic disease that affects nearly 100% of adults in developing countries. Detecting caries early is crucial for effective remineralisation and improved prognosis. However, identifying smooth surface caries in its early stages remains challenging for many healthcare professionals globally due to the subjective nature of visual inspection.

Aim: To determine the most effective method for detecting early smooth surface caries in limited resource settings.

Materials and Methods: The present cross-sectional study was conducted in the Department of Pedodontics, Dr. R. Ahmed Dental College and Hospital (tertiary care centre), Kolkata, West Bengal, India, from March 2021 to August 2022. Study was conducted involving 120 primary molars from Bengali children aged 5 years and above. The teeth were randomly selected while adhering to specific inclusion and exclusion criteria. The occlusal and proximal surfaces of the teeth were assessed using three methods: unaided Visual Examination (VE), Magnifying Loupe (ML)-assisted VE, and the fluorescence-based DIAGNOdent pen (considered the gold standard). Two assessments were performed for each method, one before air-drying and another after air-drying. Caries detection followed the International Caries Detection and Assessment System (ICDAS) II clinical scoring system, and data analysis was conducted using the Chi-square test for proportions.

Results: In the present study, there were 76 male children and 44 female children and the mean age of the children was 7±2.5 years. Unaided VE exhibited a diagnostic accuracy of 87.5% and 77.5% for air-dried and non air-dried tooth surfaces, respectively. ML-aided VE yielded a diagnostic accuracy of 88.34% and 85% for air-dried and non air-dried tooth surfaces, respectively.

Conclusion: The present study concluded that even without the assistance of an ML, drying the tooth surface can achieve a level of caries detection accuracy comparable to that of ML-aided VE.

Keywords: DIAGNOdent, Diagnostic accuracy, Magnifying loupes, Smooth surface caries

INTRODUCTION

Dental caries is a prevalent issue affecting a significant portion of school-aged children in most developed nations, with rates ranging from 60-90%. Among adults, the prevalence is even higher, affecting nearly the entire population in many countries. This disease involves a continuous process of demineralisation and remineralisation. However, interventions can be implemented to halt or reverse its progression [1].

Over the last three decades, there have been notable changes in the way this disease manifests. Enamel caries now progresses more slowly, allowing for preventive measures before irreversible damage occurs [2]. In its early stages, the caries process is reversible, and non invasive interventions can transition an active lesion to an inactive state [3,4].

Detecting caries early is crucial for preventing and treating lesions [5]. Occlusal surfaces are particularly susceptible to caries in both children and adults due to the unique morphology of pits and fissures, making plaque removal challenging. Therefore, the significance of early caries detection has grown considerably in recent years [6,7].

To achieve early caries detection, effective diagnostic techniques are essential. Implementing strategies to arrest or reverse the disease process can alleviate the economic burden, pain and suffering associated with the placement and replacement of restorations [8]. Augmenting traditional diagnostic methods with more sensitive and advanced techniques can enhance caries diagnostic procedures and improve dental care and patient treatment. Such complementary methods should provide objective information about lesion presence and severity, supplementing the clinician's subjective assessment and promoting evidence-based clinical caries diagnosis [9,10].

Traditional caries examination relies heavily on subjective interpretation during VE. Clinicians make dichotomous decisions based on their subjective assessment of colour, texture, and location using relatively basic instruments like dental mirrors, explorers and bitewing radiographs [11]. Visual aids, such as low-powered magnification (dental loupes), have gained popularity among dentists to enhance VE precision and ergonomics. However, detecting non cavitated lesions and microcavities in enamel remains challenging, and inconsistencies in diagnosis can lead to treatment variations [12]. While this method offers high specificity, its sensitivity is relatively low [13].

To overcome these limitations, a fluorescence-based approach utilising a diode laser fluorescence device, known as DIAGNOdent (KaVo, Charlotte, NC), was introduced. DIAGNOdent employs a diode laser emitting red light (655 nm), which is absorbed by bacterial by-products like porphyrins. This light is partially re-emitted as near-infrared fluorescence. The device captures and translates this fluorescence into a numerical scale ranging from 0 to 99, where higher values indicate deeper caries lesions [14,15].

Initially, DIAGNOdent was designed to detect caries on occlusal and smooth surfaces only and did not cater to proximal caries detection, requiring radiographs for assessment [16]. To address this limitation, a new version, the DIAGNOdent pen, was developed, enabling assessment of both occlusal and proximal surfaces [17]. The device operates on the same principles as the previous version but features a tip that can rotate around its axis, facilitating the evaluation of proximal surfaces from both buccal and lingual perspectives.

In resource-limited settings, the detection of early caries in primary molars primarily relies on VE and ML, considered conventional methods. In the present study, the authors explored the detection of early smooth surface carious lesions in primary molars using three different methods: VE, ML (conventional), and DIAGNOdent (gold standard). The present study aimed to compare these methods to determine the most effective conventional approach for early caries detection and also evaluated the efficacy of each method both before and after air-drying the tooth surfaces.

MATERIALS AND METHODS

The present cross-sectional study was conducted in the Department of Pedodontics, Dr. R. Ahmed Dental College and Hospital (tertiary care centre), Kolkata, West Bengal, India, from March 2021 to August 2022. The study received clearance from the Institutional Ethical Committee (DCH/2021/38).

Inclusion criteria: Children who had completed their full immunisation schedule, children aged 5 years and above with non cavitated, visually intact primary molars that exhibited no evidence of developmental defects or hypoplasia were included in the study.

Exclusion criteria: Primary molars with cavities, restorations, pulpal involvement, or dental anomalies were excluded from the study.

Sample size calculation: To determine the required sample size, G*Power software was employed using the following parameters:

1. Analysis type: A priori.
2. Test family: F tests.
3. Statistical test: Analysis of Variance (ANOVA): Repeated measures, between factors.
4. Input:
    - Effect size: 0.25 [18].
    - α error probability: 0.05.
    - Power (1-β) error probability: 0.8.
    - Number of groups: 3.
    - Number of measurements: 2.
    - Correlation among repeated measures: 0.5.

The output yielded a total sample size of 120, to achieve 80.4% power at a 95% confidence level. No control group was necessary for the present study. The 120 primary molars were randomly selected based on the inclusion and exclusion criteria from the five years and above age group.

Study Procedure

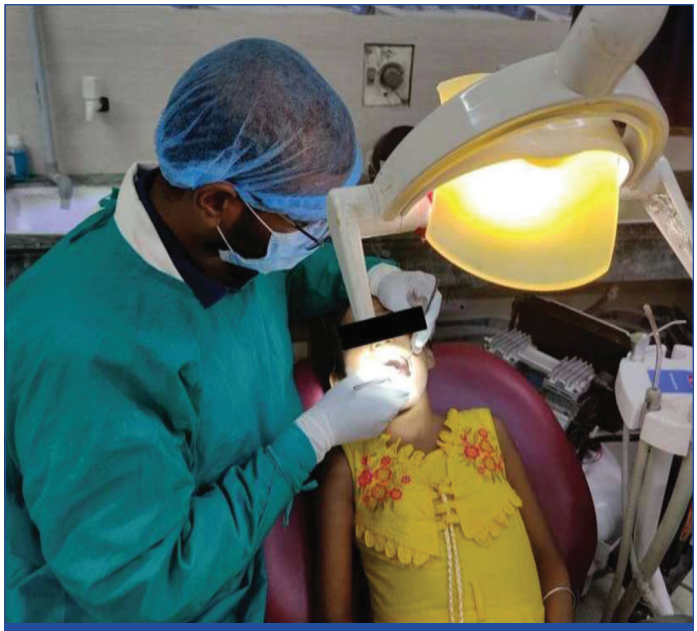
After obtaining informed consent from the guardians, a comprehensive examination was conducted, and the children's ages were recorded. Thorough oral prophylaxis was performed before readings were taken.

The occlusal surfaces (n=103) and proximal surfaces (n=39) of all primary molars were assessed using the naked eye for VE, ML-aided VE (Endo-King Dental loupes with frame 2.5x-3.5x), and DIAGNOdent pen (DIAGNOdentTM pen 2190). Each test was conducted twice on the same tooth, both before and after air-drying [Table/Fig-1-3].

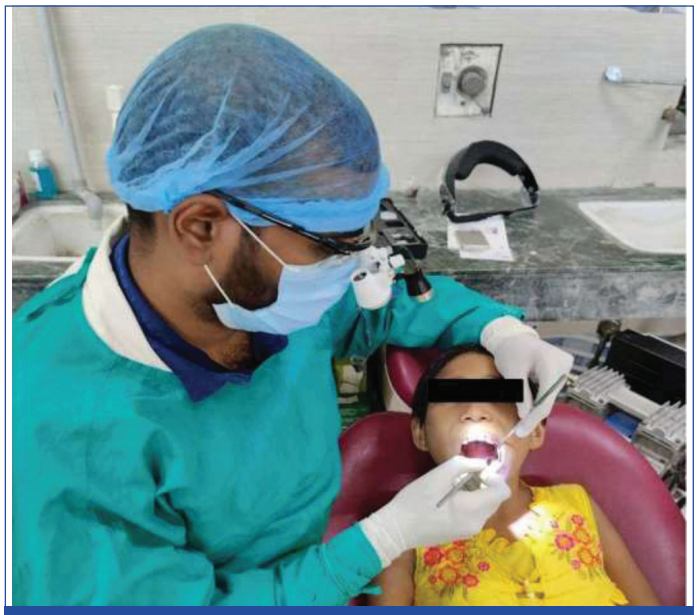
Unaided VE and ML-aided VE were carried out with the child seated in the dental chair, observing the suspect tooth from a standardised operating distance. The DIAGNOdent pen was recalibrated with the selected tip, and suspicious sites on the primary molars were examined with the handpiece's tip lightly contacting the tooth surface, moved in a pendulum-like manner. Three readings were obtained, and the highest one was considered. DIAGNOdent fluorescence readings were between 0-99, with sound teeth and non cavitated initial enamel lesions being scored as 1 and 2/3, respectively. DIAGNOdent categorical scores were as follows:

Score 1: 0-4 (healthy tooth structure).

Score 2: 5-10 (outer half enamel caries).



[Table/Fig-1]: Caries detection by unaided Visual Examination (VE) on a patient.



[Table/Fig-2]: Showing the caries detection being done by Magnifying Loupe (ML) guided Visual Examination (VE) on a patient.

[Table/Fig-3]: Caries detection by DIAGNOdent pen on a patient.

Score 3: 11-20 (inner half enamel caries).

Score 4: 21+(dentin caries) [18-20].

Scoring criteria for VE, ML-aided VE and DIAGNOdent pen followed the ICDAS II criteria [Table/Fig-4] [21]. The result from the DIAGNOdent pen was considered the gold standard.

Code	Description
0	Sound tooth surface: No evidence of caries after five seconds of air-drying
1	The first visual change in enamel: Opacity or discolouration (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	Localised enamel breakdown (without clinical visual signs of dentinal involvement) seen when wet and after prolonged drying
4	Underlying dark shadow from dentine
5	Distinct cavity with visible dentine
6	Extensive (more than half the surface) distinct cavity with visible dentine

[Table/Fig-4]: ICDAS II codes and criteria.

STATISTICAL ANALYSIS

Data collected were tabulated in Microsoft Excel 2019 software and analysed using International Business Machines (IBM) Statistical Package for Social Sciences (SPSS) Statistics for Windows, software version 26.0. Graphs, box plots, and pie diagrams were created using GraphPad Prism for Windows, software version 9.0. Normality tests revealed skewed data, prompting the use of non-parametric tests for inferential statistics. The Chi-square test was used for categorical variables. Intragroup and intergroup comparisons were performed using the Wilcoxon's signed-rank test and Friedman's ANOVA, followed by Dunn's test. A significance level of 0.05 was considered statistically significant.

RESULTS

In the present study, the children had a mean age of 7±2.5 years. Among the participants, there was a male predominance, with 76 children being males and 44 being females, resulting in a male-to-female ratio of 1.7:1.

For all three methods of caries detection (VE, ML and DIAGNOdent pen), the ability to detect smooth surface carious lesions was significantly more efficient and accurate when the tooth surface was air-dried compared to when it was not (p-value <0.001), as shown in [Table/Fig-5]. In both situations, with and without air-drying, the DIAGNOdent pen exhibited the highest accuracy in smooth surface caries detection, followed by ML, and lastly VE, with a p-value of <0.05 for all three groups.

Mode of examination	Median (IQR) with air-drying	Median (IQR) without air-drying	Z value	p-value
Visual Examination (VE)	1 (1-2)	1 (0-2)	-4.2	**<0.001**
Magnifying Loupes (ML)	2 (1-2)	2 (0-2)	-5.09	**<0.001**
DIAGNOdent pen	2 (1-2)	2 (1-2)	-5.609	**<0.001**

[Table/Fig-5]: Comparisons for the Visual Examination (VE), Magnifying Loupe (ML), and Diagnodent by ICDAS II Scoring between air-drying and without air-drying.
IQR: Interquartile range; The p-value in bold font indicates statistically significant values

There was a significant difference between each of the three methods, namely VE, ML-aided VE, and DIAGNOdent pen, in both air-dried (p-value=0.0016) and non air-dried scenarios (p-value=0.0011) [Table/Fig-6]. There were no significant differences in caries detection between VE and ML-aided VE in non air-dried primary molars (p-value=0.24). However, significant differences were observed between VE and DIAGNOdent, and between ML and DIAGNOdent in caries detection for both air-dried and non air-dried tooth surfaces (p-value <0.001) [Table/Fig-7]. The ML with air-drying demonstrated the highest diagnostic accuracy of 88.34%, closely followed by VE with air-drying at 87.5%. Without air-drying, the diagnostic validity of both VE and ML decreased and was recorded at 77.5% and 85%, respectively [Table/Fig-8].

Groups	With air-drying			Without air-drying		
Friedman's ANOVA Test	Mean ranks	Friedman's Q value	p-value	Mean ranks	Friedman's Q value	p-value
Visual Examination (VE)	1.31	223	**0.0016**	1.39	227	**0.0011**
Magnifying Loupes (ML)	1.69	223		1.61	227	
DIAGNOdent	3	223		3	227	

[Table/Fig-6]: Comparison of the three study groups for the mean ranks of the caries detection scores with and without air-drying by ICDAS II by Friedman's ANOVA.

Groups	With air-drying		Without air-drying	
Dunn's multiple comparisons test	Rank sum difference	p-value	Rank sum difference	p-value
Visual Examination (VE) vs Magnifying Loupes (ML)	-45	**0.01**	-27	0.24
Visual Examination (VE) vs DIAGNOdent	-203	**<0.001**	-194	**<0.001**
Magnifying Loupes (ML) vs DIAGNOdent	-158	**<0.001**	-167	**<0.001**

[Table/Fig-7]: Comparison of the actual differences for the mean ranks of the caries detection scores with and without air-drying by ICDAS II with the post-hoc Dunn's test.

Diagnostic validity of different groups using ICDAS II criteria	Sensitivity	Specificity	Positive predictive value	Negative predictive value	Diagnostic accuracy
VE with air-drying	93.2%	71.9%	90.1%	79.3%	87.5%
ML with air-drying	97.7%	62.5%	87.8%	90.9%	88.34%
VE without air-drying	78.5%	75.6%	86.1%	64.6%	77.5%
ML without air-drying	94.9%	65.9%	84.3%	87.1%	85%

[Table/Fig-8]: Comparison of the diagnostic validity of the various parameters used in the present study.

DISCUSSION

The present study demonstrated that all three methods exhibited significantly higher efficiency and accuracy when the tooth surface was air-dried compared to non air-dried surfaces. This suggests that using air-drying as a standard procedure during examination can enhance the diagnostic accuracy of all three methods.

In both air-dried and non air-dried scenarios, the DIAGNOdent pen outperformed the other two methods, VE and ML, in terms of accuracy, establishing it as the gold standard in the present study. This reinforces the notion that fluorescence-based diagnostic tools can offer more reliable results, particularly in the detection of early carious lesions. The DIAGNOdent pen's ability to quantify fluorescence and provide a numerical scale for caries severity enables a more objective assessment compared to the subjective judgments involved in VEs. Consequently, this can facilitate evidence based clinical decision-making [22].

Magnifying loupes have gained popularity among dentists as they improve the precision of VE and offer ergonomic advantages. However, the present study indicated that while MLs can enhance VE, they did not surpass the accuracy of the DIAGNOdent pen. The data showed that MLs had intermediate sensitivity and specificity compared to unaided VE and the DIAGNOdent pen. This suggests that while MLs provide benefits, they may not be as effective as fluorescence-based tools for early caries detection [23].

The impact of air-drying on detection accuracy is noteworthy. Both unaided VE and ML-aided VE demonstrated significantly higher accuracy when the tooth surface was air-dried. This implies that ensuring a dry tooth surface is a crucial aspect of the examination process. In resource-limited settings where advanced tools may not

Authors name and year	Place of study	Sample size	Age group considered	Parameters compared	Conclusion
Braga MM et al., (2007) [24]	New England	107 molars (Extracted tooth, in-vitro)	5-9 years	Assessment of caries lesion depth in primary molar by VE using ICDAS-II.	VE is reliable for assessment of caries in primary molars.
Diniz MB et al., (2009) [25]	Europe	163 molars (extracted tooth, in-vitro study)	4-10 years	Assessment of inter and intraexaminer reproducibility and the accuracy of the ICDAS-II in detecting occlusal caries by VE.	VE produced good reproducibility and accuracy in detecting occlusal caries using ICDAS II.
Gupta N et al., (2019) [28]	India	300 molars (in-vivo study)	5-10 years	Assessment of the effective-ness and reliability of magnification, DIAGNOdent in detection of smooth surface white spot lesions.	Magnifying Loupes (ML) with air-drying is an effective method in detection of smooth surface white spot lesion.
Mitropoulos P et al., (2012) [26]	Germany	38 molars (Extracted tooth, in-vitro)	6-10 years	Comparison of the impact of low-powered magnification on the detection of occlusal caries.	Magnification does not improve the detective performance of Visual Examination (VE).
Teo TK-Y et al., (2015) [27]	Japan	64 molars (in-vivo)	4-9 years	To assess the in-vivo and in-vitro authenticity of ICDAS II, Carie-Scan Pro and DIAGNOdent Pen in the observation and evaluation of pit and fissure caries in primary teeth.	The Inference showed that ICDAS has highest repeatability and validity and DIAGNOdent Pen's validity was on par with ICDAS, but it showed only moderate repeatability.
Nanmaran et al., (2023) (Present study)	India	120 molars (in-vivo)	5 years and above	To assess the efficiency of VE, ML and DIAGNOdent pen for detection of smooth surface early caries (with/without air-drying) in a low resource setting using ICDAS II criteria.	DIAGNOdent pen had the maximum accuracy followed by ML-aided VE and lastly VE. Air-dried tooth revealed early caries better in all three parameters.

[Table/Fig-9]: Showing the similar studies done previously by different authors [24-28].

be readily available, this finding highlights the importance of basic techniques like air-drying to improve diagnostic accuracy [19].

When using the ICDAS II criteria with air-drying, VE exhibited a sensitivity of 93.2% and a diagnostic accuracy of 87.5%. In contrast, without air-drying, the sensitivity and diagnostic accuracy were 78.5% and 77.5%, respectively. This underscores the significant impact of air-drying in increasing both sensitivity and diagnostic accuracy. Similar studies by Braga MM et al., and Diniz MB et al., have confirmed the reliability of VE for detecting early smooth surface caries in primary molars using the ICDAS II criteria [24,25].

The effectiveness of air-drying in caries detection is attributed to the fact that saliva can obstruct the pores in both cavitated and non cavitated carious teeth. This obstruction can mask differences in light reflection between carious and healthy tooth structures, making it challenging to observe changes in enamel surface colour and brightness. In contrast, dry teeth exhibit white spots more visibly due to differences in refractive indices between enamel, water and air [2,11].

The diagnostic validity of ML with air-drying, using the ICDAS II criteria, demonstrated a sensitivity of 97.7% and a diagnostic accuracy of 88.34%. This suggests that while ML did not show a statistically significant difference compared to unaided VE, it slightly enhanced sensitivity, which aligns with a study by Mitropoulos P et al., [26].

Teo TKY et al., also reported that low-powered magnification significantly improved sensitivity for occlusal and proximal caries compared to unenhanced VE [27]. When ML was used without air-drying, the sensitivity and specificity were 94.9% and 65.9%, respectively, indicating the beneficial impact of air-drying on caries detection.

After air-drying, VE aided by ML demonstrated a slight advantage over unaided VE in caries detection, with diagnostic accuracy of 88.34% and 87.5%, respectively. Without air-drying, the accuracy was 85% and 77.5%, respectively. Air-drying significantly improved the visibility of smooth surface early carious lesions in primary molars during both unaided VE and ML-guided VE.

Gupta N et al., also supported the effectiveness of VE-aided ML with air-drying for the detection of smooth surface caries in primary molars [28]. When the tooth surface was air-dried, both aided and unaided VE were almost equally efficient in caries detection. However, without air-drying, there was a notable difference in the diagnostic accuracy of smooth surface caries detection between aided and unaided VE. Similar studies have been compared in [Table/Fig-9] [24-28].

These findings have practical implications for dental practitioners working in limited resource settings. The study suggests that in such environments, unaided VE, when combined with air-drying, can be a viable option for detecting early smooth surface caries. Additionally, the results emphasise the utility of the DIAGNOdent pen when available, given its superior accuracy.

While the present study provides valuable insights, further research is warranted to explore additional factors that may influence the diagnostic accuracy of these methods. Factors such as operator experience, equipment calibration, and variations in tooth morphology could impact the results. However, it is worth noting that some researchers have observed that DIAGNOdent may have a tendency to over-score, which could potentially influence the study results [29]. Additionally, long-term follow-up studies are needed to assess the actual clinical outcomes of different diagnostic methods in terms of treatment planning and patient management.

Limitation(s)

The present study utilised DIAGNOdent as the gold standard for caries detection, comparing with histopathological evaluation might have given more accurate results.

CONCLUSION(S)

The diagnostic accuracy of ML with air-drying showed the maximum diagnostic accuracy of 88.34%, followed by VE with air-drying at 87.5%. Drying the tooth surface can bring the diagnostic accuracy of unaided VE at par with that of ML-aided VE. Therefore, it is recommended that in resource constrained settings, when detecting smooth surface early caries (both occlusal and proximal), the tooth should be dried using any mechanical or automatic device, followed by unaided VE. In cases where air-drying tools are unavailable, the reliability of unaided VE is compromised, making ML-aided VE a recommended alternative. The present study emphasises the significance of early smooth surface caries detection, particularly in resource-limited settings, and highlights the effectiveness of basic techniques in improving diagnostic accuracy when advanced tools are not accessible.

REFERENCES

[1] Petersen P, Bourgeois D, Ogawa H, Estupinan-Day S, Andv C. The global burden of oral diseases and risks to oral health. Bulletin of the World Health Organization. 2005;83(9):661-69.
[2] Mejare L, Stenlund L, Zelezny-Holmlund C. Caries incidence and lesion progression from adolescence to young adulthood: A prospective 15-year cohort study in Sweden. Car Res. 2004;38(2):130-41.
[3] Featherstone BD. Dental caries: A dynamic disease process. Aus Dent J. 2008;53(3):286-91.
[4] Fejerskov O, Kidd E. Dental caries: The disease and its clinical management, chapter 4, Blackwell Munksgaard, Copenhagen, Denmark, 2nd edition, 2008.
[5] Bader JD, Shugars DA. A systematic review of the performance of a laser fluorescence device for detecting caries. J Am Dent Assoc. 2004;135:1414-26.
[6] Sheehy EC, Brailford SR, Kidd EAM, Beighton D, Zoitopoulos L. Comparison between visual examination and a laser fluorescence system for in-vivo diagnosis of occlusal caries. Caries Res. 2001;35:421-26.
[7] Rodrigues JA, Diniz MB, Josgrilberg E, Cordeiro RCL. In-vitro comparison of laser fluorescence performance with visual examination for detection of occlusal caries in permanent and primary molars. Caries Res. 2011;45(5):221-26.
[8] Choo-Smith LP, Dong CCS, Cleghorn B, Hewko M. Shedding new light on early caries detection. J of the Can Dent Assoc. 2008;74(10):913-18.
[9] Angmar-Mansson B. How to measure the effects of fluoride treatments in clinical trials? Assessment: Modern versus traditional methods. Car Res. 2001;35(1):30-33.
[10] Pretty A. Caries detection and diagnosis: novel technologies. J of Den. 2006;34(10):727-39.
[11] Selwitz RH, Ismail A, Pitts NB. Dental caries. The Lancet. 2007;369(9555):51-59.
[12] Ari T, Ari N. The performance of ICDAS-II using low-powered magnification with light-emitting diode headlight and alternating current impedance spectroscopy device for detection of occlusal caries on primary molars. ISRN Dentistry. 2013;21(3):01-05.
[13] Wilde S, De Campos P, Marcondes A, Moura-Netto C, Novaes T, Lussi A, et al. Optical magnification has no benefits on the detection of occlusal caries lesions in permanent molars using different visual scoring systems: An in-vitro study. J Clin Exp Dent. 2020;38(2):e479-87.
[14] Hibst R, Paulus R, Lussi A. Detection of occlusal caries by laser fluorescence: Basic and clinical investigations. Med Laser Appl. 2001;16:205-13.
[15] Mendes FM, de Oliveira E, de Faria DL, Nicolau J. Ability of laser fluorescence device associated with fluorescent dyes in detecting and quantifying early smooth surface caries lesions. J Biomed Opt. 2006;11(2):24007.
[16] Mendes FM, Hissadomi M, Imparato JC. Effects of drying time and the presence of plaque on the in-vitro performance of laser fluorescence in occlusal caries of primary teeth. Caries Res. 2004;38(2):104-08.
[17] Lussi A, Hack A, Hug I, Heckenberger H, Megert B, Stich H. Detection of approximal caries with a new laser fluorescence device. Caries Res. 2006;40(2):97-103.
[18] Nyvad B, Machiulskiene V, Baelum V. Reliability of a new caries diagnostic system differentiating between active and inactive caries lesions. Caries Res. 1999;33(4):252-60.
[19] Braga MM, Mendes FM, Martignon S, Ricketts DNJ, Ekstrand KR. In-vitro Comparison of Nyvad's system and ICDAS-II with lesion activity assessment for evaluation of severity and activity of occlusal caries lesions in primary teeth. Caries Res. 2009;43(5):405-12.
[20] Yang J, Dutra V. Utility of radiology, laser fluorescence, and trans-illumination. Dent Clin North Am. 2005;49(4):739-52.
[21] Shoaib L, Deery C, Ricketts D, Nugent Z. Validity and reproducibility of ICDAS II in primary teeth. Car Res. 2009;43(6):442-48.
[22] Bloom BS, Banta HD, Gross PF, Peña-Mohr J, Sisk JE, Stocking B. The Swedish council on technology assessment in health care. Int J Technol Assess Health Care. 1989;5(1):154-58. Doi: 10.1017/s0266462300006061. PMID: 10292538.
[23] Bader JD, Shugars DA, Bonito AJ. Systematic reviews of selected dental caries diagnostic and management methods. J of Den Educa. 2001;65(10):960-68.
[24] Braga MM, Mendes FM, Imparato JC, Rodrigues CR. Effect of cut-off points on performance of laser fluorescence for detecting occlusal caries. J Clin Pediatr Dent. 2007;32(1):33-36.
[25] Diniz MB, Rodrigues JA, Hug I, De Cássia Loiola Cordeiro R, Lussi A. Reproducibility and accuracy of the ICDAS-II for occlusal caries detection. Community Dent Oral Epidemiol. 2009;37(5):399-404.
[26] Mitropoulos P, Rahiotis C, Kakaboura A, Vougiouklakis G. The impact of magnification on occlusal caries diagnosis with implementation of the ICDAS II criteria. Caries Res. 2012;46(1):82-86. Doi: 10.1159/000335988.
[27] Teo TKY, Ashley PF, Louca C. An in-vivo and in-vitro investigation of the use of ICDAS, DIAGNOdent pen and CarieScan Pro for the detection and assessment of occlusal caries in primary molar teeth. Car Res. 2015;33(5):152-59.
[28] Gupta N, Sandhu M. Comparison of visual examination and magnification with DIAGNOdent for detection of smooth surface initial carious lesion-dry and wet conditions. Int J Clin Pediatr Dent. 2019;12(1):37-41.
[29] Bahramian H, Argani P, Baghalian A. Comparison of different diagnostic techniques in detecting smooth surface caries in primary molars using the histological gold standard: An in vitro study. Photodiagnosis and Photodyn Ther. 2020;31:259-64.

PARTICULARS OF CONTRIBUTORS:
1. Postgraduate Trainee, Department of Pedodontics, Dr. R. Ahmed Dental College and Hospital, Kolkata, West Bengal, India.
2. Associate Professor, Department of Pedodontics, Dr. R. Ahmed Dental College and Hospital, Kolkata, West Bengal, India.
3. Assistant Professor, Department of Oral Medicine and Radiology, North Bengal Dental College and Hospital, Siliguri, West Bengal, India. **(Orcid- 0000-0003-2131-1126)**
4. Associate Professor, Department of Dentistry, Burdwan Medical College and Hospital, Burdwan, West Bengal, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Shiladitya Sil,
Assistant Professor, Department of Oral Medicine and Radiology,
North Bengal Dental College and Hospital, Sushrutanagar, Siliguri,
Darjeeling-734012, West Bengal, India.
E-mail: shiladitya.sil@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Aug 12, 2023
- Manual Googling: Oct 28, 2023
- iThenticate Software: Nov 17, 2023 (10%)

ETYMOLOGY: Author Origin

EMENDATIONS: 7

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: **Aug 12, 2023**
Date of Peer Review: **Oct 14, 2023**
Date of Acceptance: **Nov 20, 2023**
Date of Publishing: **Jan 01, 2024**