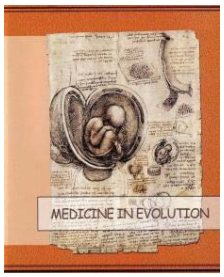
Step by step baseline calibration in ICDAS: an in vitro study



Funieru C.[1], Vişoiu A.[2], Oancea R.[3*], Cărămidă M.[4], Sfeatcu R.[4]

[1]*Preventive Dentistry Department, Faculty of Dental Medicine, "Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania*
[2]*"Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania (student)*
[3]*Preventive Dentistry, Community and Oral Health Department, Faculty of Dental Medicine, "Victor Babeş" University of Medicine and Pharmacy, Timişoara, Romania*
[4]*Oral Health and Community Dentistry Department, Faculty of Dental Medicine, "Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania*

Correspondence to:
Name: Roxana Oancea
Address: Preventive, Community Dentistry and Oral Health Department, Splaiul Tudor Vladimirescu no. 14A, Timişoara, Romania
Phone: +40 721335788
E-mail address: roancea@umft.ro

Abstract

The ICDAS II represents an algorithm developed for assessing stages of caries. It becomes the main "instrument" used in epidemiological study of dental caries. All the examiners should be trained and calibrated to use correctly the ICDAS II clinical criteria before the study begins. This study presents step by step ICDAS II calibration process for the detection of occlusal caries (in vitro phase). 40 occlusal areas from 9 lateral teeth were examined in this experiment. The occlusal areas were assessed according to ICDAS II criteria and they were selected by one experienced examiner to present only scores between o and 4. Every area was also tested using DIAGNOdent Pen device, considering this evaluation as a "golden standard". The inter-rater agreement (kappa) for the examiner to be calibrated was calculated using MedCalc® software and it was found to be 0.68. According to the weight kappa main scale the kappa value found in this study is considered to be good but for a principal investigator, it is recommended to have a higher value before the clinical study begins.

Keywords: calibration, ICDAS, DIAGNOdent Pen, golden standard

INTRODUCTION

The ICDAS II represents a set of clinical criteria developed in order to make the correspondence between different stages of caries evolution and variable numbers (7 scores, from 0 to 6). ICDAS II becomes today a valuable and mandatory instrument for every clinical study of dental caries. It could be also very useful to teach students for improving their clinical diagnosis skills, especially for better understanding of early stages of dental caries [1].

Every investigator must be well trained and calibrated before taking part in a study. The calibration has two stages: the in vitro and the clinical phases [2]. The in vitro calibration process requires extracted teeth with various caries lesions and restorations. The examinations must be focused on occlusal, smooth or proximal surfaces, together or separately. The teeth can be examined separately or in a dental arch model [3].

The in vitro calibration process for the proximal caries lesions can be realised only in a special arch model when the interdental contact areas are present. For a high accuracy of carious detection a very good calibration process is needed (inter-rater agreement – *kappa* must be "very good", according to Altman [4]).

Another important device for caries detection is DIAGNOdent Pen that uses laser fluorescence technology and provides reliable results in caries detection.

This study presents a step by step algorithm for the in vitro calibration of using ICDAS II in occlusal caries detection, considering DIAGNOdent method as a "golden standard".

MATERIAL AND METHODS

9 extracted teeth (3 premolars and 6 molars) were used in this experiment, two of them being filled with resin. The teeth were cleaned with an ultrasonic scaler. Therefore, all the remains of the periodontal tissue, calculus deposits or staining were removed. Afterward, the teeth were immersed in a sodium hypochlorite solution for 10 minutes. A DIAGNOdent pen device (KaVo Dental GmbH, Bismarckring, Wiesbaden, Germany), air drying from a dental unit and a plastic container with deionized water were also used for this experiment.

The occlusal surfaces of the teeth were observed and analysed by one experienced examiner (no. 1) using the ICDAS II clinical criteria (table I) (no magnification). A total of 40 occlusal areas (between 3 and 6 for each tooth) were chosen by the examiner in order to have ICDAS scores between 0 and 4. Afterward, the examiner who requires calibration (no. 2) analysed every area using both ICDAS II criteria and DIAGNOdent Pen device (figure nr.1, a and b). The diagnostic validity for using ICDAS II criteria reported to values obtained using DIAGNOdent Pen device for the examiner no. 2 was calculated as follow:

- ICDASII scores were transform into simplified merged scores and compared with values measured with DIAGNOdent Pen (see table II)
- inter-rater agreement (kappa) was calculated using 19.4.1 demo version of MedCalc® software; the value of kappa coefficient were assigned according to Altman [4] (see table III)

Table I. Clinical criteria for the ICDAS II

ICDAS II codes and criteria for occlusal surfaces	
Codes	Description
0	*Sound surfaces*: No evidence of caries after 5 seconds air drying; surfaces with signs of tooth wear, fluorosis or structural defects are also assessed as sounds
1	*First visual change in enamel*: a) No evidence of caries when seen wet, but after prolonged air drying for at least 5 seconds a carious opacity/discoloration (white/brown) can be seen b) Carious opacity/discoloration when seen wet, but after 5 seconds of air drying the enamel lesion becomes more clear but not exceed the pit and fissure area
2	*Distinct visual change in enamel*: Carious opacity / discoloration wider than the natural fissure/fossa and

ICDAS II codes and criteria for occlusal surfaces	
Codes	Description
	visible when seen wet or dry
3	*Localized enamel breakdown*: Visually evidence of enamel demineralization when seen dry → loss of tooth structure / cavity with no evidence of dentine involvement
4	*Underlying dark shadow from dentine*: A shadow of discoloured dentine more visible through enamel when seen wet; the enamel breakdown can be or can be not present: there are no sign of direct visible dentine
5	*Distinct cavity with visible dentine*: The presence of dentine in the cavity is obvious; the cavity is no larger than ½ of the surface; there are no signs of pulp chamber opening
6	*Extensive distinct cavity with visible dentine*: The cavity is wider than ½ of the surface; the presence of dentine is obvious and the pulp chamber roof can be opened

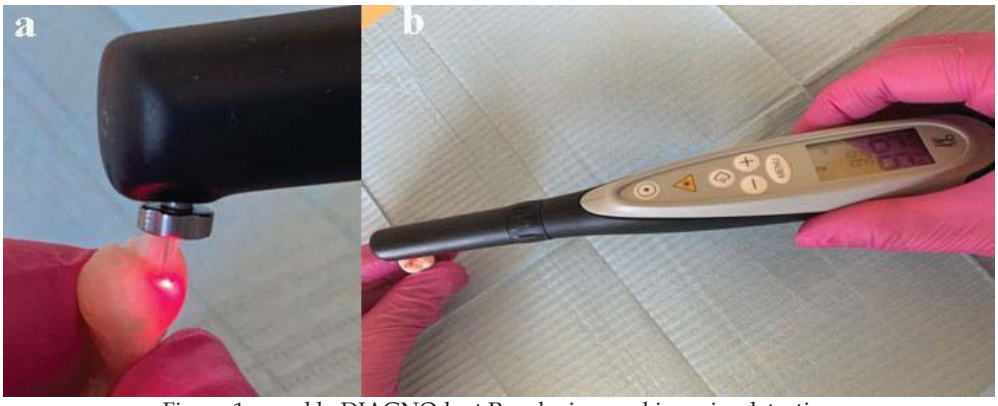


Figure 1. a and b: DIAGNOdent Pen device used in caries detection

Table II. Correspondence between ICDAS II caries codes and merged codes

ICDAS II caries codes	Merged scores	Values measured with DIAGNOdent Pen
0	0 (sound)	0 – 12 (sound)
1,2	1 (initial stage decay)	13 – 24 (initial stage decay)
3,4	2 (moderate decay)	> 25 (deep demineralization)
5,6	3 (extensive decay)	

Table III. Kappa values according to Altman 1991 [4]

Weight kappa	Strength of agreement
< 0.20	Poor
0.21 – 0.40	Fair
0.41 – 0.60	Moderate
0.61 – 0.80	Good
0.81 – 1.00	Very good

RESULTS

Calibration step 1: Mark and examine all the areas included in the study. The occlusal areas examined in this experiment are shown in the figure 2.

Calibration step 2: Assess all the areas according to ICDAS II clinical criteria. The scores detected in this experiment are graphically exposed in the figure 3.

Calibration step 3: Transform all the ICDAS scores into merge simplified scores (according to criteria presented in the table III).

Calibration step 4: Re-examine all the selected areas using the DIAGNOdent Pen device. In this experiment we found: 13 sound areas, 6 early caries and 21 cavity caries (deep demineralisation). All the results found with the DIAGNOdent Pen correspond to the values detected from the experienced examiner (no. 1) using ICDAS II criteria but one, according to correspondence criteria (table III).

Calibration step 5: The inter-rater agreement (kappa) of using ICDAS II criteria was calculated using MedCalc® software considering values collected with DIAGNOdent Pen as "golden standard". *The value of kappa for the examiner no. 2 was 0.68*, which means "good".

Calibration step 6: In case of epidemiological studies, if kappa < 0.80 than choose other occlusal areas and/or other teeth and go to step 1.

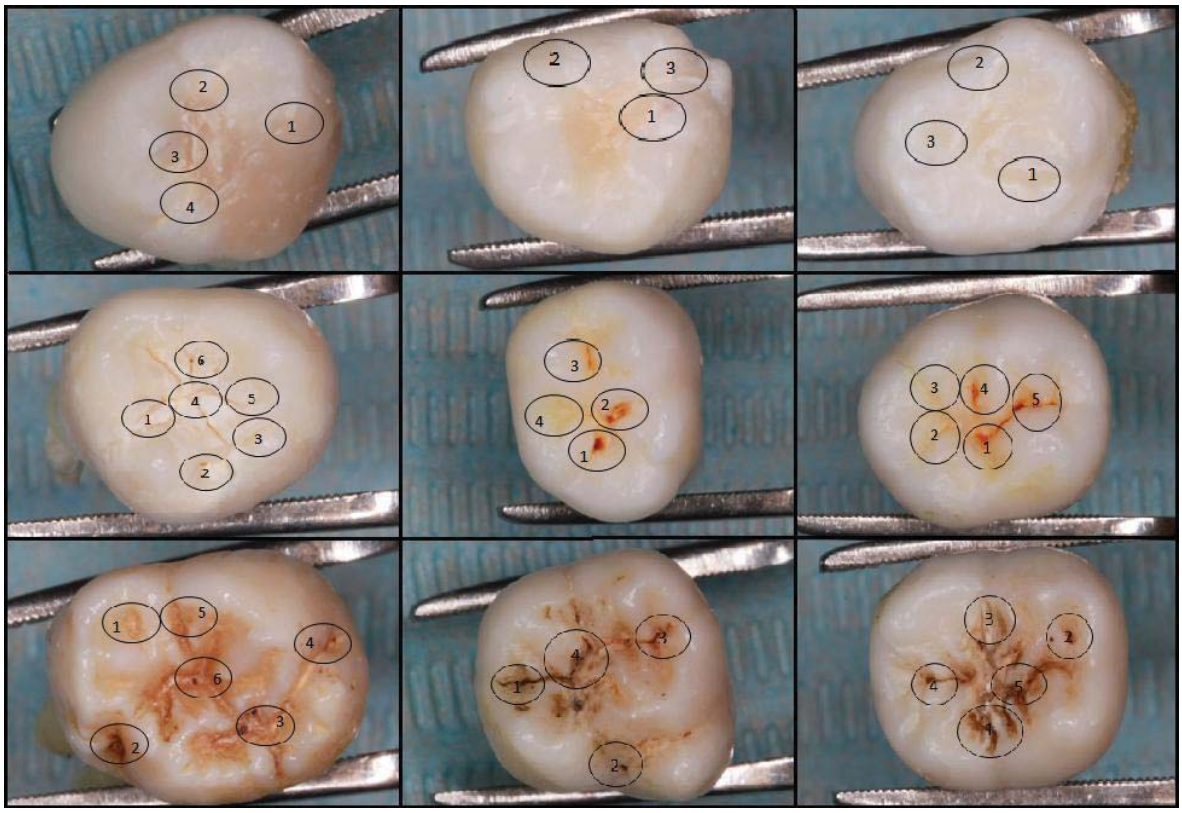


Figure 2. The 9 occlusal surfaces containing all the 40 areas examined in this experiment

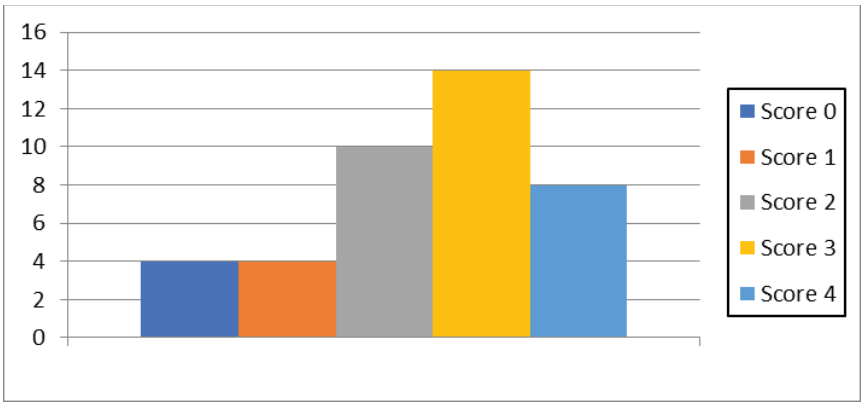


Figure 3. Number of ICDAS II scores detected in all the 40 areas examined in this experiment

DISCUSSION

This experiment presents a step by step in vitro calibration algorithm for the occlusal caries detection using ICDAS II criteria. However, this is only the first stage of calibration because for a complete process at least one clinical stage is needed. The kappa value resulted from this study was 0.68, which means a good value according to Altman [4]. However, for

accurate results in caries detection an examiner needs to be very well trained and calibrated and have a high value of kappa.

If the examiner will face an epidemiological study which involves dental caries, the calibration process can be repeated several times until a value of kappa over the 0.80 will be achieved. The rationale of our experiment was to calibrate an inexperienced examiner (no. 2) for using the ICDAS using the DIAGNOdent Pen caries detection method as a "golden standard". We did not intend to compare the ICDAS scores obtained by the novice examiner (no. 2) with the ICDAS scores of the experienced examiner (no. 1).

However, the ICDAS scores of the experienced examiner were almost the same with the results obtained using DIAGNOdent Pen device, which means that using the DIAGNOdent Pen method as "golden standard" was a good calibration method in this experiment. However, while in clinical stage of calibration at least one experienced examiner is needed, for the in vitro process some authors recommend using histological images [3] or Ekstrand and Lussi histological scores as "golden standard" [5].

On the other hand, it seems that the DIAGNOdent Pen is a very good and accurate method for caries detection only for caries with no visible dentine (0 to 4 ICDAS scores) [6]. This was the reason why the teeth and the occlusal areas were specially chosen by the experienced examiner to have only ICDAS scores from 0 to 4.

However, many authors suggest a long time training and practicing in ICDAS caries detection. This could increase the examiners' performance and help them to develop their skills and improve their accuracy in caries detection [7].

CONCLUSIONS

The DIAGNOdent Pen method can be used as "golden standard" in the in vitro phase of the ICDAS calibration process, especially for the caries with no visible dentine (o to 4 scores).

REFERENCES

1. El-Damanhoury HM, Fakhruddin KS, Awad MA. Effectiveness of teaching International Caries Detection and Assessment System II and its e-learning program to freshman dental students on occlusal caries detection. Eur J Dent, 2014;8(4):493-497
2. Funieru C. Sistemul ICDAS II de evaluare a cariei dentare. Nou ghid practic, Ediția a doua. Editura Pim, Bucharest, 2018; pp 57-63
3. Piovesan C, Moro BL, Lara JS, Ardenghi TM, Guedes RS, Haddad AE, Braga MM, Mendes FM. Laboratorial training of examiners for using a visual caries detection system in epidemiological surveys. BMC Oral Health, 2013;13:49
4. Altman DG. Practical statistics for medical research. London: Chapman and Hall, 1991; pp 1-611
5. Gugnani N, Pandit IK, Srivastava N, Gupta M, Sharma M. International Caries Detection and Assessment System (ICDAS): A New Concept. Int J Clin Pediatr Dent, 2011;4(2):93-100
6. Luczaj-Cepowicz E, Marczuk-Kolada G, Obidzinska M, Sidun J. Diagnostic validity of the use of ICDAS II and DIAGNOdent pen verified by micro-computed tomography for the detection of occlusal caries lesions—an in vitro evaluation. Lasers in Medical Science, 2019;34:1655–1663
7. Rodrigues JA, de Oliveira RS, Hug I, Neuhaus K, Lussi A. Performance of experienced dentists in Switzerland after an e-learning program on ICDAS occlusal caries detection. J Dent Educ, 2013;77(8):1086-1091