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Inter examiner reproducibility in the detection of occlusal caries using international caries detection and assessment system (ICDAS) II by unaided visual and enhanced visual examination - An in vivo study

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Abstract
ICDAS is a clinical coding system for caries detection. The detection of exact status of the carious lesions is often challenging since it holds the key in drawing out a treatment plan for its prevention and management. The objective of the study is to assess the Inter Examiner reproducibility in the Detection of Occlusal Caries using ICDAS II by Unaided Visual and Enhanced Visual Examination.
Methods: This observational study assessed 80 occlusal surfaces of human molars. Two primary examiners and other 4 examiners independently scored occlusal caries status using ICDAS II 0,1,2 criteria without magnification and under 3x magnification using operating microscope. Kappa statistics was performed
Results: In the current study, inter examiner agreement was good to fair and has acceptable reproducibility with or without magnification using ICDAS II criteria.
Conclusions: Reliability and validity of ICDAS scoring in detecting occlusal caries under magnification did not differ from clinical visual inspection.

Keywords: ICDAS–II coding, Magnification, Occlusal caries, Visual examination

Introduction
The International caries Detection & Assessment system (ICDAS) has presented a new paradigm for the measurement of dental caries, which was developed from the systematic reviews of literature on the clinical caries detection system & other sources. The detection of exact status of the carious lesions is often challenging since it holds the key in drawing out a treatment plan for its prevention and management. Reproducibility & accuracy of ICDAS II have already shown to be promising in the detection of occlusal caries [1, 9]. However, Inter Examiner reproducibility showed fair agreement in the detection of ICDAS II in the previously reported in vitro studies [2].
Other methods which can be employed in diagnosing caries includes radiographs, laser, light fluorescence-based methods. The recent methods that are used for detection of caries include intra oral camera, loupes & surgical operating microscope [2]. The International Caries Detection and Assessment System (ICDAS), was found by an international group of researchers in 2002. The main aim for designing this system was to detect caries at various stages of caries progression thereby enhancing the application of preventive and minimal invasive management protocols.
Based on the examination of occlusal caries using ICDAS II as the scoring criteria revealed that evaluation of caries was carried out by means of unaided vision. Thus in this study of ICDAS II, coding of the samples were carried out using magnification (operating microscope) [3]. An online search reveals lot of in vitro studies comparing the inter examiner reproducibility in detection of codes 0, 1, 2 ICDAS under visual & enhanced visual examination. However, there are very few in vivo studies comparing this aspect.

Methodology
This was a observational, in vivo study conducted in the Department of Conservative Dentistry

and Endodontics, Indira Gandhi Institute of Dental Sciences, Puducherry Ethical clearance was obtained from Institutional Review Board and Institutional Ethical Clearance Board. Occlusal surface of 80 molars were observed both under direct visual and enhanced visual examination by operating microscope. The samples were examined under operating microscope with maximum magnification (3X). The focal length and eye piece power were standardized. The sample size 80, was calculated based on the study done by Jablonski-Momeni *et al*. [2]

80 occlusal surfaces of unrestored and non-cavitated caries on molars were observed from patients aged between 18-30 were categorized based on ICDAS-II (code 0,1,2). Fractured tooth, developmental deformities, tooth with pits and fissure sealant, enamel hypoplasia were excluded from the study. Informed consent was obtained from the patients before procedure.

The first visual examination of the teeth was done by Examiner 1 and examiner 2 using ICDAS-II (code 0,1,2). The teeth to be observed were cleaned with pumice and water. The examination is carried out using mouth mirror, ball-ended probe, three-way syringe and cotton pellets. Other 4 examiners, who were trained in detecting caries by direct visual and enhanced visual examination by operating microscope, scored the caries based on ICDAS II (0,1,2).

Statistical analysis

Interexaminer reproducibility were calculated using weighted kappa test. The entire analysis is carried out using IBM SPSS 19.0 version and results are compared at 0.05 level of significance.

Kappa values less than 0.00 indicate poor agreement, values between 0.00 and 0.20 indicate slight agreement, values between 0.21 and 0.40 indicate fair agreement, values between 0.41 and 0.60 indicate moderate agreement, values between 0.61 and 0.80 indicate substantial agreement, and values between 0.81 and 1.00 indicate almost-perfect agreement [6].

Results

Maximum amount of agreement is present between the 2 primary examiners. Their values were taken as baseline values. Other 4 examiners agreement were compared with 2 primary examiners results.

First six table correspond to the agreement levels between the four examiners under direct visual examination method and next six tables relate to enhanced visual examination by operating microscope method.

Under direct method, it is noticed that there is good extent of agreement between pair of observers Examiner 3& 4; Examiner 4 & 5 and Examiner 3 & 5, whereas the rest of the pairs of observers do have good amount of agreement between them in detecting the caries. In other words, the agreement level between Examiner 3 and 4 may be interpreted as: the knowledge levels in assessing the caries in direct method is almost similar between Examiner 3 & Examiner 4, thus resulting to the same set of outcomes.

Under indirect method, it is noticed that there is good extent of agreement between pair of observers Examiner 3 & 4; 3& 5 and 4 & 5, whereas the rest of the pairs of observers do have good amount of agreement between them in detecting the caries. In other words, the agreement level between Examiner 3 and 4 may be interpreted as: the knowledge levels in assessing the caries in indirect method is almost similar between Examiner 3 and 4, thus resulting to the same set of outcomes. Similar interpretation can be drawn for the rest two significant inter observer pairs. Table 1-6 shows the Direct visual method results and Table 7-12 shows enhanced visual examination methods.

Discussion

The diagnosis of caries is unique in that it is lacking the hypothetico deductive reasoning Rather it is based on experiences of an individual, hence forming a caries script for cases encountered in the future. This highlights the subjective nature of occlusal caries detection. In order to reduce interpretational bias, many visual indices were developed. The unaided implementation of ICDAS–II in various studies have led to diverging scientific data on reproducibility [6].

Drawback with ICDAS I is that it is a subjective classification which has variability among examiners. Later, the criteria were modified and ICDAS II was created. It identifies carious lesions by the change in colour, texture and surface integrity.

Interobserver agreement between unaided visual examination and examination with the operating microscope was substantial for all observers. This indicates good reproducibility in the diagnosis of occlusal caries by both techniques. It is noteworthy that although the observers were not routinely using the operating microscope for detection of caries, they were familiar with using this equipment for in vitro examinations and had been trained in its use for in vivo examinations [6]

The difference in results between some examiners reported here could be related to experimental design, magnification level and observers' experience in using the microscope.

Unaided visual examination is routinely used for detecting caries in dental clinics and was also used in recent studies comparing the efficacy of various visual aids that provide magnification. Our study assessed the reproducibility and agreement of the clinical examination using unaided visual examination and an operating microscope at 16× magnification level.

The operating microscope provides a range of magnification from 2× to 20×. In the current study, only 3× magnification was used. Further research is required to evaluate the suitability of different magnification levels for detecting occlusal caries in vivo. In a previous study, no significant difference was reported between 8× and 16× magnification for detection of occlusal caries with an operating microscope.

This assessment of the use of an operating microscope in diagnosing occlusal caries in clinical settings is important to establish the utility of this non-invasive technique. Advantages of the operating microscope are homogeneous illumination and a 3-dimensional view, which together provide clear visualization of the examination site. However, further research is required before this technique can be widely adopted for clinical diagnosis of caries on occlusal surfaces [6].

Table 1: shows the coding criteria in ICDAS II. [8]

ICDAS II codes	ICDAS II criteria
0	Sound
1	First visual changes in enamel. (After prolonged air drying (approximately 5 seconds)
2	Distinct visual changes in enamel (The tooth must be viewed wet)
3	Localized enamel breakdown due to caries with no visible dentine (Once dried for approximately 5 seconds there is carious loss of tooth structure at the entrance to, or within, the pit or fissure/fossa)
4	Underlying dark shadow from dentine ± localized enamel breakdown.
5	Distinct cavity with visible dentin.
6	Extensive distinct cavity with visible dentine and more than half of the surface involved.

Table 2-7: Direct visual Method Results

Table 2:

			Examiner 4			Total
			0	1	2	
Examiner 3	0	Count	8	0	0	8
		% within Jasmine	100.0%	.0%	.0%	100.0%
		% within Chandana	100.0%	.0%	.0%	10.0%
	1	Count	0	30	0	30
		% within Jasmine	.0%	100.0%	.0%	100.0%
		% within Chandana	.0%	83.3%	.0%	37.5%
	2	Count	0	6	36	42
		% within Jasmine	.0%	14.3%	85.7%	100.0%
		% within Chandana	.0%	16.7%	100.0%	52.5%
Total		Count	8	36	36	80
		% within Jasmine	10.0%	45.0%	45.0%	100.0%
		% within Chandana	100.0%	100.0%	100.0%	100.0%
Kappa value = 0.872; p-value=0.035*						

Table 3:

			Examiner 6			Total
			0	1	2	
Examiner 3	0	Count	3	2	3	8
		% within Jasmine	37.5%	25.0%	37.5%	100.0%
		% within Nandhini	33.3%	4.3%	12.0%	10.0%
	1	Count	4	20	6	30
		% within Jasmine	13.3%	66.7%	20.0%	100.0%
		% within Nandhini	44.4%	43.5%	24.0%	37.5%
	2	Count	2	24	16	42
		% within Jasmine	4.8%	57.1%	38.1%	100.0%
		% within Nandhini	22.2%	52.2%	64.0%	52.5%
Total		Count	9	46	25	80
		% within Jasmine	11.3%	57.5%	31.3%	100.0%
		% within Nandhini	100.0%	100.0%	100.0%	100.0%
Kappa value = 0.159; p-value=0.087^{NS}						

Table 4:

			Examiner 5			Total
			0	1	2	
Examiner 3	0	Count	5	1	2	8
		% within Jasmine	62.5%	12.5%	25.0%	100.0%
		% within Prabhu	71.4%	3.2%	4.8%	10.0%
	1	Count	2	22	6	30
		% within Jasmine	6.7%	73.3%	20.0%	100.0%
		% within Prabhu	28.6%	71.0%	14.3%	37.5%
	2	Count	0	8	34	42
		% within Jasmine	.0%	19.0%	81.0%	100.0%
		% within Prabhu	.0%	25.8%	81.0%	52.5%
Total		Count	7	31	42	80
		% within Jasmine	8.8%	38.8%	52.5%	100.0%
		% within Prabhu	100.0%	100.0%	100.0%	100.0%
Kappa value = 0.584; p-value=0.001^{NS}						

Table 5:

			Examiner 6			Total
			0	1	2	
Examiner 4	0	Count	3	2	3	8
		% within Chandana	37.5%	25.0%	37.5%	100.0%
		% within Nandhini	33.3%	4.3%	12.0%	10.0%
	1	Count	4	24	8	36
		% within Chandana	11.1%	66.7%	22.2%	100.0%
		% within Nandhini	44.4%	52.2%	32.0%	45.0%
	2	Count	2	20	14	36
		% within Chandana	5.6%	55.6%	38.9%	100.0%
		% within Nandhini	22.2%	43.5%	56.0%	45.0%
Total		Count	9	46	25	80
		% within Chandana	11.3%	57.5%	31.3%	100.0%
		% within Nandhini	100.0%	100.0%	100.0%	100.0%
Kappa value = 0.173; p-value=0.091^{NS}						

Table 6:

			Examiner 5			Total
			0	1	2	
Examiner 6	0	Count	2	5	2	9
		% within Nandhini	22.2%	55.6%	22.2%	100.0%
		% within Prabhu	28.6%	16.1%	4.8%	11.3%
	1	Count	2	23	21	46
		% within Nandhini	4.3%	50.0%	45.7%	100.0%
		% within Prabhu	28.6%	74.2%	50.0%	57.5%
	2	Count	3	3	19	25
		% within Nandhini	12.0%	12.0%	76.0%	100.0%
		% within Prabhu	42.9%	9.7%	45.2%	31.3%
Total		Count	7	31	42	80
		% within Nandhini	8.8%	38.8%	52.5%	100.0%
		% within Prabhu	100.0%	100.0%	100.0%	100.0%
Kappa value = 0.254; p-value=0.083^{NS}						

Table 7:

			Examiner 5			Total
			0	1	2	
Examiner 4	0	Count	5	1	2	8
		% within Chandana	62.5%	12.5%	25.0%	100.0%
		% within Prabhu	71.4%	3.2%	4.8%	10.0%
	1	Count	2	25	9	30
		% within Chandana	5.6%	69.4%	25.0%	100.0%
		% within Prabhu	28.6%	80.6%	21.4%	37.5%
	2	Count	0	5	31	42
		% within Chandana	.0%	13.9%	86.1%	100.0%
		% within Prabhu	.0%	16.1%	73.8%	52.5%
Total		Count	7	31	42	80
		% within Chandana	8.8%	38.8%	52.5%	100.0%
		% within Prabhu	100.0%	100.0%	100.0%	100.0%
Kappa value = 0.591; p-value=0.000*						

Table 8-13: Enhanced visual examination Method results

Table 8:

			Examiner 4			Total
			0	1	2	
Examiner 3	0	Count	13	1	0	14
		% within Jasmine	92.9%	7.1%	.0%	100.0%
		% within Chandana	86.7%	3.4%	.0%	17.5%
	1	Count	2	23	0	25
		% within Jasmine	8.0%	92.0%	.0%	100.0%
		% within Chandana	13.3%	79.3%	.0%	31.3%
	2	Count	0	5	36	41
		% within Jasmine	.0%	12.2%	87.8%	100.0%
		% within Chandana	.0%	17.2%	100.0%	51.3%
Total		Count	15	29	36	80
		% within Jasmine	18.8%	36.3%	45.0%	100.0%
		% within Chandana	100.0%	100.0%	100.0%	100.0%
Kappa value = 0.840;p-value=0.000*						

Table 9:

			Examiner 6			Total
			0	1	2	
Examiner 3	0	Count	4	6	4	14
		% within Jasmine	28.6%	42.9%	28.6%	100.0%
		% within Nandhini	44.4%	13.0%	16.0%	17.5%
	1	Count	3	16	6	25
		% within Jasmine	12.0%	64.0%	24.0%	100.0%
		% within Nandhini	33.3%	34.8%	24.0%	31.3%
	2	Count	2	24	15	41
		% within Jasmine	4.9%	58.5%	36.6%	100.0%
		% within Nandhini	22.2%	52.2%	60.0%	51.3%
Total		Count	9	46	25	80
		% within Jasmine	11.3%	57.5%	31.3%	100.0%
		% within Nandhini	100.0%	100.0%	100.0%	100.0%
Kappa value = 0.122 ; p-value = 0.082^{NS}						

Table 10:

			Examiner 5			Total
			0	1	2	
Examiner 3	0	Count	9	5	0	14
		% within Jasmine	64.3%	35.7%	.0%	100.0%
		% within Prabhu	90.0%	15.2%	.0%	17.5%
	1	Count	1	20	4	25
		% within Jasmine	4.0%	80.0%	16.0%	100.0%
		% within Prabhu	10.0%	60.6%	10.8%	31.3%
	2	Count	0	8	33	41
		% within Jasmine	.0%	19.5%	80.5%	100.0%
		% within Prabhu	.0%	24.2%	89.2%	51.3%
Total		Count	10	33	37	80
		% within Jasmine	12.5%	41.3%	46.3%	100.0%
		% within Prabhu	100.0%	100.0%	100.0%	100.0%
Kappa value = 0.632;p-value = 0.000*						

Table 11:

			Examiner 6			Total
			0	1	2	
Examiner 4	0	Count	4	7	4	15
		% within Chandana	26.7%	46.7%	26.7%	100.0%
		% within Nandhini	44.4%	15.2%	16.0%	18.8%
	1	Count	3	18	8	29
		% within Chandana	10.3%	62.1%	27.6%	100.0%
		% within Nandhini	33.3%	39.1%	32.0%	36.3%
	2	Count	2	21	13	36
		% within Chandana	5.6%	58.3%	36.1%	100.0%
		% within Nandhini	22.2%	45.7%	52.0%	45.0%
Total		Count	9	46	25	80
		% within Chandana	11.3%	57.5%	31.3%	100.0%
		% within Nandhini	100.0%	100.0%	100.0%	100.0%
Kappa value =0.107;p-value = 0.176^{NS}						

Table 12:

			Examiner 5			Total
			0	1	2	
Examiner 4	0	Count	9	6	0	15
		% within Chandana	60.0%	40.0%	.0%	100.0%
		% within Prabhu	90.0%	18.2%	.0%	18.8%
	1	Count	1	22	6	29
		% within Chandana	3.4%	75.9%	20.7%	100.0%
		% within Prabhu	10.0%	66.7%	16.2%	36.3%
	2	Count	0	5	31	36
		% within Chandana	.0%	13.9%	86.1%	100.0%
		% within Prabhu	.0%	15.2%	83.8%	45.0%
Total		Count	10	33	37	80
		% within Chandana	12.5%	41.3%	46.3%	100.0%
		% within Prabhu	100.0%	100.0%	100.0%	100.0%
Kappa value = 0.636 ; p-value= 0.000*						

Table 13:

			Examiner 5			Total
			0	1	2	
Examiner 6	0	Count	2	6	1	9
		% within Nandhini	22.2%	66.7%	11.1%	100.0%
		% within Prabhu	20.0%	18.2%	2.7%	11.3%
	1	Count	5	21	20	46
		% within Nandhini	10.9%	45.7%	43.5%	100.0%
		% within Prabhu	50.0%	63.6%	54.1%	57.5%
	2	Count	3	6	16	25
		% within Nandhini	12.0%	24.0%	64.0%	100.0%
		% within Prabhu	30.0%	18.2%	43.2%	31.3%
Total		Count	10	33	37	80
		% within Nandhini	12.5%	41.3%	46.3%	100.0%
		% within Prabhu	100.0%	100.0%	100.0%	100.0%
Kappa value = 0.152; p-value = 0.069^{NS}						

Conclusion

Within the limitations of this study it can be concluded that ICDAS II is a reliable, reproducible and valid diagnostic aid. In the current study, inter examiner agreement was good to fair for ICDAS 0, 1, 2 irrespective of magnification or not. Inference can be made that ICDAS II has acceptable reproducibility with or without magnification.

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